AN ABSTRACT OF THE DISSERTATION OF

Monica L. Hunsberger for the degree of Doctor of Philosophy in Public Health presented on March 2, 2007.
Title: An Assessment of Risk Factors for Gestational Diabetes Mellitus (GDM) and Provider Practices for Post-GDM Care.

Abstract approved:

_____

Rebecca J. Donatelle

The number of women diagnosed with diabetes, including gestational diabetes, will continue to increase in the face of epidemic rates of obesity. The concurrent rise in obesity and diabetes makes it important to determine the risk factors for gestational diabetes mellitus (GDM) and the nature and extent of care offered to this population by physicians. This is a two part study. Part I explores risk factors for GDM in a state-wide sample of women who completed the Pregnancy Risk Assessment Monitoring System (PRAMS) questionnaire in 2001. PRAMS participants were randomly drawn from Oregon birth certificates. In 2001, 1783 women completed PRAMS and responded to the question regarding gestational diabetes on the birth certificate with a yes or no answer. Results indicated that approximately 4% of Oregon pregnancies are complicated by GDM, with Asian/Pacific Islander and Hispanics having the greatest incidence of GDM. Logistic regression analysis determined that significant predictors for GDM were pre-pregnancy body mass index>25 kg/m^2, racial/ethnic minority group membership, and maternal age>25 years.

Part II of this study explored the nature and extent of care offered by physicians during pregnancy and in the postpartum period using a mailed survey designed for this research. Two hundred and eighty three physicians in obstetrics and gynecology and family practice completed a survey assessing physician care patterns, beliefs, opinions and attitudes regarding GDM care. Results indicated that over 95% of Oregon physicians were testing for GDM during gestation. In the postpartum period very few physicians were testing for glucose intolerance. Only 19% of the same physicians that always tested for GDM are testing blood glucose levels in the postpartum period. Results of logistic regression that assessed variables associated with level of postpartum care indicated that female physicians were more likely to offer more comprehensive postpartum care as compared to male physicians. Logistic regression also indicated that subjective norms were associated with physician's likelihood of screening women for glucose intolerance in the postpartum period. The findings from this study will assist health care professionals in identifying women at greatest risk for GDM and identifies established care guidelines need to be brought into clinical practice.

AN ASSESSMENT OF RISK FACTORS FOR GESTATIONAL DIABETES MELLITUS (GDM) AND PROVIDER PRACTICES FOR POST-GDM CARE

by
Monica L. Hunsberger

A DISSERTATION

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Presented March 2, 2007
Commencement June 2007

Doctor of Philosophy dissertation of Monica L. Hunsberger presented on March 2, 2007.

APPROVED:

Major Professor, representing Public Health

Chair of the Department of Public Health

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Monica L. Hunsberger, Author

ACKNOWLEDGEMENTS

I would like to thank Dr. Rebecca Donatelle, my committee chair, and Dr. Melinda Manore for inspiring this research topic. In particular, Dr. Donatelle's recommendations, critical eye and enlightened mentoring were invaluable to this project and I am grateful for her continued support.

I also wish to thank Ken D. Rosenberg, MD and Alfredo P. Sandoval, from the Office of Family Health, Oregon Department of Human Services for their assistance in gaining permissions and transferring Pregnancy Risk Assessment and Monitoring System data. Thanks to Dr. Alan Acock and Annette Adams, Department of Public Health and Preventative Medicine Oregon Health & Science University, for their assistance with data analysis and interpretation. Thanks also are due to the rest of my committee, Dr. Donna Champeau and Dr. Sally Francis.

Special thanks should be given to my friends Karl and Ellison Weist who stuffed, licked, and stamped hundreds of survey envelopes and gave feedback on this manuscript. Finally, words alone cannot express the thanks I owe to Jay Hunsberger, my husband, for his encouragement and support.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

AN ASSESSMENT OF RISK FACTORS FOR GESTATIONAL DIABETES MELLITUS (GDM) AND PROVIDER PRACTICES FOR POST-GDM CARE

CHAPTER 1—INTRODUCTION

Gestational diabetes mellitus (GDM), defined as any degree of glucose intolerance with onset or first recognition during pregnancy, is the most common metabolic disorder of pregnancy (Dornhorst & Frost, 2002, p. 145, National Diabetes Data Group, 1979). People with glucose intolerance have blood glucose levels that are consistently above normal because they do not have enough insulin or they can not properly use the insulin they have. Insulin, a hormone produced by the pancreas, allows cells to take glucose from the blood, so it can be used for energy (ADA, 2005).

Approximately 7% of all pregnancies are complicated by GDM, with prevalence estimates ranging from 2%-14% (ADA, 2004). The variation in rates can in part, be attributed to the number of differing criteria that are used in diagnosing GDM; including guidelines published by the American Diabetes Association, World Health Organization, National Diabetes Data Group (NDDG), and the Carpenter and Coustan criteria (Ben-Haroush, 2003). The NDDG criteria and Carpenter Coustan criteria are most widely cited in the diabetes literature. Although it is not clear which criteria are used most often; it is clear that GDM is rising in most regions of the world.

GDM increased significantly during the 1990s, consistent with the overall diabetes trends in the United States (USDHHS CDC 2001, BRFSS, 2006). A recent report from the Kaiser Permanente Health Care Plan in Northern California found a 35% increase in GDM cumulative incidence between 1991 and 2000; an average 4% increase a year, using the National Diabetes Data Group criteria for diagnosis of GDM (Ferrara, 2004).

The incidence of GDM has increased in Oregon as well. In 1989, 2.91% of pregnancies were complicated by GDM (ODHS, 2005). By 2003, 3.64% of pregnancies were complicated by GDM (ODHS, 2005). Although the trend is not linear, GDM does appear to be increasing over time in Oregon. In 2002, 3.97% of Oregon pregnancies were complicated by GDM; the highest rates on record since 1989 (ODHS, 2005).

While the cause of GDM is not clear, a variety of factors contribute to the development of GDM. The changes related to pregnancy, including increased blood volume and hormonal changes; modifiable risk factors such as obesity prior to pregnancy; and unmodifiable risk factors such as a family history of diabetes increase the risk for GDM (ADA, 2004). Although the placenta plays an important role in supporting fetal growth, hormones from the placenta may block the action of insulin in the mother (ADA, 2005). Without the action of insulin the mother's blood glucose stays elevated, a state that is called *hyperglycemia*. Generally women's bodies are able to compensate for the increased demands of pregnancy. However, in some cases glucose intolerance will be too great and women will have elevated fasting blood glucose levels.

Being overweight or obese at the onset of pregnancy may be the most significant modifiable risk factor for GDM development (Rosenblatt 2002, Flegal, 1999). Specifically, obesity (>120% ideal body weight) is a risk factor for GDM (Hanna, 2001, Johnson 1987). Researchers speculate that with the epidemic rise in overweight and obese women in the United States, concomitant increases in GDM prevalence are inevitable (Dabelea, 2005, Metzger, 1998).

Although obesity may be the most significant modifiable risk factor for GDM, it is not the only modifiable risk factor. Other risk factors include an elevated fasting or random plasma glucose, glycosuria on two or more occasions (glucose in the urine), polycystic ovarian syndrome, and previous impaired glucose tolerance (Lauenborg 2004, Hanna, 2001, Kjos, 1994, Jovanovic 2001). These risk factors can all be modified by diet and physical activity.

Risk factors that are not modifiable include a first-degree relative with diabetes, being a member of a high risk ethnic groups (Hispanic, Black, Native American, South-east Asian, Pacific Islander or indigenous Australian), and previous gestational diabetes (Hanna, 2001, Jovanavic 2001, Berkowitz, 1992).

Public Health Implication of GDM

The increasing prevalence of GDM is an important public health concern. The consequences of high-blood glucose are both immediate and long-lasting for the fetus, child, and the mother. The infants of women with GDM are at increased risk for macrosomia (large for gestational age), operative delivery (caesarean), shoulder dystocia, and birth trauma. Macrosomia occurs in approximately 50% of pregnancies complicated by GDM (Jazayeri, 2004). Operative delivery is indicated more often in women with GDM because of the macrosomia. In a study comparing the rates of cesarean sections in glucose tolerant women to glucose intolerant women, the rate of cesarean sections was 19.8% for the glucose intolerant compared to 15.6% for the glucose tolerant women, a statistically significant difference (Moses, 2000). The greater size of macrosomic infants increases the risk for shoulder dystocia (Lerner, 2004). Shoulder dystocia occurs when the neck retracts back against the mother's

perineum because the baby's anterior shoulder has caught on the mother's pubic bone (Lerner, 2004). If the baby is not freed within a few minutes they can suffer permanent brain damage or even death. Controlling GDM to normalize blood glucose helps to minimize these complications.

Influences on Offspring of GDM Mothers

Later in life the consequences of high blood glucose can be equally devastating to the child. The children of GDM pregnancies are at increased risk for obesity and diabetes. A study compared offspring of GDM (OGDM) women that were large- for-gestational age (LGA), to offspring that were appropriate-for-gestational age (AGA) against controls with offspring that were LGA and APA (Vohr, 1999). Findings from this study indicate that the LGA offspring of GDM women have evidence of increasing body size and fat with increasing age and that maternal GDM and maternal pre-pregnant adiposity are significant predictors of the unique growth patterns seen in the OGDM women (Vohr, 1999). Furthermore, the disturbances of intrauterine metabolic and hormonal environment may lead to infant and adult diseases in the OGDM women (Dörner, 1994). Gestational diabetes increases the risk for the offspring to develop overweight, metabolic syndrome, and type 1 diabetes (Dörner, 2000).

Recently, researchers in Berlin, Germany examined birth weight and parental body-mass-index (BMI) as predictors of childhood overweight. The sample consisted of 324 children born to Caucasian women with GDM. The children, ranging from 2-8 years of age, had significantly higher BMIs when compared with the average German population (Schaefer-Graf, 2005). Independent predictors for childhood overweight

included the child's BMI at birth, maternal BMI and paternal BMI indicating that the pre- and postnatal environment contributes to childhood overweight (Schaefer-Graf, 2005).

This research highlights the need for regular medical screening of children following a GDM pregnancy. The American Diabetes Association recommends that offspring of women with GDM be monitored closely for the development of obesity and/or abnormalities of glucose tolerance by health professionals (ADA 2004). The mothers are also at increased risk for future blood glucose abnormalities.

GDM Influences on Maternal Health

Women with GDM are at increased risk for hypertensive disorders, cesarean delivery, and future type 2 diabetes (ACOG, 2001). Although the mechanisms are not completely understood, it is clear that women who have had gestational diabetic pregnancies are at increased risk for the development of type 2 diabetes (Csorba, 1995, Dornhorst, 1998). A systematic review of GDM patients from 1965-2001 found the cumulative incidence of type 2 diabetes increased markedly in the first 5 years after a GDM pregnancy and appeared to plateau after 10 years (Kim, 2002). Others have found the risk of converting to Type 2 diabetes to be as high as 75% following a GDM pregnancy (Henry, 1991). "In some populations, women who have had GDM comprise a substantial proportion of subjects who ultimately develop diabetes" (Cheung, 2003).

Women with diabetes have an increased risk for cardiovascular disease. Over the past 30 years deaths from heart disease have declined by 27% in women without diabetes. In contrast, heart disease has increased by 23% in women with diabetes

(ADA, 2005). Diabetic women have a 7.6 times greater risk for peripheral vascular disease (PVD) than women without diabetes as a result of reduced blood flow and oxygen to the tissues in the feet and legs (ADA, 2005). Diabetes is also the leading cause of blindness and treated end-stage renal diseases in adults (ADA, 2002). There is tremendous potential for reducing type 2 diabetes if women are informed about their increased risks and the steps they could take to ameliorate risk (ADA, 2004, 2003, 2000, Bottalico, 2001, Dornhorst, 1998).

Reducing Risk of Progression to Type 2 Diabetes

To stop or delay the progression from GDM to type 2 diabetes women with GDM must first be identified by health professionals, learn to control their blood glucose during pregnancy, and receive appropriate diabetes intervention and treatment follow-up care. Routine screening for GDM typically occurs around 24-28 weeks gestation (American College of Obstetricans and Gynecologists, 2001, American Diabetes Association, 2000, Kim, 2006). In an ideal situation, once a woman is diagnosed with GDM she will take steps to control her blood glucose. GDM can often be controlled through medical nutrition therapy (MNT) and moderate exercise (Sigal, 2006, Garcia-Patterson, 2001, Jovanovic, 2001, Kjos, 1999). During a GDM pregnancy the goal is to maintain a normal blood glucose in order to minimize complications for the mother and fetus.

Following a GDM pregnancy, blood glucose testing is the only way to ensure blood glucose levels have returned to normal. Immediately following a GDM pregnancy a small percentage of women will test positive for type 2 diabetes. The range varies by ethnic/racial groups from 3% in a predominantly Caucasian population

to 9% in a Hispanic population (Kjos, 1990, Catalano, 1991). However, because of the potential for conversion to type 2 diabetes among an indeterminate number of women the American College of Obstetrics and Gynecology, the World Health Organization, the American Diabetes Association, and the American Dietetics Association, and the American Family Physician Practice Guidelines all recommend that women be screened in the postpartum period. Women should be screened immediately following the GDM pregnancy and annually thereafter. Testing in the postpartum period is the only means for reclassify blood glucose levels as normoglycemic (normal) or hyperglycemic (high). Postpartum testing also provides an opportunity for health professionals discuss risk factors with women and explain how they can minimize their risk of progressing to type 2 diabetes. Post-GDM follow-up could greatly increase the chances of early diagnosis and treatment of pre-diabetes and diabetes as well as reducing morbidity and mortality from subsequent diabetes (American Association of Clinical Endocrinologists, 2002).

Preventing or Delaying Type 2 Diabetes-A Public Health Priority

Preventing or delaying the progression to type 2 diabetes in post-GDM patients should be a public health priority. Approximately 9.3 million or 8.7% of all women over the age of 20 in the United States have diabetes. About one-third of diabetics are unaware that they have diabetes, indicating a need for further patient education and screening (ADA, 2005). Because so many GDM women progress to type 2 diabetes they are one important population to target for prevention of type 2 (Langer, 2006, Kaaja, 2006, Dornhorst, 1998). In a 2003 publication, Cheung concluded that

"effective measures to prevent women from progressing to frank diabetes could therefore have a significant population health impact" (Cheung, 2003).

In order to prevent or delay type 2 diabetes in post-GDM women in Oregon, a better understanding of the nature and extent of existing health care for post-GDM women is necessary.

To date there is little known about practitioner care patterns in the post-GDM period. Recently a Canadian group assessed physicians' follow-up patterns in Ottawa Hospital. Researchers found that physicians are not following the Canada guidelines to screen women in the postpartum period for glucose intolerance (Clark, 2003). In another study by Kaufmann et al., (1999) questionnaires were sent to post-GDM women regarding follow-up care. The questionnaire was returned by all 66 individuals. Twenty (30.3%) reported receiving yearly 2-hour glucose tolerance testing (GTT) (Kaufmann et al., 1999). Of the remaining 46 individuals, 19 had been tested once in the 5 years since pregnancy (Kaufmann et al., 1999). Kaufmann et al. concluded that although physicians and patients knew the risks of diabetes development, compliance with follow-up testing was poor and the risk of developing diabetes was high. Most recently Kim et al. reported that rates of glucose testing were low. Kim et al. found recommended glucose testing occurred 23% of the time in a sample from the University of Michigan Hospital (Kim et al., 2006).

Lessons from the Field

Rising diabetes rates demonstrate the need for preventative measures in the United States. Physicians working with post-GDM women are poised to deliver preventative care for type 2 diabetes; however, questions arise as to what this

preventive care should include and how it can be delivered efficaciously. Women are encouraged to return for post-partum checkups presenting an opportune time for physicians to perform post partum glucose testing and make lifestyle recommendations that can prevent or delay diabetes. The Diabetes Prevention Program (DPP) demonstrated that lifestyle modification can prevent type 2 diabetes (Diabetes Prevention Program Research Group, 2002). In addition, physicians and other health professionals have played key roles in helping patients change behavior in the areas of smoking cessation, increasing physical activity, and alcohol cessation or reduction.

In the area of smoking cessation two approaches have effectively reduced smoking; pharmacotherapy and counseling (US Public Health Service, 2000, Fiore, 2000, Lancaster 2000). Tobacco cessation research indicates the efficacy of treatment correlates with treatment intensity, although brief physician interventions during an office visit do promote smoking cessation (Rigotti, 2002, Whitlock, 2004, Lancaster, 2000, U.S. Public Health Service, 2000, Gorin, 2004). The programs that were most effective utilized the "five A's" recommended in the Public Health Service guidelines and combined the five A's with motivational strategies, including the use of incentives (U.S. Public Health Service, 2000, Gorin, 2004, Fiore, 2000, Donatelle, 2006). This strategy uses five steps: *ask, advise, assess, assist*, and *arrange* follow-up. The steps include: asking the patient if they smoke, offer personalized advice, assess the patient's readiness to change, assist the patient in moving along in the change process, and arrange a follow-up visit or phone call. In the above studies, physicians and their

staff played a key role in motivating resistant populations of smokers, particularly pregnant women, to stop smoking.

The 5 A's mnemonic has been applied to physical activity promotion in the primary care setting (CDC, 1998, Wee, 1999). Many national organizations recommend that physicians and health professionals counsel patients on physical fitness (Fletcher, 1992, Fletcher, 1996, Expert Panel on Detection, Evaluation and Treatment of High Blood Pressure, 1993 National High Blood Pressure Education Program, 1997, National Institutes of Health consensus Development Panel on Physical Activity and Cardiovascular Health, 1996 Harris, 1989, US Department of Health and Human Services, 1997).

Alcohol abuse represents another effective area where physicians have played a role in providing advice to reduce intake of alcohol. By providing effective screening and assessment, patient education, office-based interventions, and referral to specialty services if indicated, physicians assist problem drinkers (O'Connor, 1998). The U.S. Preventive Services Task Force found brief behavioral counseling interventions in primary care reduced alcohol use (Whitlock, 2002).

Translating "Lessons Learned" to GDM Interventions

Physician counseling strategies that have worked with other problem behaviors have the potential to be effective in reducing risk for GDM during pregnancy and in the postpartum period. Women may be more likely to comply with recommended follow-up testing and make lifestyle changes if their physician encouraged them. According to published recommendations by the American College of Obstetrics and Gynecology, World Health Organization, and American Family Practice Therapeutics

follow-up care should consist of blood glucose testing after the birth, counseling that addresses appropriate diet and exercise to prevent type 2 diabetes, and repeated blood glucose testing annually following a negative screen. Diet counseling would include instructing women on a balanced diet, for example, using the 2005 *Dietary Guidelines for Americans* (Executive Office of the President and the Department of Health and Human Services, 2005). Exercise instruction could include the recommendation made by the Surgeon General, the Center for Disease Control and Prevention, and the American College of Sports Medicine, individuals should get 30-60 minutes of moderate physical activity most days of the week.

The Problem

Little is know about state-wide GDM trends in Oregon. Further, little is known about physician practice patterns during pregnancy or in the post-GDM period in Oregon.

Study Purpose and Design

The purpose of this study is to asses the nature and extent of GDM among various subgroups of women in Oregon and determine which factors best predict GDM in these groups. Additionally, this study will describe the practice patterns, attitudes, and beliefs of practitioners working with GDM women during pregnancy and in the post-GDM period. Evidence-based guidelines for post-GDM care are widely available to physicians, yet little is known about the implementation of guidelines in practice (Larme, 2001, Davis, 1997, Cabana, 1999). Using constructs from several behavioral theories including diffusion of innovations, social cognitive theory, and the theory of reasoned action; physician personal factors, behaviors, attitudes, beliefs and subjective norm are examined.

This study is comprised of two distinct parts. Part I is designed to assess prevalence and risk factors for GDM in a population-based, stratified random sample of postpartum women who delivered in Oregon in 2001. Part I utilizes data collected for Oregon Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS, administered by the Center for Disease Control and Prevention, is an ongoing, state-specific, population-based surveillance system of maternal behaviors and experiences before, during, and after pregnancy.

Part II is designed to assess physician practice patterns in Oregon during pregnancy and in the post-GDM period. This sample is comprised of MDs in the specialties of Family Practice and Obstetrics and Gynecology that held active practice licenses in Oregon in November 2005, when the list was generated by the State of Oregon: Board of Medical Examiners.

RESEARCH QUESTIONS

Part I Research Question:

RQ1a. What is the prevalence of GDM among various subpopulations of women in Oregon?

RQ1b. What is the prevalence of obesity pre-pregnancy in Oregon?

RQ1c. To what extent are pre-pregnancy BMI, race/ethnicity, and mother's age associated with GDM?

Part II Research Questions:

RQ2a. What is the demographic profile of Physicians working with pregnant women in Oregon?

RQ2b. To what extent are Oregon physicians testing for GDM during pregnancy and which screening guidelines do they use?

RQ2c. To what extent are Oregon physicians screening for glucose intolerance following a GDM pregnancy (postpartum)?

RQ 2d. Do Family Practice and Obstetric/Gynecologists differ in level of follow-up care?

RQ 3a. Are differences in practice patterns associated with specialty, years of practice, practice setting (Health Maintenance Organization, clinic, solo, two or more, center, other), geographic placement (urban, rural, suburban), and gender of the physician?

RQ3b. Are selected physician characteristics, attitudes, subjective norm and beliefs associated with level of care for GDM?

RQ4a. What percentage of Oregon Physicians offer post-GDM care?

HYPOTHESIS

Hypothesis Part I:

H1. Women with greater BMIs, racial or ethnic group membership and increasing maternal age will have a higher frequency of GDM.

Hypotheses Part II:

H2. Physician specialty, years in practice, practice setting, geographic setting, and gender influence post-GDM care**.**

H3: Physician behavior, attitudes, knowledge, beliefs and subjective norm will influence post-GDM care.

Assumptions

1. The assumption is made that respondents are truthful in their responses.

2. The assumption is made that respondents' answers refer only to gestational diabetes that meet the criteria for diagnosis as defined by any of the accepted guidelines.

3. The assumption is made that only a small fraction of practitioners are recommending changes in diet and lifestyle following Gestational Diabetes to prevent or slow the progression to type 2 diabetes.

Limitations

1. The sample was drawn from the Oregon State Medical Examiners Board membership list of MDs in the areas of Family Practice and Obstetrics & Gynecology. These two specialties may not encompass every physician that might treat a patient post-GDM.

2. As all data is self-reported, respondents may provide socially desirable answers.

3. Limited response rates from Oregon MDs.

Delimitations

1.The study population is limited to Oregon.

Terminology

Terms	**Definitions**
glucose	The primary form of sugar in the blood.
insulin	A hormone made in the pancreas that allows the uptake of glucose by body cells and has other metabolic effects.
glucose tolerance	A general term used in reference to the disorders of glucose or blood glucose including: type 1 diabetes, type 2 diabetes, gestational diabetes mellitus (GDM), impaired glucose tolerance (IGT), & impaired fasting glucose (IFG).

Terms Continued	Definitions Continued
diabetes mellitus	A disease caused by either insufficient insulin production or decreased sensitivity of cells to insulin.
type 1 diabetes mellitus	A form of diabetes that is caused by the autoimmune destruction of insulin-producing cells in the pancreas, usually leading to absolute insulin deficiency. Previously known as insulin dependent diabetes.
type 2 diabetes mellitus	A form of diabetes that is characterized by insulin resistance and usually relative insulin deficiency. Previously known as noninsulin-dependent diabetes mellitus.
gestational diabetes mellitus (GDM)	Diabetes with onset or first recognition during pregnancy.
impaired glucose tolerance (IGT)	Defined as two-hour glucose levels of 140 to 199 mg per dL (7.8 to 11.0 mmol) on the 75-g oral glucose tolerance test. This glucose level is above normal but below the level that is diagnostic for diabetes.
impaired fasting glucose (IFG)	Defined as glucose levels of 100 to 125 mg per dL (5.6 to 6.9 mmol per L) in fasting patients. This glucose level is above normal but below the level that is diagnostic for diabetes.
post-prandial	After a meal
pre-diabetes	A condition marked by IFG or IGT
ketones	Molecules formed in the liver when there is not sufficient carbohydrate to completely metabolize the acetyl-CoA produced from fat breakdown
blood glucose test	A blood sample taken from a vein or a small blood sample taken from pricking your finger
oral glucose tolerance test (OGGT)	A series of blood glucose measurements taken after drinking a solution containing a specific amount of glucose, typically 50, 75, or 100 grams. An oral glucose tolerance test is most commonly used to diagnose GDM
fasting blood glucose	a measurement of blood glucose taken after no food for 12 to 14 hours. It is often the first test done to help detect diabetes
random blood glucose (casual blood glucose)	Test of blood glucose regardless of when food was last taken

(Peace Health, 2005, Smolin, 2003, American Diabetes Association, 2005)

CHAPTER 2—REVIEW OF THE LITERATURE

OVERVIEW OF DIABETES

Diabetes is one of the most costly and burdensome chronic diseases of our time (King, 1998). Persons with diabetes do not produce or properly use insulin, a hormone produced by the pancreas. Insulin allows carbohydrates or starches to convert to energy in the body (ADA, 2005). Without sufficient insulin the blood glucose remains high.

It is estimated that the number of adults with diabetes will increase globally from 135 million in 1995 to 300 million by the year 2025 (King, 1998). Greater than 75% of people with diabetes will reside in developing nations (King, 1998).

In the U.S., 7.0% of the population has diabetes (ADA, 2005). One study predicts that 30.3 million U.S. citizens will have diabetes by 2030, or nearly double the 17.7 million people with diabetes in 2000 (Wild, 2004). In 2005, 1.5 million new cases of diabetes were diagnosed in people age 20 years or older in the U.S. (ADA, 2005). In addition to diagnosed cases, the American Diabetes Association estimates that 6.2 million people in the U.S. have undiagnosed diabetes (ADA, 2005). Another 41 million Americans have pre-diabetes; a condition characterized by impaired fasting glucose or impaired glucose tolerance (ADA, 2005). Pre-diabetes is a condition that raises the risk of developing type 2 diabetes, heart disease, and stroke. Diabetes is a clear threat to a long and healthy life. According to the American Diabetes Association, “diabetes is the fifth-deadliest disease in the United States” (ADA, 2005). Since 1987 the death rate due to diabetes had increased by 45 percent, while death

rates for other leading causes of death, including heart disease, cancer, and stroke declined. (ADA, 2005).

Data from the National Diabetes Surveillance System clearly illustrate a dramatic increase in diabetes.

> "Among the 49 states having data for 1994 and 2004, the age-adjusted prevalence of diagnosed diabetes was at least 50% higher in 2004 than in 1994 in 23 states (Alabama, Florida, Georgia, Idaho, Indiana, Kentucky, Maine, Mississippi, Montana, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Tennessee, Virginia, Washington, West Virginia, Wyoming). In 2004, the age-adjusted prevalence of diagnosed diabetes ranged from a high of 10.8% in Puerto Rico to a low of 4.8% in Colorado" (CDC, 2005).

Diabetes results in significant morbidity and mortality. Heart disease and stroke are estimated to be 2 to 4 times higher in adults with diabetes (Centers for Disease Control and Prevention, 2002). A related complication, high blood pressure, is also more prevalent in individuals with diabetes. About 73% of individuals with diabetes have blood pressure greater than 130/80 millimeters of mercury (mm/Hg) or use prescriptions for hypertension (Center for Disease Control and Prevention-National Diabetes Data Sheet, 2005). Diabetes is the leading cause of blindness and treated end-stage renal disease in adults (Centers for Disease Control and Prevention/National Diabetes Data Sheet, 2005). In 2000, approximately 41,000 people with diabetes began treatment for end-stage renal disease. End-stage renal disease results in a great number of people requiring dialysis or kidney transplant. Many people with diabetes experience nerve damage to the vascular system caused by elevated blood glucose levels. Nerve damage varies in severity but the most severe forms are the major contributing cause of lower-extremity amputations. The total cost of diabetes in the United States for the year 2002 was $132 billion; this figure

includes $92 billion in direct medical costs and $40 billion in indirect costs such as disability, work loss, and premature death (Centers for Disease Control and Prevention, 2002, ADA, 2005).

TYPES OF DIABETES

There are essentially three types of diabetes; type 1, type 2, and GDM. Additionally, there is pre-diabetes, a condition in which a person has impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) (CDC, 2003). People with pre-diabetes have blood glucose levels that are above normal, but not high enough for a diagnosis of diabetes. The American Diabetes Association estimates that two million adolescents aged 12-19 years have pre-diabetes, placing them at high risk for developing type 2 diabetes. All individuals with pre-diabetes are at a high risk of developing diabetes in the future (CDC, 2003, ADA, 2005).

Type 1 diabetes is a condition in which the body's immune system destroys cells of the pancreas responsible for making insulin. Insulin is the hormone an individual needs to control blood glucose. Type 1 diabetes typically occurs in children and young adults but it can strike at any age (ADA, 2002).

Type 2 diabetes is more common, accounting for 90-95% of all cases of diabetes. Type 2 diabetics produce insulin but do not use insulin properly. When insulin is not used properly the pancreas continues to make insulin at a greater rate in an effort to compensate. This burdens the pancreas and results in a gradual loss of the ability to produce insulin. Type 2 diabetes was historically referred to as adult onset diabetes because it was typically seen in older adults. Now type 2 diabetes is being diagnosed in children and this terminology is no longer used. Further more, although

there is no national data available for monitoring type 2 diabetes in youth, regional studies are suggesting that type 2 diabetes is being diagnosed more frequently in children and adolescents, particularly in overweight or obese children (CDC, 2006). Most children who develop type 2 diabetes are American Indians, Blacks, and Hispanic Americans (ADA, 2005, CDC, 2006). The Center for Disease Control and Prevention currently conducts research in 6 U.S. cities involving more than 5 million children age 0-19 years examining the extent to which type 2 diabetes has emerged among U.S. children and adolescents (CDC, 2006).

GDM is glucose intolerance that begins, or is first diagnosed, during pregnancy (ADA, 2002). GDM complicates approximately 7% of all pregnancies, with prevalence estimates ranging from 2%-14% (ADA, 2004). The most recent data for Oregon comes from the 2004 Oregon Vital Statistics Annual. In Oregon, 4.0 % of all pregnancies were complicated by GDM in 2004 (Oregon Vital Statistics Annual, 2004). This represents an increase of 0.37% from the previous year. Figure 1, depicts GDM trends in Oregon from 1989 to 2004. Figure 2, represents the differences in rates of GDM for racial/ethnic groups for the most recent years available. Asians had the highest rate of GDM in 2004, complicating 7.88% of pregnancies. Hispanics had the second highest rate of GDM (5.36%), followed by American Indians (4.87%), African Americans (3.63%), and non-Hispanic whites (3.38%). Data for these calculations are from Oregon Vital Statistics Annuals 2000-2004 and by request from the archives of the Oregon Center for Health Statistics. Data for 1991 and 1997 could not be located. (Center for Health Statistics, 2004).

Figure 1: **GDM Incidence Trends in Oregon**

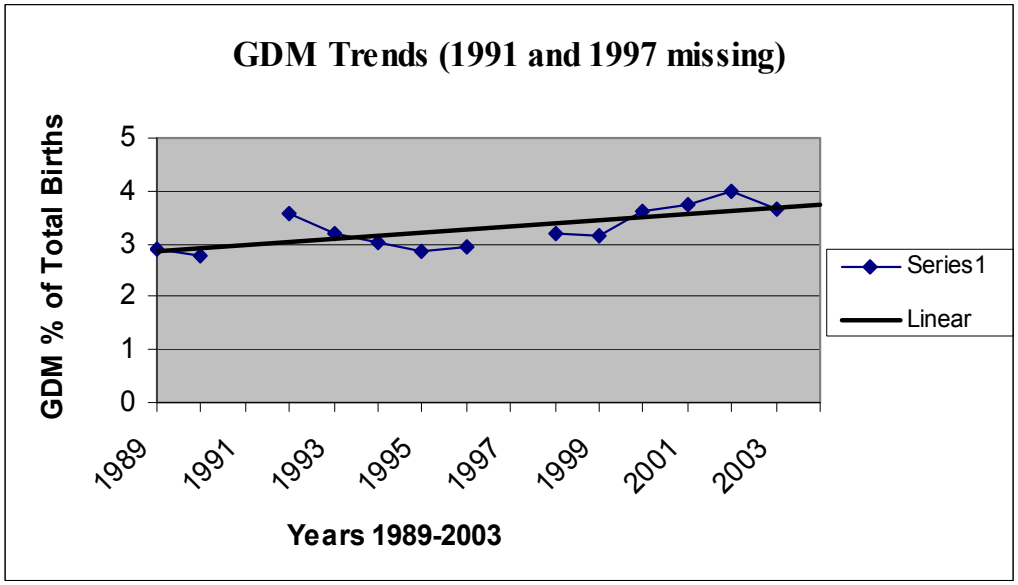
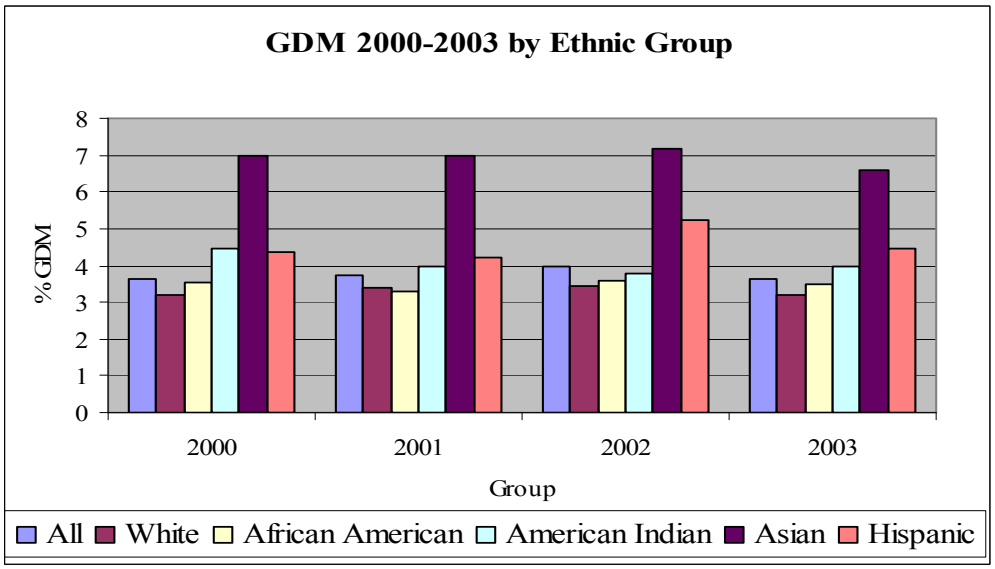


Figure 2: **Disparities in the Rates of GDM in Oregon 2000-2004**



MATERNAL IMPLICATIONS OF GESTATIONAL DIABETES

GDM typically goes away after pregnancy; however, 3-10% of women are diagnosed with type 2 diabetes immediately following pregnancy (Kjos, 1990, Catalano, 1991, Metzger, 1998, CDC, 2005). Another 20-50% will develop type 2 diabetes in the next 5-10 years (ADA, 2004, CDC, 2005). Other researchers estimate

that greater than 70% will develop type 2 diabetes within the 5-10 years following a GDM pregnancy (Kim, 2002, Henry, 1991). Substantial evidence demonstrates that post-GDM women will progress to type 2 diabetes later in life (Damm, 1998, CDC, 2005, Lauenborg, 2004, Cheung, 2003, Albareda, 2003).

The health significance of gestational diabetes has been calculated using population-attributable risk (PAR). PAR is an epidemiological tool used to estimate the proportion of all events of interest that may be attributed to a given exposure (Heller, 2003). Using PAR researchers estimate the cases of type 2 diabetes that can be attributed to a GDM pregnancy. Researchers concluded that up to one-third of parous women, women that have given birth one or more times, would have gone through a GDM pregnancy (Cheung, 2003). A study conducted in Spain compared rates of diabetes in post-GDM women (N=696) with a control group (N=70). In the GDM group 44 women had diabetes, 61 had IGT, and 25 had IFG at 6.16 year follow-up compared to 0 women in the control group (Albareda, 2003). In a Danish cohort of 481 women with a history of GDM, 171 had type 2 diabetes and 130 had IFG or IGT at 9.8 years follow-up, 35.6% and 27% respectively (Lauenborg, 2004).

Type 2 diabetes results from an impaired ability to utilize insulin. Reported rates of overt diabetes vary widely, ranging from 11%-100%. The variation is due to differences in screening, the guidelines used to screen, and the length of follow up (Coustan 1993, Ali 1990, Mestman, 1987, Cheng, 2003). Testing may include the 50-g, 75-g, and the 100-g oral glucose tolerance test (Damm, 1998, Thomas, 2005, Langer 2006). The length of follow-up also influences the number of women who reportedly develop overt diabetes because some studies may be only weeks long.

Study lengths have ranged from as few as five weeks to as long as 28 years (Kjos, 1999, O' Sullivan, 1991, Gregory, 1993, Cheung, 2003).

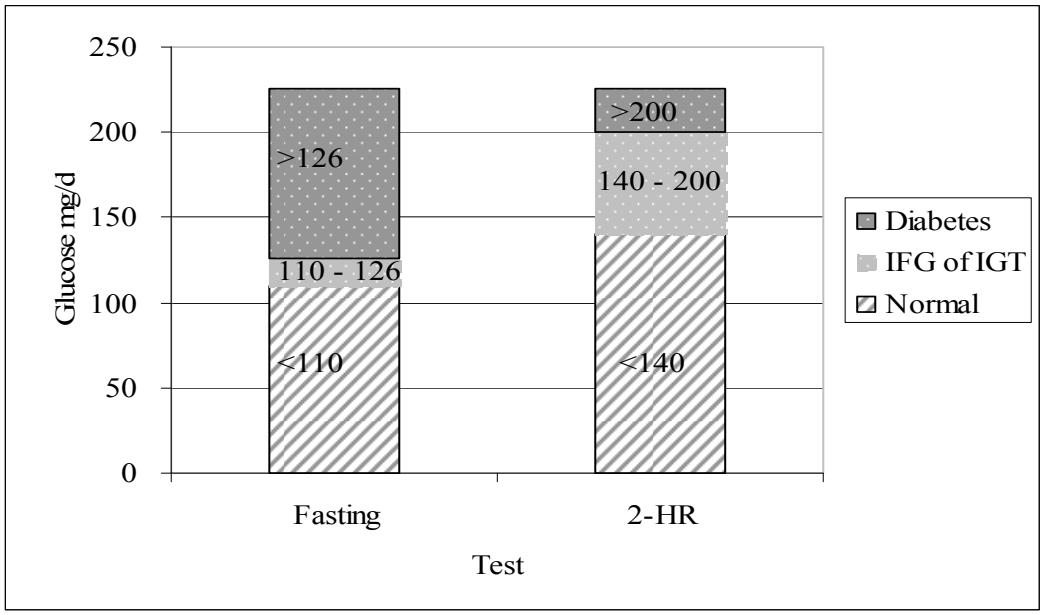
The increased risk for type 2 diabetes in previously gestational diabetic women is heavily influenced by modifiable risk factors. Risks for type 2 diabetes include overweight, obesity, and sedentary lifestyles, as well as family history of diabetes. The prevalence of GDM has increased over time with the increased prevalence of obesity (Flegal, 1999, Albareda, 2003). Recently, researchers at Kaiser Permanente of Colorado GDM Screening Program found increases in the prevalence of GDM with reported trends in obesity (Dabelea, 2005). Modifiable risk factors indicate that public health interventions can serve as an important treatment modality for preventing type 2 diabetes (Diabetes Prevention Program Research Group, 2002). Preventable risk factors such as maintaining a healthy weight, engaging in physical activity, and making healthy dietary choices that will delay or reduce the onset of type 2 diabetes should be discussed with patients by their health care providers.

DIAGNOSIS OF DIABETES

The criteria for diagnosing pre-diabetes, type 1, and type 2 will be discussed in this section. The criteria for diagnosing GDM will be discussed in detail in the subsequent section. Pre-diabetes, type 1, and type 2 are diagnosed by testing the blood of a patient in the fasting state, 2 hours after a 75 gram glucose load, or in the casual or random state. The fasting state means that a person has not had energy intake for eight or more hours (Committee Report, 2003). The 75 gram glucose load means that the patient has consumed glucose for the purpose of testing. Casual or random is defined as any time of day without regard for when the last meal was eaten (Committee

Report, 2003). Figure 3 illustrates the fasting state, 12 hours without food, on the left compared with the 2-hour criteria used in the fed state, after a meal, on the right. The diagnostic criteria for normal blood-glucose, pre-diabetes, and diabetes (type 1 or type 2) are shown.

Figure 3: Normal Blood Glucose, Pre-diabetes, and Diabetes



In addition to the criteria depicted above, criteria for the diagnosis of diabetes mellitus also include symptoms of diabetes along with a casual glucose concentration of ≥200mg/dl. Symptoms of diabetes include frequent urination, excessive fluid intake, and unexplained weight loss (Expert Committee, 2003).

DIAGNOSIS OF GESTATIONAL DIABETES MELLITUS

Pregnant women are routinely screened for GDM around 24-28 weeks of pregnancy. While there is currently no consensus on the guidelines to use for screening patients, it appears that some type of screening for GDM is practiced by most prenatal care health practitioners (Turok, 2003, U.S. Preventative Services Task

Force, 2003). The first guidelines for testing GDM were proposed approximately 40 years ago. Since that time there have been guideline debates.

In 1964 screening for GDM was initially proposed by O'Sullivan and Mahan (Langer, 2006). O'Sullivan and Mahan proposed a statistical approach to the diagnosis, designating "abnormal", as any two out of four blood glucose values exceeding 2 standard deviations about the mean. For their research O'Sullivan and Mahan gave 752 women, in their second and third trimesters, 100 grams of glucose and recorded glucose tolerance (O' Sullivan, 1964). The National Diabetes Data Group (NDDG) serves as the major Federal focus for the collection, analysis, and dissemination of data on diabetes and its complications. The NDDG later adopted the O'Sullivan and Mahan criteria (National Diabetes Data Group, 1979). The NDDG is part of the National Institute of Diabetes & Digestive & Kidney Disease, a division of the National Institutes of Health, which draws from research, medicine, and lay individuals to better understand diabetes (NIDDK, 2005).

Carpenter and Coustan proposed another set of screening criteria in 1982. The Carpenter and Coustan criteria had less strict cut-off values than the NDDG criteria, and were favored over the NDDG criteria because women meeting the less stringent criteria were at similar risk (Carpenter, 1982, Magee, 1993). A less strict cut-off value means that when a blood sample is analyzed for diagnoses of GDM, the Carpenter and Coustan criteria would diagnose a woman as a gestational diabetic at a lower blood glucose level than the NDDG criteria for diagnosis.

With two main sets of criteria in practice GDM estimates may be low. If a practitioner uses the NDDG criteria they will fail to diagnose women considered

gestational diabetics using Carpenter & Coustan criteria. Some researchers believe that hyperglycemia (high blood glucose) in levels even lower than those used for diagnosis of GDM by either criterion are at increased risk of having obese offspring and early onset of type 2 diabetes (ADA, 2002). With funding from the American Diabetes Association researchers at Kaiser Permanente Northwest and Hawaii are studying hyperglycemia in pregnancy to answer this question (ADA, 2002). In the future more women may be diagnosed with GDM and hence greater opportunity for primary prevention of type 2 diabetes.

The American Diabetes Association provides much of the diabetes information in the United States. The American Diabetes Association recommends that screening with a 50-gram oral glucose load measured one-hour later by venous plasma glucose serve as the screening tool for GDM not as diagnosis (ADA, 2004). If the 50-gram oral glucose load is positive it is followed by a 100-gram 3-hour glucose tolerance test. The follow-up test in which the larger amount of glucose is given and measures of blood glucose levels are taken each hour, for three hours determines the GDM diagnosis. However, the American Diabetes Association accepts both the Carpenter and Coustan guidelines and the stricter NDDG criteria. The American Diabetes Association and the World Health Organization (WHO) also accept a 2-hour, 75-gram glucose tolerance test that uses the same cut-off points as the 3-hour test (Jovanovic, 2001). The WHO recommends testing women in the first trimester if they are at a heightened risk for GDM based on weight, history, and ethnicity (WHO, 1999). The differing sets of criteria for diagnosing GDM make it difficult to identify the number

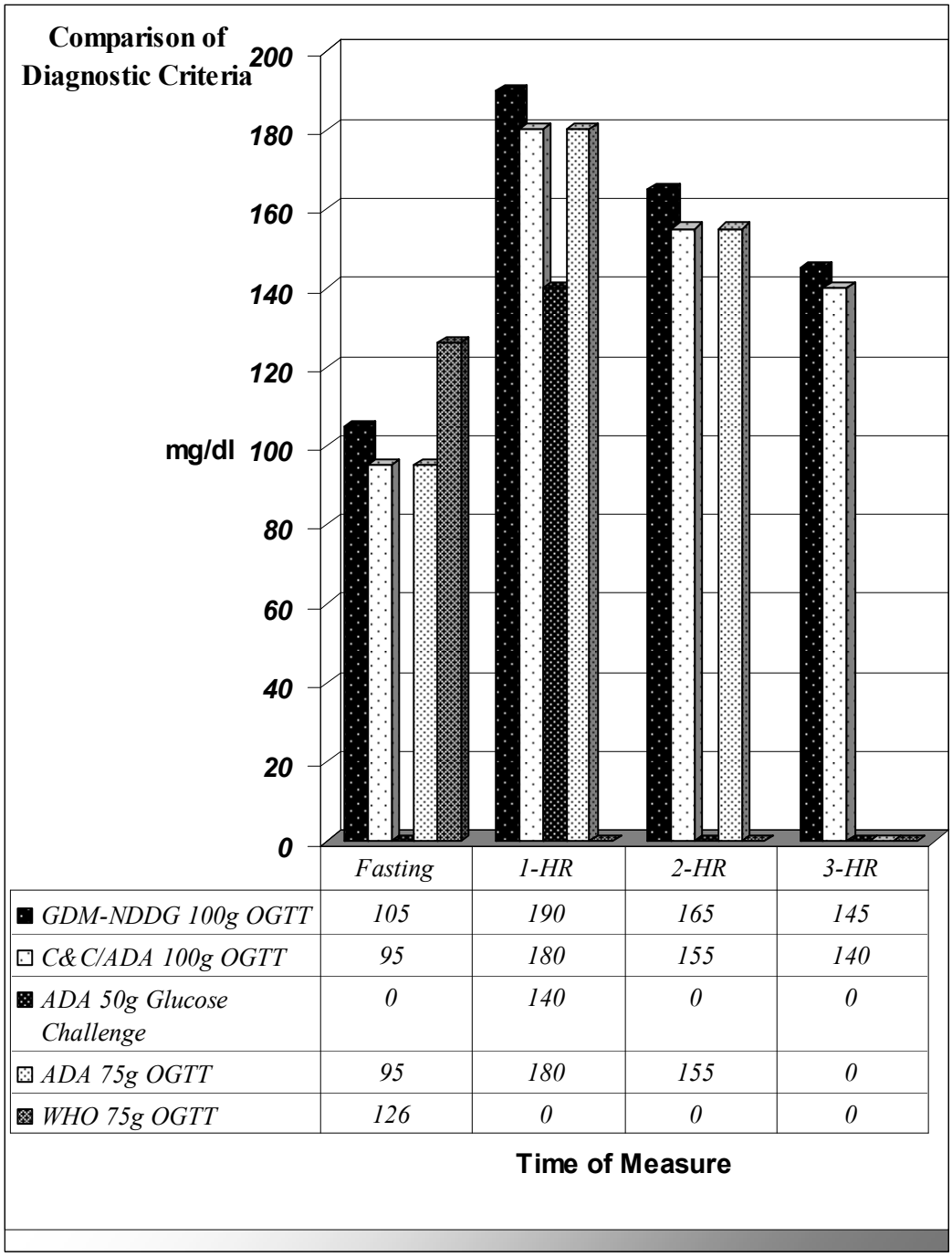
of pregnancies complicated by GDM and may account for the variation in reported prevalence of GDM.

Table 1: Criteria for the Diagnosis of Gestational Diabetes Mellitus

	National Diabetes Data Group	***Carpenter and Coustan*** and ***American Diabetes Association***	***American Diabetes Association and World Health Association***†	***American Diabetes Association***	***World Health Organization***
Glucose Load and Time of Measure	100-gram oral glucose tolerance	100- gram oral glucose tolerance	50-gram glucose challenge	75-gram oral glucose tolerance	Fasting/Casual
Fasting	105	95	NA	95	126/200
1 hour	190	180	140	180	NA
2 hour	165	155	NA	155	NA
3 hour	145	140	NA	NA	NA

*All data are mg/dL, unless indicated otherwise. To convert mg/dL to mmol/L, multiply by 0.555. Two or more concentrations as high as or higher than those shown (National Diabetes Data Group and American Diabetes Association) and 1 or more concentrations as high or higher than those shown (World Health Organization) make the diagnosis of gestational diabetes. NA indicates time points not preformed.
†50 g oral glucose challenge is a screening tool. A positive test is followed by an oral glucose challenge test. (*NDDG* 1979, Carpenter and Coustan1982, WHO 1999 and 2002, ADA 2004, Jovanovic, 2001).

Figure 4: Criteria for the Diagnosis of Gestational Diabetes Mellitus



	Fasting	1-HR	2-HR	3-HR
GDM-NDDG 100g OGTT	*105*	*190*	*165*	*145*
C&C/ADA 100g OGTT	*95*	*180*	*155*	*140*
ADA 50g Glucose Challenge	*0*	*140*	*0*	*0*
ADA 75g OGTT	*95*	*180*	*155*	*0*
WHO 75g OGTT	*126*	*0*	*0*	*0*

Note: "0" values indicate that there is no measure taken for this test at that time point.

GUIDELINES IN PRACTICE

There are published guidelines that health care practitioners can use to guide GDM care practice. Guidelines have been developed by groups such as, Family Practice Physicians, American College of Obstetrics and Gynecology, and the World Health Organization. Studies conducted to describe routine care in healthcare practice have established that most Ob/Gyn and Family Practice physicians screen for GDM during pregnancy (Marrero, 1992, Turok, 2003).

Members of family practice medicine publish guides called "Practical Therapeutics" that help direct clinical practice. A recent article titled *Management of Gestational Diabetes Mellitus* reported that screening for gestational diabetes is widely practiced despite lack of evidence that screening prevents adverse perinatal outcomes (Turok, 2003). An earlier publication reported that family practitioners in Indiana screen at a lower rate for GDM than obstetricians and gynecologists (Marrero, 1992). The family doctors screened 72% universally versus obstetricians and gynecologists who reported screening 86% universally (Marrero, 1992). A lack of well designed studies has contributed to the controversy surrounding diagnosis and management of gestational diabetes (ACOG, 2001). The therapeutic guidelines provided in the American Family Physician promote initial diagnosis using the 50-gram, 1-hour glucose challenge test at 24-28 week of gestation. Patients are given 50 grams of oral glucose in a non-fasting state. After one hour, a normal value would include a serum glucose value of less than 130 mg/dL (7.2 mmol per L) or plasma glucose value of less than 140 mg/dL (7.8 mmol per L). Both the American Diabetes Association and the American College of Obstetricians accept either of these results

(Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2003 and ACOG, 2001). If a patient has an abnormal one hour screen test the American Diabetes Association recommends that they receive a 100-gram, 3-hour venous serum or plasma glucose tolerance test. This test requires an overnight fast followed by a 100-g glucose load, after which a blood sample is drawn each hour, for a total of three blood samples. Two or more abnormal values indicate GDM. Depending on the criteria used, the cut off values for an abnormal result on the 100-g, 3-hour oral glucose tolerance test vary (refer back to Table 1).

The practice bulletin created by the American College of Obstetricians and Gynecologists (ACOG) provides recommendations similar to the *Practical Therapeutics*. While practitioners have debated the practicalities of testing, a 1996 survey of obstetrics groups found that 94% reported universal testing (Wilkins-Haug, 1996). The American College of Obstetricians and Gynecologists recommends screening all pregnant patients for GDM. Laboratory screening is accomplished in the same manner as that reported by family physicians. The 50-gram glucose challenge test, if positive, is followed by a 100-gram, 3-hour oral glucose tolerance test. Both the Carpenter and Coustan or the National Diabetes Data Group diagnostic criteria are used in practice (ACOG, 2001). While it is clear that most health care providers screen for GDM as part of routine practice, it is not clear what the nature and extent of routine practice is in the post-GDM period.

TYPICAL MANAGEMENT/TREATMENT OF GESTATIONAL DIABETES

Women with GDM can be taught to self-monitor their blood glucose by physicians, nurses, or dietitians. Daily blood glucose self monitoring has proven to be

more effective than office visit monitoring (ADA, 2004). Other metabolic abnormalities are monitored by physicians.

For instance, a physician might monitor ketonuria, or ketones in the urine. Ketones may indicate poor blood glucose control. Ketonuria can also develop as a result of fasting, dieting, or starvation. Therefore, detection of urine ketones can be beneficial in identifying carbohydrate or energy insufficiency in GDM women (National Guideline Clearing House, 2004). Carbohydrate and energy sufficiency will most likely be achieved if the patient receives adequate education.

Physicians should also monitor maternal blood pressure and urine protein to detect hypertension in women with GDM (ADA, 2004, National Guideline Clearinghouse, 2004). Increased surveillance is recommended for pregnancies at risk for fetal demise (ADA, 2004, National Guideline Clearinghouse, 2004). If fasting glucose levels exceed 105 mg/dl or a pregnancy is past term the fetus may be at risk. Assessment of asymmetrical growth of the infant should also be conducted by the physician (ADA, 2004 and National Guideline Clearinghouse, 2004). Along with self-monitoring and physician monitoring, health care providers should encourage women to make dietary and physical activity changes if needed. Making these health behavior changes might require the support and encouragement of health practitioners.

All women with GDM should receive nutritional counseling from a registered dietitian, consistent with the American Diabetes Association recommendations. MNT is based on an individuals needs and takes into account the person's height and weight. The goal of MNT is to reduce hyperglycemia, or high blood glucose, while providing

adequate energy for the mother and baby. If diet alone fails to normalize blood glucose exercise serves as another potential means.

Exercise has been shown to successfully lower maternal glucose concentrations. If no other complications would limit a person with GDM from exercising, physicians should recommend exercise as part of treatment for controlling blood glucose. The recommendation by the Surgeon General Vice Admiral Richard H. Carmona, M.D. and the Center for Disease Control and Prevention is to be physically active for 30 minutes or more on most days of the week (Surgeon General, 2005, CDC, 2005). A health care provider should use their professional judgment in recommending a level of physical activity that is appropriate for the pregnant patient. When diet and exercise fail to control hyperglycemia, providers might recommend insulin.

The ADA reports that insulin therapy added to MNT most consistently reduces fetal morbidities. Health care providers should add insulin therapy when MNT fails to maintain glucose at the following levels: ≤105 mg/dl fasting plasma glucose; ≤155 mg/dl 1 hour after a meal (1-h postprandial plasma glucose); or ≤130 mg/dl 2 hours after a meal (ADA, 2004). There are a number of different types of insulin, each classified by how long it maintains blood glucose. The type of insulin a person needs is individualistic and must be selected based on the foods they eat, exercise levels, and how often blood glucose will be tested. The American Diabetes Association recommends that blood glucose be tested several times a day in order to tightly control blood glucose levels. A doctor prescribes the appropriate insulin, or combination of insulin, based the patients needs. Insulin can be given into the skin (subcutaneously),

the muscle (intramuscularly), or into a vein (intravenously). Oral agents provide an alternative to insulin that is often prescribed to type 2 diabetics but not typically to gestational diabetics.

There are five classes of oral glucose agents; Sulfonylureas, Meglitinides, Biguanides, Thiazolidinediones, and Alpha-glucosidase inhibitors (Luna, 2001). Sulfonylureas and Meglitinides work by stimulating insulin release from the beta cells of the pancreas and may slightly improve insulin resistance in peripheral muscle and fat tissues. Biguanides reduce hepatic (liver) glucose output while enhancing insulin sensitivity in hepatic and peripheral tissues. Thiazolidinediones enhance insulin sensitivity in both muscle and adipose tissue and to a lesser extent by inhibiting hepatic (liver) glucose production. Alpha-glucosidase inhibitors act by inhibiting the breakdown and subsequent absorption of carbohydrates (dextrins, maltose, sucrose and starch; no effect on glucose) from the gut following meals. The largest impact of these drugs is on postprandial hyperglycemia or high blood glucose after a meal (Luna, 2001). These drugs target different mechanisms in the body but the desired outcome is the same, lowered blood glucose.

Oral glucose agents have generally not been recommended for pregnant women because they can cross the placenta. Crossing the placenta has been linked to teratogenisis, the production of developmental malformations, and an increase in fetal insulin secretion that can promote macrosomia, or large for gestational age (Luna, 2001). Additionally, oral agents can cause *hypoglycemia*, a low blood glucose, in the fetus (Vazirani, 2003). However, one randomized clinical trial compared the use of insulin and Glyburide, a generic Sulfonylurea oral-agent, and found similar perinatal

outcomes (ADA 2004). Glyberide may be used to treat GDM in the future but currently it is not recommended for use with GDM patients and has not received Food and Drug Administration (FDA) approval for the treatment of GDM (AHRQ, 2004 and ADA, 2004). More research needs to be done in this area to determine the safety of oral-agents on the fetus. Whether treatment involves MNT, physical activity, insulin, or the use of oral-agents the goal is to maintain blood glucose in the normal range thereby reducing adverse outcomes for the mother, fetus, and child.

For some women the failure to maintain normal blood glucose results in a macrosomic, or large-for-gestational age, infant. Health care providers may encourage women carrying large-for-gestational age babies to deliver at 38 weeks to reduce the need for caesarean delivery. A GDM pregnancy, though not necessitating a caesarean delivery, does heighten the risk.

RECOMMENDED FOLLOW-UP CARE FOR GESTATIONAL DIABETES

The Agency for Health Research and Quality (AHRQ), The Family Practice Therapeutic Guidelines, ACOG, and the ADA make similar recommendations for GDM postpartum care. The AHRQ, Family Practice Physicians, and ADA recommend breastfeeding after a GDM pregnancy as a means for improving glycemic control, or blood glucose control (Turok, 2003). The recommendations set forth by the AHRQ are as follows:

- Reclassify maternal glycemic status in first 6 weeks after delivery
- As required, provide MNT and exercise

- Provide patient education regarding normal body weight, avoidance of medications that worsen insulin resistance, when to seek medical attention, family planning, and oral contraceptives
- Assess offspring of women with GDM for the development of obesity and or abnormalities of glucose tolerance (National Guideline Clearinghouse, 2004).

The Therapeutic Guidelines for Family Physicians concur with AHRQ. They recommend testing blood glucose at six-weeks postpartum with fasting blood glucose measurements taken on two occasions, or a 2-hour 75-g glucose tolerance test in order to reclassify as normal, impaired glucose tolerance, or diabetic. A normal glucose tolerance test is represented by a two-hour glucose tolerance test value of less than 140 mg per dl. Values between 140-200 mg per dl represent impaired glucose tolerance. Greater than 200 mg per dL is diagnostic of diabetes (Turok, 2003). The Therapeutic Guidelines for Family Practice recommend that screening for diabetes should be repeated annually following a GDM pregnancy. Furthermore, it is recommended that practitioners should counsel patients about diet and exercise. Diet and exercise encourage glycemic control, weight loss or maintenance, and can reduce the risk of progressing to type 2 diabetes.

The ACOG guidelines contain the following statement regarding postpartum care, "*Diagnostic testing for diabetes may be performed after the immediate effects of pregnancy on glucose metabolism have dissipated and is most convenient at around the time of the postpartum checkup*" (ACOG, 2001). A value of 110-125 mg/dL in the non-pregnant state indicates impaired fasting glucose. A value ≥ 126 mg/dL in

the fasting state indicates diabetes. ACOG also recommends that individuals should be counseled regarding diet, exercise, and weight reduction or maintenance to forestall or prevent the onset of type 2 diabetes.

The ADA recommends that women be reclassified for maternal glycemic status within six weeks after delivery using the guidelines of the "Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus". The ADA advocates the use of fasting plasma glucose over the 75-gram glucose tolerance test because it reduces the burden on the patient. However, the 2-hour oral glucose tolerance test is more accurate in identifying women with impaired glucose tolerance or diabetes (Conway, 1999).

When using the 2-hour oral glucose tolerance test in the non-pregnant state, a value less than 140 mg/dL indicates a normal value. A value of 140-199 mg/dL indicates impaired glucose tolerance. Diabetes mellitus is indicated by a 3-hour value $\geq$ 200 mg/dL (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2000).

If glucose levels are normal, the ADA recommends reassessment take place at a minimum of three year intervals (ADA, 2004). Women with impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) should receive annual diabetes testing. Patients with IFG or IGT should receive intensive Medical Nutrition Therapy and be prescribed individualized exercise programs. Furthermore, ADA states, "All patients with prior GDM should be educated regarding lifestyle modifications that lessen insulin resistance, including maintenance of normal body weight through MNT and physical activity."

In summary, all the major organizations concerned with prenatal and perinatal care as it applies to GDM find that women should be tested in the weeks following delivery. In addition, MNT and exercise counseling are recommended. Practitioners should warn women of their increased risk for type 2 diabetes and counsel them on the importance of follow-up testing, even if the postpartum test results indicate a normal fasting blood glucose. Many Americans have undiagnosed diabetes and, therefore, untreated diabetes. By encouraging post-GDM patients to get the recommended follow-up care, health care providers can prevent or slow the progression to type 2 diabetes. There is evidence that many of these women will progress to type 2 diabetes and health care practitioners are poised to deliver type 2 diabetes prevention and detection information to this high risk group.

PREVENTION OF TYPE 2 DIABETES IN POST-GDM WOMEN

Health practitioner recommendations to lose weight or maintain weight can help reduce or prevent future diabetes. Research shows that weight gain and additional pregnancies increase the risk of diabetes after GDM (Peters, 1996, Lauenborg, 2004). This suggests that insulin resistance may accelerate the decline in beta-cell function, the cells of the pancreas that produce insulin, which leads to diabetes (Kjos, 1999). Therefore, treatment of women with a history of GDM should include measures to minimize insulin resistance, such as exercise and maintenance of normal weight. Recommending nutritious diets and exercise to women in the postpartum period can serve as an effective means of prevention and early intervention for women at risk of advancing to type 2 diabetes.

Several studies have demonstrated that intervening with women in the postpartum period is an effective means of improving health. One behavioral intervention demonstrated that group sessions along with correspondence materials and phone contacts was effective in reducing weight (Leemakers, 1998). Study participants were encouraged to follow a low-calorie diet of 1000-1500 kcal a day along with walking 2 miles a day/ 5 days per week. Participants in the intervention reduced weight by 7.8 kg, significantly more than controls (Leemakers, 1998). Another study demonstrated that diet and exercise plans that included individualized calorie goals, coupled with 45 minutes of physical activity four days a week, were able to reduce the weight of participants by an average of 4.8 kg in 10 weeks versus the controls who lost only 0.8 kg in 10 weeks (Lovelady, 2000). O'Toole demonstrated that a structured exercise and diet program compared with controls that followed a self-guided brochure had much better results. The participants were compared at one year with the structured exercise and diet program participants losing an average of 7.3 kg, while the self-guided group had no change in body weight (O'Toole 2003). These studies demonstrate that exercise and diet can be effective tools in maintaining a healthy weight, an important step in preventing type 2 diabetes. The American Diabetes Association states, "*All patients with prior GDM should be educated regarding lifestyle modifications that lessen insulin resistance, including maintenance of normal body weight through MNT and physical activity*" (ADA 2004). While it is not realistic to enroll all post-GDM patients in a diet and exercise program, it is reasonable to ask practitioners to encourage follow-up testing and to offer dietary and exercise advice.

PHYSICIANS ADVICE AND BEHAVIOR CHANGE

Limited evidence exists that physician advice is effective in changing patient behavior following a GDM pregnancy because little research has occurred in this area. However, health care providers have been effective in helping patients change behaviors in other areas. Physicians and other health professionals have effectively helped patients change behavior in the areas of smoking cessation, increasing physical activity, and alcohol cessation or reduction.

In the area of smoking cessation two approaches have been effective; pharmacotherapy and counseling (US Public Health Service, 2000, Fiore, 2000, Lancaster 2000). Tobacco cessation research indicates the efficacy of treatment correlates with treatment intensity, although brief physician interventions during an office visit do promote smoking cessation (Rigotti, 2002). The Cochrane Review Group studied 31 trials that included over 26,000 smokers and found that brief advice increased the quit rate (OR 1.69, 95% CI 1.45 to 1.98) (Whitlock, 2004). A meta-analysis of randomized controlled trials conducted in primary care practices demonstrated that physician's brief (3 minutes or less) advice to stop smoking increases the rates of smoking cessation by approximately 30% (Lancaster, 2000). Counseling for three minutes or less is more effective than simply advising the patient to quit smoking, doubling the cessation rate when compared with no intervention (U.S. Public Health Service, 2000).

A meta-analysis of 37 randomized and quasi-experimental interventions on the efficacy of tobacco counseling by health care providers compared physicians to other providers (dentists, nurses, and teams of providers) found that physician interventions

were most successful in promoting smoking cessation (Gorin, 2004). Advice from teams of providers and physicians showed significant effects on smoking cessation (teams overall: ES=.79; 95% CI, -0.19 to 3.71, P=0.01 and physicians overall: ES=6.01; 95% CI, -2.46 to 13.29; P=0.002) however, physicians were significantly more effective in promoting cessation than were multi-provider teams (physicians: β= 4.13, P=0.005) (Gorin, 2004). Over half of the studies included used biochemical verification of quit rates (27% saliva, 19% expired air, 8% urinary cotinine, and 3% serum) (Gorin, 2004). The mean duration in was thirty weeks (SD=15.3), approximately 4-11months, with a mean number of four sessions. These finding support the use of physician counseling. To assess long-term cessation a number of rigorous studies are needed to measure follow-up cessation rates at twelve months or more. The meta-analysis conducted in 2004 found a trend toward reduced cessation in the longer assessment period but the small number of rigorous studies with twelve month follow-up did not permit subgroup analysis. Current findings indicate continued provider prompts may be necessary for long term behavior change.

Those programs that were most effective utilized the "five A's" recommended in the Public Health Service guidelines (Donatelle, 2005, U.S. Public Health Service, 2000, Gorin, 2004, Fiore, 2000). This strategy uses five steps: ask, advise, assess, assist, and arrange follow-up. The steps include: asking the patient if they smoke, offer personalized advice, assess the patient's readiness to change, assist the patient in moving along in the change process, and arrange a follow-up visit or phone call.

The 5 A's mnemonic has been applied to physical activity promotion in the primary care setting (CDC, 1998, Wee, 1999). The key steps include; (1) Assess the

patient's current level of physical activity and function (a brief questionnaire in the waiting room), (2) Advise the patient on the benefits of physical activity and relate the benefits back to the patient's health, (3) Assess with the patient their physical activity goals, barriers they might encounter, and what specific goals they have for type, intensity, duration, and frequency of activity, (4) Assist the patient in developing strategies to reach goal, (5) Arrange for follow-up assessment, support, and problem solving.

Several of these tasks can be done by staff to alleviate time spent by the physician. Nurses, dieticians, or educators can work with patients following physician advice to develop coping strategies, action plans, and to conduct follow-up. A variety of modalities can be incorporated to achieve results, such as computer interactive software, tailored printed materials, and telephone support (King, 1991, Piette, 2002, Glasgow, 2001).

Physicians and health care providers can also help patients increase their levels of physical activity. Many national organizations recommend that physicians and health professionals counsel patients on physical fitness (Fletcher, 1992, Fletcher, 1996, Expert Panel on Detection, Evaluation and Treatment of High Blood Pressure, 1993 National High Blood Pressure Education Program, 1997, National Institutes of Health consensus Development Panel on Physical Activity and Cardiovascular Health, 1996 Harris, 1989, US Department of Health and Human Services, 1997). Despite recommendations, physician counseling to exercise is low nationally; a recent survey found a national rate of only 34% (Wee, 1999). Common barriers to counseling include a lack of time during office visits, inadequate insurance reimbursement,

patient refusal to discuss or comply with recommendations, and a lack of physician expertise in counseling techniques (Burack, 1989, Kottke, 1993, McPhee, 1986, Spitz, 1992, Wender, 1993). Despite these barriers, physicians could assist patients with behavior change and overcome barriers by utilizing other health professionals for resources and referrals.

Alcohol abuse represents another effective area for physician advice. Generalist physicians who provide continuous care can play a major role in the care of patients who have alcohol problems, or who are at risk for alcohol problems by providing effective screening and assessment, patient education, office-based interventions, and referral to specialty services if indicated, physicians assist problem drinkers (O'Connor, 1998). The efficacy of brief interventions for nondependent drinkers has been documented in seven of eight clinical trials in health care settings (Bien, 1993). The acronym FRAMES (feedback: review problems; responsibility: change is the patient's responsibility; advice: make recommendation; menu: provide options for behavior change; empathy: use an empathetic approach; and self-efficacy: encourage optimism about changing behavior) summarizes the steps taken in counseling change (Miller, 1991). In a multinational study sponsored by the World Health Organization, 1500 heavy drinkers were randomly assigned to have a twenty-minute health interview only (control), or in addition, five minutes of "simple advice", or twenty minutes of "brief counseling". Men in both intervention groups reduced their daily alcohol consumption by 17% more than controls, with simple advice being as effective as brief counseling (WHO Brief Intervention Group, 1996).

A study conducted by Fleming et al. in Wisconsin evaluated brief intervention by a physician in a sample of 723 subjects (Fleming, 1997). Both the intervention and control groups received a booklet on general health issues. The intervention group also received structured counseling about their drinking behavior during two 15-minute visits to a physician and a follow-up call from a nurse. After one year, the intervention group significantly reduced the mean number of drinks per week (19.1 to 11.5) and the mean number of episodes of binge drinking over 30 days (5.7 to 3.1). Although general physicians might not be experts in alcohol problems, they can play a significant role in helping patients with problem drinking behaviors (O'Connor, 1998).

The U.S. Preventive Services Task Force summarized behavioral counseling interventions in primary care to reduce alcohol use by adults and found that good-quality brief multi-contact behavioral counseling interventions reduced risky and harmful alcohol use by primary care patients (Whitlock, 2002). Brief multi-contact interventions have an initial session lasting up to 15 minutes and several follow-up contacts. Meta-analysis of 7 clinical trials showed a total risk reduction of 10.5%. Very brief or brief single-contact interventions were less effective in reducing risky drinking. Very brief interventions consisted of one session, up to one minute long, and brief interventions consisted of one session, up to 15 minutes long. This is in contrast with tobacco findings that demonstrate effective very brief and brief interventions in primary care (Fiore, 2000). However, the effective elements in alcohol reduction are consistent with tobacco, effective interventions generally contained the 5 A's approach to behavioral counseling (Whitlock, 2002).

PHYSICIANS ROLE IN PRIMARY PREVENTION OF TYPE 2 DIABETES

Epidemiological data suggest that lifestyle and dietary changes can prevent diabetes or improve glycemic control (Helmrich, 1991, Manson, 1991, Wing, 1989, Diabetes Prevention Program Research Group, 2002, Tuomilehto, 2001). The Diabetes Prevention Program Research Group demonstrated that lifestyle intervention, including moderate exercise and a low-fat, low-calorie diet, reduced the incidence of diabetes by 58% (Diabetes Prevention Program Research Group, 2002). Researchers from Cedars-Sinai Medical Center in Los Angeles, CA proposed that annual follow-up of GDM would provide ongoing incentive for permanent life-style changes that may decrease the development of diabetes (Gregory, 1993). Health practitioners can continually check-in with patients about their diet and physical activity habits during annual exams. Practitioners have the ability to encourage healthy lifestyles and save on health costs. Davidson states, "*Diabetes care is different from most other types of medical care in that it is mostly preventive. Meeting ADA guidelines will go along way toward, if not preventing, at least delaying the complications of diabetes*" (Davidson, 2003).

Primary prevention of type 2 diabetes would save millions of health care dollars. In 2002, total medical expenditures incurred by people with diabetes were $13, 243 per person, compared to $2,560 for people without diabetes (National Committee for Quality Assurance, 2006). In the 1990s, researchers compared the projected costs to treat non-insulin dependent diabetic women against the cost of offering preventative care to post-GDM women, including counseling and screening for diabetes, from a birth cohort of women with gestational diabetes (Gregory, 1993).

The researchers projected a modest 3% of the cohort would progress to type 2 diabetes. They then compared the health care costs that would be incurred for overt diabetes against the cost of offering counseling at annual visits and a serum glucose screening test to all women in the same cohort. The projected cost of treating the non-insulin-dependent diabetics over 10 years was $818 million, compared to $39.8 million to counsel and evaluate the entire cohort over the 10-year observation period reported in 1990 dollars (Gregory, 1993). Even with modest prevention efforts there would be a large savings in health care dollars.

Post-GDM women are an ideal cohort for primary prevention strategies. A prevention strategy postpartum capitalizes on existing health resources with a minimal amount of spending (Gregory, 1993, Davidson, 2003). Most women return for a postpartum visit as well as annual exams (National Committee for Quality Assurance, 2006, 2003). Thus, regularly scheduled exams can serve as primary prevention. Additionally, further health care savings may be realized as women whom are new parents adopt healthier diets and exercise behaviors. Parents serve as role models for their children and influence their children through both the type of foods bought and the dietary behaviors they model.

In the *Clinician's Handbook of Preventative Services*, published by the Agency for Healthcare Research and Quality (AHRQ), clinicians are encouraged to "Put Prevention into Practice" (AHRQ, 2006, 2003, 1998). This handbook offers chapters devoted to counseling patients on both nutrition and physical activity in the section titled Metabolic, Nutritional and Endocrine Conditions (AHRQ, 2006, 2003, 1998).

Guidelines published by AHRQ encourage practitioners to discuss dietary choices and physical activity with patients in an effort to reduce and prevent chronic disease.

In the publication titled, *Guide to Clinical Preventative Services, 3rd Edition Recommendations*, the National Library of Medicine provides further evidence that practitioners can offer primary prevention services to patients. This publication summarizes the U.S. Preventive Services Task Force (USPSTF) recommendations for over 80 health conditions. The recommendations include behavioral counseling in the primary care setting for dietary change and increasing physical activity. The USPSTF recommends intensive behavioral dietary counseling for adult patients with hyperlipidemia and other known risk factors for cardiovascular and diet-related chronic disease. Primary care clinicians can deliver intensive counseling or refer patients to other specialists, such as nutritionists or dietitians. The USPSTF statement reads as follows:

> "The USPSTF found good evidence that medium - to high -intensity counseling interventions can produce medium -to -large changes in average daily intake of core components of a healthy diet (including saturated fat, fiber, fruit, and vegetables) among adult patients at increased risk for diet -related chronic disease. Intensive counseling interventions that have been examined in controlled trials among at -risk adult patients have combined nutrition education with behavioral dietary counseling provided by a nutritionist, dietitian, or specially trained primary care clinician (e.g., physician, nurse, or nurse practitioner). The USPSTF concluded that such counseling is likely to improve important health outcomes and that benefits outweigh potential harms." (U. S. Preventive Services Task Force Staff, 2002).

Though USPSTF found clear evidence of the benefits of dietary counseling, the task force found insufficient evidence to recommend for or against physical activity counseling in the primary care setting. The USPSTF concluded that regular physical activity had clear benefits. However, whether routine counseling and follow-

up by a primary care physician results in increased physical activity was unclear (U.S. Preventative Services Task Force Staff, 2002).

Evidence from the USPSTF task force provides some indication that counseling and screening post-GDM women in the primary care setting may reduce or slow the progression to type 2 diabetes. However, many mothers receive inadequate counseling from busy clinicians after delivery (Kleinfield, 2006). Furthermore, a surprising number of patients fail to confirm that the gestational diabetes went away following pregnancy (Kleinfield, 2006).

New York health officials have concerns about insufficient attention being paid to the rise in gestational diabetes. In New York gestational diabetes has risen by nearly 50% in ten years (New York State Department of Health, 2006). Nationally, the nature and extent of post-GDM care is unclear. This study will assess health care practices in the post-GDM period in Oregon that will be used to identify gaps in care and provide information for future planning and implementation of health interventions.

METHODS—CHAPTER 3

This methods chapter is comprised of two distinct parts. Part I was designed to assess risk factors for GDM in a population-based sample of Oregon women utilizing data collected for Oregon Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS, administered by the Center for Disease Control and Prevention (CDC), is an ongoing, state-specific, population-based surveillance system of maternal behaviors and experiences before, during, and after pregnancy. Part 1 utilized PRAMS and Department of Human Services Center for Health Statistics Birth Certificates, to examine the relationship between the dependent variable (GDM) and three independent variables (BMI, ethnicity/race, and maternal age).

Part II was designed to assess Oregon physician practice patterns during and following a GDM pregnancy. The sample consisted of MDs in the specialties of Family Practice and Obstetrics and Gynecology that held active practice licenses in Oregon in November 2005, when the list was generated by the State of Oregon: Board of Medical Examiners. Part 2 utilized the *Post Gestational Diabetes Mellitus Care Survey*, developed for this research, to examine the nature and extent of care given to patients after a GDM pregnancy.

PART 1 INTRODUCTION

The first portion of this study was based on PRAMS data from 2001 and the corresponding birth certificates. PRAMS is a Centers for Disease Control and Prevention (CDC) surveillance project. At the state level, PRAMS is carried out by state health departments. In Oregon, the Department of Human Services administers the PRAMS survey each year. PRAMS researchers collect state-specific, population-

based data on maternal experiences. The PRAMS data, used in conjunction with state birth certificates, examine a number of health conditions. Each PRAMS survey has an identification number that links the survey with the corresponding birth certificate.

Study Population

Each year PRAMS researchers survey a stratified random sample of the total population of women who have given birth in that particular year. The most recent PRAMS data available for analysis was 2001. In 2001 there were 45,318 (total population) births in Oregon (Oregon Center for Health Statistics, 2002). In order to survey a representative sample, researchers surveyed a disproportionate number of minorities using a formula that represents that actual population of the state. The Oregon Department of Human Services (OHDS) selects survey respondents using the following sampling fractions:

- 41.17% African Americans
- 53.81% America Indians
- 21.17% Asian Pacific Islanders
- 6.85% Hispanics
- 1.48% Whites

The total sampling fraction was 5.0% in 2001. The sampling plan for Oregon assumes a risk factor proportion of 0.50, a 95% confidence interval, and a precision level of +/- 0.05. This plan calculates sampling fractions based on the population proportion of births. Each of the five groups listed above was allocated 400 people to randomly sample from. Researchers then calculated an initial sampling fraction based on the proportions of births. Next, the response rate for each group was considered. The expected response rate was 70% for African Americans, American Indians, and Asian Pacific Islanders; the expected response rate for Hispanics and Whites was 80%.

PRAMS inflates the sample size of each group based on response rates. The expected response rate for each group changed the allocation to the following:

- 407 African Americans
- 357 American Indians
- 487 Asian Pacific Islanders
- 500 Hispanics
- 500 Whites

Finally, researchers calculated the sampling fractions and multiplied the numbers of births by the final sampling fraction to get the number surveyed each year. ODHS calculated the sample on a monthly basis using the sampling fractions shown above. The population of births in 2001 (45, 318) yielded a sample size of 2,490 women, representing 5% of the total population.

Sample

The PRAMS survey was sent to 2,490 women in 2001. A weighted response rate of 72.1% yielded N=1,795. For this research the entire 2001 sample was used in the analysis less 12 women who had "unknown" GDM status. The sample size was large enough to insure that each stratum, or racial or ethnic group, had enough respondents to reasonably represent the population of Oregon. Each stratum had approximately 200 people to insure group representation and make it possible to examine ethnic and racial variations.

PART I DESIGN/PROCEDURE FOR DATA COLLECTION

For this research a secondary data analysis was preformed on the 2001 PRAMS survey data. Use of the PRAMS data was approved by the institutional review board at Oregon State University and by the Oregon Department of Human Services. The data for 2001 was transferred to the researchers of this study in

December of 2005. The data used in this study was collected by PRAMS researchers at ODHS in 2001. Researchers at ODHS examined the surveys for missing data patterns. The 2001 PRAMS data had no particular pattern to the missing data. In other words, questions were randomly left blank. To handle missing values, ODHS weights the sample for non-responses and over sampling. To handle missing data cases with similar characteristics make up for those with missing data by using weights. This means that other cases from the same strata are given more weight to represent the case that is not complete. Likewise, if there are too many survey respondents in a particular stratum, they are given less weight to avoid over-representation of a particular racial or ethnic group. Weighting the data was done by mathematical formula. In this sample missing data values were computed by ODHS researchers.

PART I PROCEDURES FOR DATA ANALYSIS

Part I includes analyses of 1783 responses from participants who completed the PRAMS survey in 2001 and responded to the GDM question on the birth certificate with a yes or no answer. We examined the following research questions:

- RQ1a. What is the prevalence of GDM among various subpopulations of women in Oregon?
- RQ1b. What is the prevalence of obesity pre-pregnancy in Oregon?
- RQ1c**.** To what extent are pre-pregnancy BMI, race/ethnicity, and mother's age associated with GDM?

These questions were assessed by analysis of PRAMS data and the corresponding birth certificates.

Both PRAMS surveys and birth certificates were used to explore the research questions for part I. Descriptive statistics were used to demonstrate the distribution of BMIs, race/ethnicity and GDM, and GDM distribution by age among Oregon pregnant women in 2001. BMI distribution was further examined by ethnic/racial group membership and maternal age. The remaining question, "*To what extent are pre-pregnancy BMI, race/ethnicity, and mother's age associated with GDM"* was analyzed with logistic regression. Using Stata software, the relationship between the independent variables (IVs) pre-pregnancy BMI, mother's age, and race/ethnicity; and the dependent variable, GDM, were assessed.

The IV, pre-pregnancy BMI, was calculated using questions 15 and 16 on the PRAMS survey. Question number 15 asks the respondent to report pre-pregnancy weight, "*Just before you got pregnant, how much did you weigh?*" and question 16 asks the respondent to report their height in feet and inches, "*How tall are you without shoes*?" (PRAMS, 2001). The second IV, mother's age, is question #2 of PRAMS. Finally, the third IV, information regarding ethnicity, was recorded from the birth certificate, looking at questions number 14 and 15, which ask the mother to specify if she is "OF HISPANIC ORGIN" (yes or no) and her race (Oregon Center for Health Statistics -Vital Records Unit, 1995). The dependent variable, GDM, is identified on the birth certificate in question 33. Question 33 asks, *Did you have GDM during this pregnancy?,* with responses including *yes, no, or unknown*. This information is self-reported.

PART I REPORTING

The results of this research are reported in three articles prepared in manuscript format. The results for Part I are reported in Article 1. Articles 2 and 3 are explained in Part II below. Article 1 examines GDM prevalence in Oregon including variations in racial/ethnic groups. Article 1 includes an analysis of GDM and the risk factors pre-pregnancy BMI, race/ethnicity, and mother's age in the OR PRAMS 2001 sample. Stata 9 (for Windows, StataCorp LP, College Station, Texas, 2001) was used to perform all analyses.

PART II INTRODUCTION

Part II of this study utilized the *Post Gestational Diabetes Mellitus Care Survey*, developed for this research, to examine the nature and extent of care given to patients during and after a GDM pregnancy.

Study Population

The survey population included MDs working in the area of Family Practice or Obstetrics and Gynecology who held active licenses in Oregon at the time the sample was drawn. These specialties were selected for this research after interviewing physicians in the Portland area to determine which practitioners would be most likely to treat pregnant and postpartum women. In addition, the Oregon Center for Health Statistics data was used to determine which type of specialist delivers the majority of babies in Oregon. An MD attends over 80% of pregnancies in Oregon, representing the vast majority of births (Oregon Center for Health Statistics, 2001).

Sample

A random sample was drawn from each of the two specialties obtained from the Oregon State Medical Examiners Board using Stata 9.

PART II DESIGN/PROCEDURE FOR DATA COLLECTION

The Gestational Diabetes Mellitus Care Survey was designed by the authors for use in this study in order to describe practitioners' routine practice patterns, attitudes, and behaviors regarding post-GDM care in Oregon. The survey was reviewed by experts in public health and behavioral sciences and by MDs in family practice and obstetrics and gynecology. Based on reviewer feedback the survey was modified prior to mailing. In order to assess reliability the reviewers provided feedback on the instrument's ability to reliably obtain information about GDM post-partum care (Aday, 1996). Content validity was also assessed by the expert reviewers. Content validity relies on judgments about whether the questions are representative of the concepts they are intended to reflect (Aday, 1996).

The demographic portion of the questionnaire (Questions 1-6) collected information about the health practitioner in order to compare differences between groups. Statements about routine practice patterns (Question 7-11) give insight into the nature and extent of care during pregnancy, including the type of screening criteria most commonly used in the state of Oregon. Question 12 asked participants to report on their postpartum care practices. Statements about routine care after a GDM pregnancy provided the authors with a description of routine post-GDM care in Oregon. Questions 13 and 14 allowed the researchers to gain an understanding of the

attitudes and beliefs practitioners have regarding GDM. Question 15 gave the participant room for comments regarding the survey.

Each potential participant was mailed a questionnaire on November 18, 2005, which included a postage-paid return envelope and a cover letter explaining the purpose of the study. The cover letter explained that the information provided would be kept confidential if they chose to participate, but potential participants had the right to refuse participation. The participants were informed in the cover letter that by returning the survey they consented to the use of the information they provide in aggregate form. The cover letter explained that each survey had an identification number which was used to identify who returned questionnaires.

A follow up postcard was mailed to all members of the sample on November 26, 2005, eight days after the original mailing. The purpose of this postcard was to thank those who had responded and to encourage those who had not responded to do so. Three weeks after the first mailing, on December 9, 2005, a final mailing was sent to those that had not responded. This mailing included a new cover letter encouraging participation, a copy of the questionnaire, and a postage-paid return envelope.

The survey was sent in a plain white envelope with a first-class stamp, not as a bulk mailing. The return envelope also had a first-class stamp. The cover letter had a personalized message in the first and third mailing that clearly explained the importance of this research. The second mailing was the postcard reminder which contained only a brief message thanking the participant and encouraging participation if they had not done so.

PART II PROCUDURES FOR DATA ANALYSIS

Part II includes analyses of 283 physician responses to the GDM Care Survey. We examined the following research questions for article 2:

- RQ2a**.** What is the demographic profile of Physicians working with pregnant women in Oregon?
- RQ2b**.** To what extent are Oregon physicians testing for GDM during pregnancy and which screening guidelines do they use?
- RQ2c. To what extent are Oregon physicians screening for glucose intolerance following a GDM pregnancy (postpartum)?
- RQ2d**.** Do Family Practice and Obstetric/Gynecologists differ in level of follow-up care?
- RQ3a**.** Are differences in practice patterns associated with specialty, years of practice, practice setting (Health Maintenance Organization, clinic, solo, two or more, center, other), geographic placement (urban, rural, suburban), and gender of the physician?
- RQ3b**.** Are selected physician characteristics, attitudes, subjective norm and beliefs associated with level of care for GDM?
- RQ4a. What percentage of Oregon Physicians offer post-GDM care?

These questions were examined using descriptive statistics, chi-square, and logistic regression.

PART II REPORTING

Article 2 contains the results of the GDM Care Survey. Article 3 contains a call to action for standard testing guidelines for diagnosing GDM, referral to a diabetes specialist once a diagnosis has been made and for postpartum care that follows established guidelines. Article 3 continues with a discussion of how care patterns and inconsistent testing guidelines impact women's health. These articles will be a significant addition to the literature because to date few articles have been published on post-GDM care practices. We propose a public health approach and encourage primary prevention of type 2 diabetes.

RESULTS-CHAPTER 4

ARTICLE 1: **Assessment of Risk Factors for Gestational Diabetes in Oregon**

Objective: We sought to determine the prevalence and factors associated with gestational diabetes mellitus (GDM) in a large sample of Oregon women.

Research and Design Methods: The Oregon Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing state survey system that collects information on individual maternal characteristics, behaviors, and experiences that occur several months prior to conception, during pregnancy, and immediately following delivery. Women are asked to reflect back on the time prior to conception, during pregnancy and then immediately following pregnancy and answer survey questions. Each month all women who give birth in Oregon are eligible for random selection from a file of birth certificate records using stratified systematic sampling. In 2001 there were 45, 318 births in Oregon. Analysis was conducted on the data from 1783 women who participated in the 2001 PRAMS survey and responded to the question regarding gestational diabetes.

Results: Risk factors for gestational diabetes mellitus (GDM) including body mass index, racial or ethnic minority group membership, and maternal age were analyzed using logistic regression. Being overweight or obese, as indicated by pre-pregnancy BMI, increased a women's risk for GDM by greater than 2.5 times (OR 2.68, p=0.03, CI=1.10-6.56). Racial and ethic group members had a 1.26 fold increase for GDM or 26% greater risk (OR 1.26, p=0.014, CI=1.05-1.53). Racial and ethnic groups examined in this research included non-Hispanic African Americans, non-Hispanic Native American Indians, non-Hispanic Asian/Pacific Islanders, non-Hispanic whites,

and Hispanics. Advancing mother's age also increased the risk for GDM (OR 1.10, p=0.008, CI=1.03-1.18).

Conclusions: Maternal risk factors for GDM included pregravid overweight, minority group membership and advancing maternal age. Being overweight or obese pre-pregnancy places pregnant women at increased risk for GDM and for the long-term GDM-associated consequences to both the mother and child. Racial or ethnic minority group membership was also a significant risk factor for GDM that may require earlier screening and/or intervention by health professionals. Advancing maternal age was a risk factor that, like ethnicity or race, is not modifiable and may require earlier screening and monitoring by health professionals. Since the condition of being overweight or obese is largely preventable or modifiable, efforts to counsel women on how to achieve and/or maintain a healthy weight should be a public health priority. The health priority is to minimize risk by educating patients about their modifiable risk factors; body weight, diet, and physical activity.

Introduction

Gestational Diabetes Mellitus (GDM) is defined as glucose intolerance with onset, or first recognition during pregnancy (1, 2). GDM affects approximately 3-8% of all pregnant women, with approximately 135, 000 cases diagnosed annually in the United States (1, 3). Variation in prevalence among different racial/ethnic groups has been documented, with higher prevalence among Native-American, Asian, African-American, and Hispanic populations than among non-Hispanic whites (4, 5).

Exposure to maternal hypoglycemia has implications for both the mother and infant. The consequences of high-blood glucose are both immediate and long-lasting

for the mother and child. The infants of women with GDM are at increased risk for macrosomia (large-for- gestational age), operative delivery (caesarean), shoulder dystocia, and birth trauma. Macrosomia occurs in approximately 50% of pregnancies complicated by GDM (6). Operative delivery, or caesarian section, is indicated more often in women with GDM because of macrosomia. In a case-control study comparing the outcome of pregnancy in 65 women with GDM and 153 women with normal carbohydrate metabolism, matched for age, height, and pre-pregnancy weight, more primary cesareans sections occurred in pregnancies complicated by GDM (7). The greater size of macrosomic infants increases the risk for shoulder dystocia (8). Shoulder dystocia occurs when the neck retracts back against the mother's perineum because the baby's anterior shoulder has caught on the mother's pubic bone (8). If the baby is not freed within a few minutes they can suffer permanent brain damage or even death (6). Controlling GDM to normalize blood glucose helps to minimize these complications.

Later in life the consequences of GDM can be equally devastating to the child. Children of GDM pregnancies face increased risk for obesity and diabetes. A study compared offspring of GDM (OGDM) women that were large- for-gestational age (LGA) to offspring that were appropriate-for-gestational age (AGA) against controls with offspring that were LGA and AGA (9). The authors concluded that the LGA offspring of GDM women have evidence of increasing body size and fat with increasing age. Maternal GDM and maternal pre-pregnant adiposity significantly predicted the unique growth patterns seen in the offspring of GDM women (9). Furthermore, the disturbances of intrauterine metabolic and hormonal environment

can lead to infant and adult diseases (10). Gestational diabetes increases the risk for offspring to become overweight, develop metabolic syndrome, type 1 diabetes, impaired glucose tolerance (IGT), and type 2 diabetes (11, 12, 13). Silverman found that IGT in offspring is a long-term complication of maternal diabetes (13). More recently researchers in Berlin, Germany examined birth weight and parental BMI as predictors of childhood overweight. The sample consisted of 324 children born to Caucasian women with GDM. The children, ranging from 2-8 years of age, had significantly higher BMIs when compared with the average German population (14). This research highlights the need for regular medical screening of children following a GDM pregnancy. Compared to the general population, offspring of GDM women are more likely to be overweight, have impaired glucose tolerance, and type 1 or type 2 diabetes. The American Diabetes Association recommends that offspring of women with GDM be monitored closely for the development of obesity and/or abnormalities of glucose tolerance (1). The long-term consequences associated with GDM do not stop with the children.

Women with GDM are at increased risk for type 2 diabetes, hypertensive disorders, and cesarean delivery (12, 15, 31). Although the mechanisms are not completely understood, it is clear that women who have had GDM are at increased risk for the development of type 2 diabetes (16, 17). A systematic review of GDM patients from 1965-2001 found the cumulative incidence of type 2 diabetes increased markedly in the first 5 years after a GDM pregnancy and appeared to plateau after 10 years (18). Others have found the risk of progressing to type 2 diabetes to be as high as 75% following a GDM pregnancy (19). Cheung stated, “In some populations,

women who have had GDM comprise a substantial proportion of subjects who ultimately develop diabetes" (20). Diabetes increases the risk for other serious diseases including hypertensive disorders and cardiovascular diseases.

Cardiovascular disease has a significant impact on women with diabetes. Over the past thirty years, deaths from heart disease have declined by 27% in women without diabetes. In contrast, heart disease has increased by 23% in women with diabetes (21). Women with diabetes are 7.6 times more likely to suffer peripheral vascular disease (PVD) than women without diabetes. PVD is the result of reduced blood flow and oxygen to the tissues in the feet and legs (21). Diabetes is the leading cause of blindness and treated end-stage renal diseases in adults (22).

Another complication of GDM is cesarean delivery. While cesarean delivery is not unique to diabetic pregnancies, the percent of cesarean deliveries performed is greater in diabetics compared to non-diabetic pregnancies (7). Increased cesarean deliveries are due to the large-for-gestational-age infants that are often the product of a diabetic pregnancy. Identifying the populations most at risk for GDM is an important step in reducing the incidence of GDM and the related complications during pregnancy.

Previous studies have found that women are at high risk for GDM if they are overweight or obese, members of a high-risk ethnic group (Hispanics, African, Native American, South or East Asian, or Pacific Island ancestry), or of advancing maternal age. (1,12). A recent study conducted by Kaiser Permanente of Colorado found that being overweight and a member of an ethnic group other than non-Hispanic white was significantly associated with GDM (23). The same study concluded that GDM

increases with advancing maternal age. The Kaiser study plotted trends in four generations and a rise in GDM prevalence was seen in the decade after 25 years of age. Another study found maternal age ≥33 years and pre-gravid BMI indicative of overweight was the most important risk factor for aboriginal women in Saskatoon, Canada, whereas in non-aboriginal women ≥38 years was a significant predictor of GDM (12).

A Dutch research group examined risk factors for mild hyperglycemia and GDM comparing these two groups against a control group (32). Researchers found maternal age, pre-pregnancy BMI, and non-Caucasian ethnicities were associated with GDM, whereas only maternal age and pre-pregnancy BMI were associated with mild maternal hyperglycemia. The mean age of the control group subjects (33.2 ±5.1) was lower than for those with mild hyperglycemia and GDM. The difference was significantly different, ($p<0.05$), maternal hyperglycemic subjects (35.2±5.3) and GDM women (35.2±5.0) were older than the controls (32). Maternal age is an established risk factor for GDM, but there is no consensus on the age above which there is significantly increased risk of GDM (33). The American Diabetes Association recommends testing all women 25 years or older (1, 33).

The problem is there is no clear rationale 25 years is the critical age. In this study we examined the risk factors for GDM in a sample of Oregon women, including maternal age, pre-pregnancy BMI, and racial/ethnic group membership.

Research Design and Methods

This study was approved by the Oregon State University Institutional Review Board. Permission to use the Oregon Pregnancy Risk Assessment Monitoring System

(PRAMS) data was granted by the Oregon project coordinator for PRAMS, Dr. Ken Rosenberg, at the Oregon Department of Human Services. The cohort of women described below was identified through the PRAMS database. PRAMS survey data supplement birth certificate information and provides Oregon with information specific to the state which can be used to plan and evaluate maternal and child health programs and make health policy decisions. Each month female residents of Oregon who have recently delivered a live-born infant during the preceding 2-4 months are randomly selected from birth certificate records using stratified systematic sampling. Each mother is eligible for random selection only one time in the 2-4 month period following childbirth. Potential participants are mailed a letter that introduces them to the project, followed by a self-administered 14-page standardized questionnaire and a participant consent form several days later. The PRAMS questionnaire consists of 60 core questions that are designed to supplement vital records by providing state-specific data on maternal behaviors and experiences to be used for planning and assessing prenatal health programs.

Researchers in Oregon, as well as researchers in other states participating in PRAMS, collect and submit data to Center for Disease Control and Prevention (CDC) from three different sources: the PRAMS questionnaire, the birth certificate, and survey operational data. Researchers annually weight the data to adjust for non-response, non-coverage, and sampling fractions. The PRAMS data contain mothers' responses to the questionnaire. The birth certificate data contain information on selected maternal characteristics (e.g. race, ethnicity, age) and pregnancy outcomes (e.g. birth weight, gestational age). The PRAMS operational software generates

operations data used primarily for operational evaluations and analyses of survey methods. In addition, a comment data set is maintained separately from the weighted project area data sets. The comment data set consists of mothers' comments on the questions or comments about answering questions related to their pregnancies. Analysts use the comment file to re-code maternal responses or to obtain qualitative data from written or verbatim comments.

Statistical Analysis

Included in this analysis are women who responded to the 2001 Oregon PRAMS and responded yes or no to the birth certificate question asking them whether they had been diagnosed with GDM during pregnancy (N=1783). The outcome of interest was the presence or absence of GDM. From the initial PRAMS sample of 1795 women twelve respondents indicated that they did not know if they had GDM. These cases were dropped from the analysis for the final N=1783.

Potential predictor variables selected for correlational analysis were based on the knowledge of associations reported in the literature. We computed the annual prevalence of GDM for five race/ethnic groups: non-Hispanic whites, non-Hispanic African Americans, non-Hispanic Native American Indians, non-Hispanic Asian/Pacific Islander, and Hispanics. In order to determine the relative importance of pre-pregnancy BMI, mother's age, and race/ethnicity ($p<.05$) as predictors of GDM a standard logistic regression with GDM as a dichotomous dependent variable was performed. The variables entered the model simultaneously since no clear theoretical rationale about the order or significance of the predictors existed. We used Stata 9

(for Windows, StataCorp LP, College Station, Texas, 2005) to perform all analyses. All *p* value tests were 2-sided.

Results

A total of 1783 women who had responded to PRAMS in 2001 and had responded to the birth certificate question asking them if they had GDM during their pregnancy were eligible for analysis. Women ranged from 13-49 years of age, with a mean maternal age of 26.4 years. The prevalence of GDM was computed for five racial/ethnic groups; non-Hispanic white, African American, Native American Indian, Asian/Pacific Islander, and Hispanics. The results are shown in Table 1. The overall prevalence of GDM was 4.3% in the 2001 sample. Asian and Pacific Islanders had the highest GDM prevalence (5.4%) when compared with other racial and ethnic groups.

Table 1: **Race and GDM 2001**

Group	*Sample Size (N)*	**N (%) with GDM**
Non-Hispanic white	569	21 (3.7%)
African American	187	8 (4.3%)
Indian	187	5 (2.7%)
Asian/Pacific Islander	314	17 (5.4%)
Hispanic	525	26 (5.0%)
Overall	1,783	77 (4.3%)

The PRAMS survey collects height and weight data from the women. The information is self-reported. Women are asked to reflect back and record their pre-pregnancy weight and their height. The reported values for height and weight were used to calculate the body mass index (BMI) of each respondent. Table 2 presents the frequency distribution for BMI divided into four body mass index (BMI) groups (underweight, normal, overweight and obese).

Table 2: **Frequency of BMI Groups**

Body Mass Index kg/m²	*Frequency*	*Percent*	**Cum.**
Underweight BMI <18.5	102	6.48 %	6.48
Normal BMI ≤18.5-<25	843	53.59 %	60.08
Overweight BMI >25-<30	370	23.52 %	83.60
Obese BMI ≥ 30	258	16.40 %	100.00
Total	1,573	100.00 %	

These frequencies reflect the frequency of overweight and obesity in the United States. The Center for Disease Control and Prevention Pregnancy Nutrition Surveillance reported 13% of U.S. women had a pre-pregnancy BMI indicative of underweight and 41.5% had a pre-pregnancy BMI indicative of overweight/obesity in 2001. Our findings suggest that fewer Oregon women are entering pregnancy underweight (6.48%) as compared to the national average (13%). However, the prevalence of overweight and obesity in Oregon (40%) approximates the national average (41.5%).

For the purpose of analysis, the four BMI groups were collapsed into two groups: (a) underweight and normal (BMI 18.5-24.9 kg/m^2), and b: overweight and obese (BMI 25 kg/m^2 or greater), a dichotomous variable, indicating the absence or presence of overweight. The dichotomous variable was used to assess whether being overweight was a significant risk factor for GDM. This is consistent with other studies that have examined BMI ≥ 25 kg/m^2 and found it to be a significant risk factor (12, 32, 33).

The logistic regression included final survey weights for all variables and analyzed the risk factors for GDM including; body mass index, racial/ethnic group membership, and maternal age (see table 3).

Being overweight or obese, as indicated by pre-pregnancy BMI, increased a women's risk for GDM by greater than 2.5 times (OR 2.68, p=0.03, CI=1.095-6.57). Racial and ethic group members, other than non-Hispanic whites, had a 1.26 fold increase for GDM or 26% greater risk (OR 1.26, p=0.014, CI=1.049-1.531). Advancing maternal age was also a significant predictor for GDM (OR 1.10, p=0.008, CI= 1.026-1.182).

Table 3: **The effect of Maternal Age, Pre-pregnancy BMI and Race/Ethnicity on GDM (N=1,783)**

GDM	***OR***	***Linear Std. Err.***	***t***	***P>|t|***	95% Conf. Interval
Mother Age	1.10	.039	2.67	0.008	1.026-1.182
Race/Ethnic	1.26	.122	2.46	0.014	1.049-1.532
BMI Group	2.68	1.22	2.17	0.031	1.095-6.566

There are significant differences in GDM occurrence by age, χ^2 (4, N=1,783) =16.958, p=0.002. As shown in Table 4, less than 1% of women under the age of 20 years developed GDM. In women age 20-24 years, only 2% experienced pregnancies complicated by GDM. With age comes a concomitant increase in GDM occurrence. By age 25-34 years, 5.5% of women had pregnancies complicated by GDM and those 35 years and older had 7.5% of their pregnancies complicated by GDM.

Table 4: GDM by Age Group (N=1,783)

GDM	***Under 18***	***18-<20***	***20-24***	***25-34***	**35 and up**
No	73	93	545	823	172
Yes	1	1	13	48	14
Total	74	94	558	871	186
% with GDM	1%	1%	2%	5.5%	7.5%

Conclusions

We found that being a member of a minority group, especially non-Hispanic Asian/ Pacific Islander and Hispanic, increasing maternal age, and pre-gravid BMI greater than 25 kg/m^2 are all significant risk factors for GDM.

Being a member of a minority racial or ethnic group is a significant risk factor for GDM and for future type 2 diabetes. Minority racial or ethnic group membership is not modifiable but it may require earlier blood glucose testing and closer monitoring by health professionals (23, 28). We found that non-Hispanic Asian/Pacific Islander women had the highest prevalence (5.4%) of GDM followed by Hispanic women (5.0%) in Oregon. This is consistent with the Kaiser Permanente of Colorado findings. In a study of 36, 403 women from 1994-2002 prevalence increased for all women, 2.1% in 1994 to 4.1% in 2002, but most significantly in Asian/Pacific Islander women, 6.3% to 8.6% respectively (23).

Advancing maternal age represents another unalterable risk factor for GDM. We found that maternal age over 25 years indicated a significant jump in prevalence (5.5%). Women with the highest risk for GDM are 35 years are older (7.5%) This finding is supported by a 1997 Canadian study that found among 741 women prevalence rates for GDM increased with age**,** peaking at 46.9% in the age-group ≥ 35 years of age (29). A recent publication states that maternal age is an established risk factor for GDM but the age of increased risk is not clear (30). Our findings support the American Diabetes Associations recommendation to screen all women ≥25 years of age.

The most significant risk factor for GDM appears to be a BMI ≥ 25 kg/m^2 pre-pregnancy. There is also strong evidence that overweight/obesity is a main modifiable risk factor in the development of type 2 diabetes later in life (22). Several studies have found an association between pre-pregnancy BMI and type 2 diabetes (34-38).

These findings highlight the importance of obtaining or maintaining a healthy weight throughout the lifespan.

In spite of major efforts to prevent overweight and obesity prior to pregnancy, greater than 40% of women continue to enter pregnancy overweight. Pregnancy and the postpartum period may offer one of the greatest windows of opportunity to work with women in modifying both their health risks and their children's health risks (18). Kim et al. concluded in a 2002 review that future research should examine the applicability of prevention strategies in the "unique" post-GDM population. This period is unique because pregnant women are seeing their health providers often, as much as once a week as delivery nears. In the postpartum period women return for a postpartum checkup most of the time. Nationally, women with commercial insurance return 81.5% of the time (40). Women using Medicaid insurance return 57% of the time (40). The Diabetes Prevention Program Research Group concluded that type 2 diabetes can be prevented or delayed in persons at high risk for the disease, including women with a history of GDM, by making lifestyle changes (39). Pregnancy and the postpartum period offer an opportunity to motivate women to improve their health through lifestyle changes.

Public health efforts should be placed on preventing and reducing overweight and obesity in all women but especially those in the post-GDM period because of the heightened risk for type 2 diabetes in the future. Since the condition of being overweight or obese is preventable efforts to counsel women on a healthy weight during and following pregnancy should be a public health priority. Health professionals can play a significant role in connecting with this at risk population.

Future research should examine the role health professionals can play in helping women achieve or maintain a healthy body weight throughout the lifespan. Specifically, future research should examine the advice given by medical professionals pre-conception and during pregnancy regarding diet and physical activity.

References

1. Gestational diabetes. Alexandria (VA): American Diabetes Association; [cited 2006 Jan 17]. Available from: http://www.diabetes.org/gestational-diabetes.jsp.
2. World Health Organization Study Group: Prevention of diabetes mellitus. Geneva, World Health Organization. 1980. (Tech. Rep. Ser., no. 844).
3. American College of Obstetricians and Gynecologists: ACOG Practice Bulletin: Assessment of risk factors for preterm birth: clinical management guidelines for obstetrician-gynecologists. *Obstet Gynecol* 2001; 98 (no31):709-716.
4. Centers for Disease Control and Prevention. Diabetes and women's health across the life stages: a public health perspective. Available at: http://www.cdc.gov/diabetes/pubs/pdf/women.pdf. Accessed May 8, 2006.
5. Kaaja RJ and Greer IA. Manifestations of Chronic Disease During Pregnancy. *JAMA* 2005; 294: 2751-57.
6. Jazayeri A, Cotreras D. Macrosomia. 2004. [Article online] Available from <http://www.emedicine.com/med/topic3279.htm>.
7. Jang HC, Cho NH, Min YK, Han IK, Jung KB, and Metzger BE. Increased macrosomia and perinatal morbidity independent of maternal obesity and advanced age in Korean women with GDM. *Diabetes Care.* 1997; 20(10):1582-1588.
8. Lerner H. Shoulder Dystocia. 2004. [Article online]. Available from <http://shoulderdystociainfo.com/index.htm >
9. Vohr B, McGarvey S, Tucker R. Effects of Maternal Gestational Diabetes on Offspring Adiposity at 4-7 Years of Age. *Diabetes Care*.1999;22(8): 1284-1292.
10. Dörner G and Plagemann A. Perinatal hyperinsulinism as possible predisposing factor for diabetes mellitus, obesity, and enhanced cardiovascular risk in later life. *Horm Metab Res*. 1994; 26:213-221.
11. Dörner G, Plagemann A, Neu A, Rosenbauer J. Gestational diabetes as possible risk factor for type I childhood-onset diabetes in offspring. *Neuroendocrinolgoy Letters* 2000; 21: 355-359.
12. Dyck R, Klomp H, Tan LK, Turnell RW, Boctor M. A Comparison of Rates, Risk Factors, and Outcomes of Gestational Diabetes Between Aboriginal and Non-Aboriginal Women in the Saskatoon Health Districk. *Diabetes Care* 2002; 25: 487-493.

13. Silverman BL, Metzger BE, Cho NH, Loeb CA. Impaired glucose tolerance in adolescent offspring or diabetic mothers. Relationship to fetal hyperinsulinism. *Diabetes Care* 1995; 18: 611-617.
14. Schaefer-Graf UM, Pawliczak J, Passow D, Hartmann R, Rossi R, Buhrer C, Harder T, Plagemann A, Vetter K, Kordonouri O. Birth Weight and Parental BMI Predict Overweight in Children From Mothers With Gestational Diabetes. *Diabetes Care* 2005;28(7): 1745-1750.
15. ACOG Practice Bulletin. Clinical Management Guidelines for Obstetrian-Gynecologists. *Obstetrics & Gynecology*. 2001; 98(3): 525-538.
16. Csorba TR and Edwards AL. The Genetics and Pathophysiology of type II and Gestational Diabetes. Critical Reviews in Clinical Laboratory Sciences 1995; 32(5): 509-550.
17. Dornhorst A and Rossi M. Risk and Prevention of Type 2 Diabetes in Women with Gestational Diabetes. *Diabetes Care.* 1998; 21(S2):B43-B49.
18. Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: A systematic review. *Diabetes Care*. 2002; 25(10): 1414-1431.
19. Henry O and Beischer N. Long-term implications of gestational diabetes for the mother. *Bailliere's Clinical Obstetrics and Gynaecology* 1991;5(2): 461-483.
20. Cheung NW and Byth K. Population Health Significance of Gestational Diabetes. *Diabetes Care* 2003; 26 (7): 2005-2009
21. American Diabetes Association. (2005) The Dangerous Toll of Diabetes. [Article online] Available from <http://www.diabetes.org/diabetes-statistics/dangerous-toll.jsp>
22. American Diabetes Association National Diabetes Fact Sheet. 2002. [Article online] Available from <http://www.diabetes.org/utils/printthispage.jsp?PageID=STATISTICS_233193>
23. Dabelea D, Snell-Bergeon JK, Hartsfield CL, Bischoff KJ, Hamman RF, McDuffie RS. Increasing Prevalence of Gestational Diabetes Mellitus (GDM) Over Time and by Birth Cohort. 2005;28(3): 579-584.
24. Tuomilehto J. Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, Keinanen-Kiukaanniemi S, Laakso M, Louheranta A, Rastas M, Salminen V, Uusitupa M. Finnish Diabetes Prevention Study Group. Prevention of type 2 diabetes mellitus by change in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med*. 2001;344:1343-1350.
25. Kjos SL, Buchanan TA. Gestational diabetes mellitus. *New Engl J Med*. 1999; 341:1749-1756.
26. Kjos SL. Postpartum care of the women with diabetes. *Clin Obstet Gynecol*. 2000; 43: 75-86.
27. Kjos SL, Henry O, Lee RM, Buchanan TA, Mishell DR Jr. The effect of lactation on glucose and lipid metabolism in women with recent gestational diabetes. *Obstet Gynecol.* 1999;82:451-455.
28. Hanna FWF, Peters JR. Screening for gestational diabetes; past, present, and future. *Diabetic Medicine*. 2002; 19:351-358.

29. Harris SB, Caulfield LE, Sugamori ME, Whalen EA and Henning B. The epidemiology of diabetes in pregnant Native Canadians. *Diabetes Care.* 1997; 20(9):1422-1425.
30. Lao TT, Ho L, Chan BCP, Leung WC. Maternal Age and Prevalence of Gestational Diabetes Mellitus. *Diabetes Care*. 2006; 29:948-949.
31. Jarvela IY, Juutinen J, Koskela P, Hartikainen A, Kulmala P, Knip M, Tapanainen JS. Gestational Diabetes Identifies Women at Risk for Permanent Type 1 and Type 2 Diabetes in Fertile Age. Diabetes Care 2006; 29: 607-612.
32. Weijers RNM, Bekedam DJ, Smulders YM. Determinants of Mild Gestational Hyperglycemia and Gestational Diabetes Mellitus in a Large Dutch Multiethnic Cohort. *Diabetes Care*. 2002; 25: 72-77.
33. Lao TT, Ho LF, Chan BCP, Leung WC. Maternal Age and Prevalence of Gestational Diabetes Mellitus. *Diabetes Care.* 2006;29:948-949.
34. Catalano P, Vargo K, Bernstein I, Amini S. Incidence and risk factors associated with abnormal postpartum glucose tolerance in women with gestational diabetes. *Am J Obstet Gynecol* 1991; 165: 914-919.
35. Kjos S, Peters R, Xiang A, Henry O, Montoro M, Bchanan T. Predicting future diabetes in Latino women with gestational diabetes: utility of early postpartum glucose tolerance testing. *Diabetes* 1995; 44:586-591.
36. Coustan D, Carpenter M, O'Sullivan P, Carr S. Gestational diabetes: predicators of subsequent disordered glucose metabolism. *Am J Obstet Gynecol*. 1993. 168: 1139-1145.
37. Metzger B, Cho N, Roston S, Radvany R. Prepregnancy weigth and antepartum insulin secretion predict glucose tolerance in five years after gestational diabetes mellitus. *Diabetes Care*. 1993; 16:1598-1605.
38. Kaufmann R, Schleyhahn F, Huffman D, Amankwah K. Gestational diabetes diagnostic criteria: long-term maternal followup. *Am J Obstet Gynecol.* 1995; 172: 621-625.
39. Knowler WC, Barrett-Connor E, Flower SE, Hamman RF, Lachin JM, Walker EA, Nathan DM, Diabetes Prevention Program Research Group. *N Engl J Med* 2002; 346: 393-403.
40. National Committee for Quality Assurance. Prenatal and Postpartum Care. HEDIS Measures of Care. 2006. Available online <www.ncqa.org>

ARTICLE 2: **Physician Care Patterns During and after Gestation Diabetes Mellitus (GDM) in Oregon**

Objectives: To examine physician (Ob/Gyn and Family Practice) GDM care patterns during pregnancy and in the post partum period in Oregon. To evaluate physician attitudes, beliefs, and opinions regarding postpartum care following a GDM pregnancy.

Design, Setting, and Participants: A mailed survey using a randomly selected sample of licensed Oregon physicians (N=286) practicing in Family Practice and Obstetrics/gynecology, conducted from November 2005 through December 2005.

Results: Screening for GDM in Oregon is an almost universal practice. Ninety-five percent of physicians surveyed responded that they *always* or *almost always* screen for GDM. Once the women delivers, however, interest in testing for glucose intolerance in the postpartum period drops precipitously. Logistic regression was performed to assess predictors of "more comprehensive" post-GDM care, defined by a physician self-report of following established care guidelines most of the time or always. The only significant predictor was a physician's sex, (p=0.024, OR=2.03, CI=1.09-3.79). Female physicians (65.29%) reported giving "more comprehensive care" more often than male physicians (51.89%), χ^2=4.2, p=0.04. A second logistic regression was performed to determine significant predictors of follow-up glucose testing in the postpartum period. One variable was found to be significant predictor. Those physicians who believed that postpartum care by peers included GDM testing were significantly more likely to perform these tests themselves, (p=.001, OR=2.197, CI=1.383-3.459). Conversely, a belief that GDM should be treated to improve the

mother's health was associated with decreased likelihood of post-GDM testing, (p=0.005, OR=.44, CI=.249-.784).

Conclusions: Despite the important public health implications, follow up testing for women who experienced GDM during pregnancy is seldom practiced. Follow-up glucose testing could provide early identification of women at risk for type 2 diabetes and have a significant, long term effect on their health status and related health care costs. Although guidelines for postpartum care are established, physicians appear to either be unfamiliar with them and/or do not prioritize these guidelines in clinical practice. As such, opportunities for significant impact on the long term consequences of type 2 diabetes, remain largely unrealized.

Introduction

The prevalence of diabetes is increasing worldwide (1). It is estimated that 5.4% of adults worldwide will have diabetes by 2025 and that most will reside in the United States, India and China (1).

Obesity is a significant risk factor for diabetes; as obesity rates rise in the United States diabetes increases concomitantly. Parallel increases in prevalence of both health problems have prompted the Center for Disease Control and Prevention (CDC) to refer to obesity and diabetes as twin epidemics (2). From 1991 to 2001, the CDC found a 61% increase in diagnosed diabetes (including gestational diabetes) in Americans and a 74 % increase in obesity, reflecting the correlation between obesity and the development of diabetes (2).

Dual epidemics of obesity and diabetes are present throughout the United States and globally, with some states bearing disproportionate disease burdens. In

2004, 59.2 % of adult Oregonians were obese or overweight. From 1990 to 2004 the prevalence of obesity increased by 103 % (3). In 2005, only 4 states had obesity prevalence rates less than 20 % (4). Nationally the percent of women entering pregnancy overweight has increased from 24.2% in 1983 to 43.3% in 2004 (12).

Gestational diabetes mellitus (GDM), or impaired glucose tolerance, is diabetes first diagnosed during pregnancy (5). GDM affects approximately 14% of pregnancies, or 135,000 women a year in the United States, and is a significant risk factor for type 2 diabetes in the mother (6). National research on GDM trends is limited; however it appears that similar to type 2 diabetes, the prevalence of GDM has increased over time along with the increased prevalence of obesity (7, 8). In Oregon the prevalence of GDM has increased from 2.9% in 1989 to 4.0% in 2004 (9, 10). At the same time in Oregon, the prevalence of obese adults has increased from 10-14% in 1990 to 20-24% in 2005 (11).

The need for swift public health intervention has never been greater. The National Diabetes Education Program reported in 2006 that much of this burden could be prevented with early detection, improved delivery of care, and better education on diabetes self-management (13).

Physicians are uniquely situated to detect diabetes, deliver improved care, and educate patients during the prodromal period of disease. Women with a history of GDM represent a unique group because a pregnancy complicated by gestational diabetes mellitus serves as a warning sign for future type 2 diabetes. Improving care to women with a history of GDM could reduce the incidence of type 2 diabetes. The puerperium period, the period immediately following birth, has been called “a unique

window of opportunity" for a woman's "physician to institute health habits and medical therapy that ultimately may have far-reaching effects on her quality of life and on any subsequent pregnancies" (14).

GDM and type 2 diabetes are conditions of severe insulin resistance, mainly muscle cells are either not responding to the insulin as they should be or the pancreatic beta cells, the cells responsible for insulin secretion, have impaired insulin secretion. Langer states, "type 2 and gestational diabetes should be viewed as the same disease with different names" (15). This statement has significant importance for the clinical practice of the future. If GDM foreshadows type 2 diabetes it offers health professionals an opportunity to take actions that could prevent type 2 diabetes.

There is mounting evidence that GDM does indeed foreshadow type 2 diabetes. A systematic review of GDM patients from 1965-2001 found the cumulative incidence of type 2 diabetes increased markedly in the first 5 years after a GDM pregnancy and appeared to plateau after 10 years (16). Studies have demonstrated variable risk (17-75%) of developing diabetes in a 5-16 year period with significant variations by ethnic group (16-25). In a 2003 publication, Cheung states, "In some populations, women who have had GDM comprise a substantial proportion of subjects who ultimately develop diabetes" (18). Evidence indicates that GDM may predict future type 2 diabetes and the need for prevention and early intervention.

As such, health care professionals can play an important role in preventing type 2 diabetes by detecting GDM during pregnancy, following up with GDM patients in the postpartum period and motivating post-GDM women to make lifestyle changes necessary to substantially reduce their risks (26, 37, 28). Preventing type 2 diabetes is

possible, as demonstrated by the Diabetes Prevention Program (DPP), Da Qing IGT and Diabetes Study, and others (29, 30, 31).

A number of things can be done to reduce a woman's risk for type 2 diabetes. Both diet and exercise interventions can slow the progression to type 2 diabetes (14, 15). Excess body fat is perhaps the most modifiable risk factor for the development of type 2 diabetes (32). The risk of type 2 diabetes attributed to obesity is estimated to be as high as 75% (33). Obesity is a manifestation of energy imbalance caused by excessive intake of calories and/or a lack of physical activity.

Physical inactivity, apart from energy imbalance, is an independent risk factor for type 2 diabetes. A number of studies have demonstrated that an active lifestyle may prevent or delay the development of type 2 diabetes (34-38). A recent study examining patterns of postpartum physical activity among women with recent GDM found that 26.5% of these women were classified as sedentary and only 33.6% reported sufficient physical activity (39). Approximately half (48.9%) of the women studied did not know the type of physical activity that would be beneficial for diabetes prevention (39). Health care professionals could play an important role in educating and motivating women with a history of GDM to be physically active.

Unfortunately, evidence is mounting that physicians are not playing a significant role in motivating women to be physically active. Recently, a survey of post-GDM women in Pennsylvania found that only 14% of women reported that a doctor or nurse motivated them to exercise (40). Standard care following a GDM pregnancy includes encouraging exercise, yet only 39% of the women reported exercise patterns that met current time and intensity standards (40). Another study

found physicians were more likely to counsel patients to exercise if they had diabetes. In this study, 73% of adults with diabetes were encouraged to exercise (41). Physician advice during pregnancy was found to have a significant impact on exercise behavior. Recent research examining health care provider's exercise advice to pregnant women in Oregon found practitioners giving outdated advice (42). Data indicated that many health care providers in Oregon advised pregnant women not to exercise during pregnancy and were using outdated ACOG guidelines for prescribing exercise to this population (42). Women reported receiving advice that was contrary to the most recent guidelines published by the American College of Obstetrics and Gynecology (42, 43). It would seem that health care provider education is necessary if providers are to deliver current preventative care information to patients from the existing prevention guidelines.

Practice guidelines for the treatment of many conditions have been established; however the degree to which these guidelines have been adopted, varies. Many factors affect the degree to which innovations are accepted and adopted. According to Diffusion of Innovation Theory a sequence of events must occur for an innovation to be adopted into practice (44). Whenever individuals are asked behave/take action in a new direction, they must 'buy into' the innovation and then, the best ways for dissemination must be developed. Dissemination is the transfer of knowledge from the developer of an innovation to the user (45). Once the program or innovation reaches the users they must decide to adopt the program, implement the program in their practice and maintain the innovation to have successful implementation. We consider diffusion of innovations in health care focusing on the differences between

adopters and those that largely ignore the established guidelines. Traditional models of explaining physician behavior assumed that once a physician was given knowledge by a respected health authority, the knowledge would lead to change in physician clinical behavior (46). Guideline awareness is not enough for physicians to make behavior change. Despite established guidelines for post-GDM care there is scant evidence of successful interventions. However, interventions with other difficult behavioral problems have been successful. What follows is an overview of effective interventions that have been explained in detail elsewhere (47).

Physicians and Patient Behavior Change

Physicians and other health professionals have effectively helped patients change behavior in the following areas: smoking cessation, increasing physical activity, and alcohol cessation or reduction. In the area of smoking cessation two approaches have been effective, both pharmacotherapy and counseling (48-50). Tobacco cessation research indicates the efficacy of treatment correlates with treatment intensity, but brief physician interventions during an office visit do promote smoking cessation (51, 52)

Those programs that were most effective utilized a "five A's" approach recommended in the Public Health Service guidelines as well as motivational strategies such as the use of incentives (48, 52-55). Typically, this strategy uses five steps: *ask, advise, assess, assist*, and *arrange* follow-up (53). The steps include: asking the patient if they smoke, offer personalized advice, assess the patient's readiness to change, assist the patient in moving along in the change process, and arrange a follow-up visit or phone call.

The 5 A's mnemonic has also been applied to physical activity promotion in the primary care setting (56, 57). It is recommend that physicians counseling their patients on physical activity by leading health agencies (53, 58). Support staff can help physicians accomplish counseling goals and alleviate physician time constraints (59-61).

Alcohol abuse represents another area in which physician advice is effective. Generalist physicians who provide continuous care can play a major role in the care of patients who have alcohol problems, or who are at risk for alcohol problems (62). The efficacy of brief interventions for nondependent drinkers has been documented in many clinical trials in health care settings (57, 63-67). The effective elements in alcohol reduction are consistent with tobacco, effective interventions generally contained the 5 A's approach to behavioral counseling (57).

Methods

Because Oregon Center for Health Statistics estimates that 80% of pregnancies in Oregon are attended by an MD, a representative sample of Oregon physicians (MDs) with licenses in Family Practice and Obstetrics and Gynecology were surveyed (68). This project was approved by the institutional review board at Oregon State University. Stata Intercooled statistical software (Version 9; College Station, Texas) was used to draw a random sample from the two specialties, Family practice and Obstetrics/gynecologists, holding active licenses with the Oregon Board of Medical Examiners in November of 2005. The total population of MDs in these two specialties was 2171 (Family practice physicians N=1614 and obstetrics/gynecology N=557) at the time the population list was received from the Oregon Board of Medical

Examiners on November 14, 2005. A random sample of 750 MDs was drawn from the population. Assuming a response rate of 50%, a power analysis was conducted using Jan deLeeuw's Web-based *Statistics: The Study of Stability in Variation* for two-sided tests and alpha=.05, power =1.0 (69).

Each potential participant was mailed a questionnaire, a postage-paid return envelope, and a cover letter explaining the nature of the study November 18, 2005. Confidentiality and informed consent were explained in the cover letter. A follow-up postcard was sent eight days after the original mailing to thank those who had responded and encourage the others to return a completed survey. Three weeks after the original mailing, December 9, 2005, a final mailing was sent to those that had not responded. The final mailing included a cover letter encouraging participation, a copy of the questionnaire, and a postage-paid return envelope.

Results

A total of 286 of 683 eligible physicians participated in the GDM care survey, representing a response rate of 42%. The power of the actual response rate=.84 for two-sided tests with alpha=.05 (69). Forty-five MDs did not participate because of inactive status or relocation. Twenty-two physicians identified their primary practice as “other” and they were excluded from the analysis; of these 4 were licensed in Family Practice and 18 in Ob/Gyn. Family Practice physicians returned 167/383 completed surveys, a response rate of 44%, and Ob/Gyn returned 119/ 300 completed surveys, a response rate of 40%. The survey response rates were similar for Family Practice and Ob/Gyn, 44% and 40% respectively for a overall response rate of 42%. Respondent demographic characteristics are summarized in Table 1.

Table 1: Characteristics of Survey Respondents by Specialty (N=286)

	Family Practice	***Ob/Gyn***	**Total**
# of Respondents	167 (58.0%)	119 (42.0%)	286 (100%)
Sex			
Male	92 (63.0%)	53 (37.0%)	145 (100%)
Female	75 (53.6%)	65 (46.4%)	140 (100%)
Refused		1 (0.3%)	1 (100%)
Location			
Urban	54 (60.7%)	35 (39.3%)	89 (100%)
Suburban	53 (43.8%)	68 (56.2%)	121 (100%)
Rural	60 (78.9%)	16 (21.1%)	76 (100%)
Years			
<2	20 (76.9%)	6 (23.1%)	26 (100%)
2-5	23 (53.5%)	20 (46.5%)	43 (100%)
>5-10	27 (51.9%)	25 (48.1%)	52 (100%)
>10-20	55 (59.1%)	38 (40.9%)	93 (100%)
>20	39 (59.1%)	27 (40.9%)	66 (100%)
Refused	3 (50.0%)	3 (50.0%)	6 (100%)
Screen for GDM **			
Always	75 (42%)	103 (58%)	178 (100%)
Most of the time	3 (33.3%)	6 (66.7%)	9 (100%)
Some of the time	1 (100%)	0	1 (100%)
Refused	4 (100%)	0	4 (100%)

**Screen for GDM was answered by MDs that see pregnant patients

Survey Instrument

We designed our survey to examine physician care patterns in the postpartum period. Physicians responded to 11 statements about postpartum care practices using a 5 point Likert-scale that ranged from Never to Always. A summary of responses can be seen in Table 2.

Table 2: Postpartum Care Practice Patterns

	Never	*Rarely*	*Some of the time*	*Most of the time*	*Always*	Significance
a. postpartum visit by week 10	17 (7.14%)	8 (3.36%)	7 (2.94%)	20 (8.40%)	186 (78.17%)	238 (100%) p<.001
b. screen for IGT postpartum	51 (21.34%)	70 (29.29%)	40 (16.74%)	37 (15.48%)	41 (17.15%)	239 (100%) p=.117
c. screen overweight/obese	53 (21.99%)	66 (27.39%)	44 (18.26%)	37 (15.35%)	41 (17.01%)	241 (100%) p=.264
d. screen if family history	61 (25.74%)	61 (25.74%)	42 (17.72%)	33 (13.92%)	40 (16.88%)	237 (100%) p=.131
e. screen > one GDM pregnancy	42 (17.5%)	45 (18.75%)	32 (13.33%)	60 (25%)	61 (25.42%)	240 (100%) p=.160
f. screen high risk ethnic group	60 (25.21%)	67 (28.15%)	36 (15.13%)	37 (15.55%)	38 (15.97%)	238 (100%) p=.080
g. screen over 35 years	65 (26.32%)	69 (27.94%)	33 (13.36%)	39 (15.79%)	41 (16.60%)	247 (100%) p=.026
h. counsel dietary choices	9 (3.56%)	12 (4.74%)	39 (15.42%)	85 (33.60%)	108 (42.69%)	253 (100%) p<.001
i. counsel exercise regularly.	6 (2.39%)	6 (2.39%)	29 (11.55%)	87 (34.66%)	123 (49.0%)	251 (100%) p<.001
j. post-GDM to a diet support	52 (20.88%)	68 (27.31%)	90 (36.14%)	24 (9.64%)	15 (6.02%)	249 (100%) p<.001
k. warn increased risk Type 2	5 (1.94%)	2 (.78%)	8 (3.1%)	49 (18.99%)	194 (75.2%)	258 (100%) p<.001

**Significant p-values indicate the distribution is significantly different from expected values for each cell assuming an even distribution.

Level of Postpartum Care

The responses to the 11 Likert-scale questions shown above were used to assess the number of physicians offering *more comprehensive* care in the post-GDM period. *More comprehensive* was defined as including the responses "most of the time" or "always" for each of the 11 questions. Responses that included: "never", "rarely" or "some of the time" represent *non-comprehensive* postpartum care. In Table 3 a summary of non-comprehensive and more comprehensive care by specialty is shown.

Table 3: Comprehensive Care (N=221)

	Non comprehensive	*More comprehensive*	Total
Family Practice	47 (40.5%)	69 (59.5%)	116 (100%)
Ob/Gyn	44 (41.9%)	61 (58.1%)	105 (100%)
Total	91 (41.2%)	130 (58.8%)	221 (100%)*

There were no significant differences by specialty between Family Practice and Ob/Gyn in reported "adequacy of care", χ^2=0.045, p=0.834. Family Practice and Ob/Gyn physicians reported giving *more comprehensive* care 59.5 % and 58 % of the time respectively.

Logistic regression was used to analyze physician characteristics that predict *more comprehensive* care. The analysis included all physicians that responded to the series of questions regarding postpartum care, N=221. Logistic regression was run using Stata 9.0, 2005. The results are presented in Table 4.

Table 4: Variables Predictive of More Comprehensive Care (N=221)

Variables	Odds Ratio	Std. Err.	z	P>|z|	*[95% Confidence Interval]*	
HMO Practice	1.216	.584	0.41	0.684	.475	3.115
Clinic Practice	.409	.220	-1.66	0.096	.143	1.173
University Practice	1.705	.864	1.05	0.293	.631	4.605
Other Practice	1.934	1.015	1.26	0.209	.691	5.411
Suburban Setting	1.844	.683	1.65	0.099	.892	3.809
Rural Setting	2.493	1.511	1.51	0.132	.760	8.180
Specialty (FP or OB)	.751	.250	-0.86	0.389	.391	1.442
Years of Practice	.999	.016	-0.03	0.974	.970	1.031
Population service area	1.205	.181	1.24	0.214	.898	1.617
Sex (1=Female)	2.033	.645	2.24	0.025	1.092	3.785

This analysis was conducted with *more comprehensive* care as the dependent variable. The independent variables included: specialty, years, type of practice (8 responses were recoded into dummy variables: HMO, Clinic, Center, and Other, with Solo and

Group Practices are the referent group), size of practice, practice setting (urban, suburban and rural were recoded into dummy variables with urban as the referent group), and physician sex. The only variable that was statistically significant in predicting *more comprehensive* care was physician sex (p=0.025, OR 2.033, 95% CI=1.092-3.785). Controlling for the other predictors, the odds of a female physician providing more comprehensive care are just over twice as great as the odds of a male physician providing *more comprehensive* care. Female physicians are 103.3% more likely to provide *more comprehensive* care than are male physicians, when we control for other predictors. We can see how this by examining the bivariate relationship between physician's sex and the comprehensiveness of care (see table 5). Note that 65.3% of the female physicians provided *more comprehensive* care compared to 51.9% of the male physicians. This bivariate difference is statistically significant, χ^2=(1)= 4.197, p<.05. Although this bivariate difference is substantial, the logistic regression shows that when we control for the other predictors the effects of the physician's sex is even stronger.

Table 5: Comprehensive Care by Sex of the Physician (N=227)

Sex	***Non-comprehensive***	***More comprehensive***	**Total**
Male	51 (48.11%)	55 (51.89%)	106 (100%)
Female	42 (34.71%)	79 (65.29%)	121 (100%)
Total	93 (40.97%)	134 (59.03%)	227 (100%)

Postpartum Glucose Screening

We asked physicians to respond to 11 additional statements that would help us understand their thoughts and opinions regarding glucose testing in the postpartum period. We used a 4 point Likert-scale that included the responses: strongly disagree,

somewhat disagree, somewhat agree, and strongly agree. A summary of the questions can be found in Table 6, ά=.655.

Table 6: Physician Beliefs and Opinions about GDM

	Strongly Disagree	***Somewhat Disagree***	***Somewhat Agree***	***Strongly Agree***	Significance
a. treat to improve mom's health	1 (0.35%)	13 (4.56%)	75 (26.32%)	196 (68.77%)	285 (100%) p<.001
b. treated to improve baby's health	1 (0.35%)	23 (7.99%)	0 (0%)	264 (91.67%)	288 (100%) p<.001
c. all pregnant women should be screened	1 (0.35%)	9 (3.46%)	30 (10.38%)	249 (86.16%)	289 (100%) p<.001
d. After lactation screen IGT	6 (2.14%)	28 (10%)	111 (39.64%)	135 (48.21%)	280 (100%) p<.001
e. annually for glucose intolerance	5 (1.75%)	65 (22.73%)	112 (39.16%)	104 (36.36%)	286 (100%) p<.001
f. screened every 2 to 3 years for IGT	20 (7.14%)	43 (15.36%)	129 (46.07%)	88 (31.43%)	280 (100%) p<.001
g. Testing is cost-effective prevention of Type 2 diabetes	24 (8.63%)	83 (30.22%)	104 (37.41%)	66 (23.74%)	278 (100%) p<.001
h. Over 50% will progress to Type 2	14 (4.95%)	53 (18.73%)	120 (42.40%)	96 (33.92%)	283 (100%) p<.001
i. adequate patient education materials are available	29 (10.47%)	112 (40.43%)	90 (32.49%)	46 (16.61%)	277 (100%) p<.001
j. transient metabolic condition	87 (30.74%)	117 (41.34%)	74 (26.15%)	5 (1.77%)	283 (100%) p<.001
k. Most Dr. provide follow-up glucose testing	47 (17.09%)	116 (42.18%)	93 (33.82%)	19 (6.91%)	275 (100%) p<.001

**Significant p-values indicate the distribution is significantly different from expected values for each cell assuming an even distribution.

Logistic regression using Stata 9.0 was used to examine the association between physician thoughts and opinions and glucose tolerance testing in the postpartum period. Logistic regression results are shown in Table 7.

Table 7: Follow-up Glucose Testing Predictors (N=275)

Variables	Odds Ratio	Std. Err.	z	P>|z|	[95%Conf.	***Interval]***
Mom's Health	.442	.129	-2.79	0.005	.249	.784
Baby's Health	.394	.198	-1.85	0.065	.146	1.059
Should Screen	1.282	.480	.66	0.506	.616	2.670
Screen After	1.551	.408	1.67	0.095	.927	2.597
Annually	1.240	.312	.85	0.393	.757	2.030
Educ. materials	1.433	.293	1.76	0.079	.960	2.141
Typical	2.197	.512	3.34	0.001	1.383	3.459
Priority	1.459	.341	1.61	0.107	.922	2.308
Transient	1.005	.228	0.02	0.082	.644	1.69

Follow-up Glucose Testing Predictors

One variable was statistically significant with follow-up glucose testing. Physicians that reported believing, *follow-up care is typically provided*, were more likely to offer follow-up glucose testing (p=0.001, OR=2.197, CI=1.383-3.459). This finding supports the influence of "subjective norm". Physicians are more likely to adopt a behavior if they perceive relevant others are performing the behavior.

Subjective norm, a belief about whether referent others approve or disapprove of a behavior is influenced by perceived behavioral control, attitude, and past behavior. (70). This concept has been applied to physician behavior in previous research examining physician compliance to guidelines (71). We postulated that physicians would be more likely to report postpartum glucose testing if they believed relevant others were doing so. Physicians responded to the following statement, "Most physicians provide follow-up glucose testing after a GDM pregnancy" using a Likert-scale with responses ranging from *strongly disagree* to *strongly agree*. Nearly 60% believe that follow-up testing is not typical. Only 6.9% of physicians strongly

agreed that follow-up testing was practiced. Our results indicate few physicians believe relevant other physicians are conducting following testing.

The belief that *GDM is a condition that should be treated to improve the mother's health* was predictive of a reduced likelihood of follow-up glucose testing, (p=.005, OR .44, CI=.249-.784). This finding suggests that concern for the mother's health is a priority during gestation but not in the postpartum period.

The factors that were not statistically significant included: 1) GDM is a condition that should be treated to improve the baby's health (p=0.065). 2) All pregnant women should be screened for GDM was not a statement that was predictive of follow-up testing (p=.506). This was congruent with our reported findings; screening for GDM is not predictive of follow-up testing for glucose intolerance. 3) The belief that screening should be done after lactation was not significant (p=0.095). 4) A belief that women should be screened annually following GDM was also not a significant predictor of follow-up testing behavior (p=.393). Again, this is not surprising given the low rates of follow-up testing in the postpartum period. Annual screening is recommended by leading health agencies but does not appear to be done in practice. 5) A belief that adequate patient education materials are readily available for physicians in working with GDM women did not predict screening behavior (0.079). Half of the survey respondents indicated that they strongly or somewhat disagreed that adequate education materials are available to them. 6) A belief that GDM is a transient metabolic condition was not predictive of follow-up testing (p=0.082). 7) A belief that screening in the postpartum period is a practice priority (p=0.107). This finding is noteworthy in that 62% claimed screening post-GDM

women was a somewhat high or very high priority, yet few physicians indicated that they conducted follow-up screening in practice. All variables, including those that were not statistically significant should be explored in future studies to replicate results and determine a true lack of effect or a lack of statistical power.

Screening Priority

Thirty-eight percent of Oregon physicians indicated that post-GDM screening is a very low or somewhat low priority in their practice. Although the extent to which post-GDM screening is a priority was not a predictor of follow-up glucose testing we did examine this variable for differences by practice specialty. We asked MDs, "To what extent is screening post-GDM women a priority in your practice." The responses are shown in Table 8. There are significant differences in responses between specialties, χ^2 (3, N=269) = 12.065, p = 0.007. More Ob/Gyn practitioners indicated that screening in the post-GDM period was a very high priority (30.77%) compared with (16.45%) of Family Practice physicians. Family practice physicians (46.71%) indicated screening was a somewhat high priority more often than Ob/Gyn (30.77%).

Table 8: Follow-up Testing is a Priority (N=269)

	Very low	***Somewhat low***	***Somewhat high***	***Very High***	**Total**
F.Practice	12 (7.89%)	44 (28.95%)	71 (46.71%)	25(16.45%)	152 (100%)
Ob/Gyn	15 (12.82%)	30 (25.64%	36 (30.77%)	36 (30.77%)	117 (100%)
Total	27 (10.04%)	74 (27.51%)	107(39.8%)	61 (22.68%)	269 (100%)

[2] (3, N=269) = 12.065, p = 0.007

Conclusion

Diabetes is a major threat to public health. The American Diabetes Association reports 20.8 million Americans have diabetes and these numbers are increasing daily. Terrance Gregg, Chair, American Diabetes Association Research

Foundation states, “We've seen a dramatic increase in the prevalence of type 2 diabetes in the last decade, and we need more resources in the fight against this often preventable disease”.

One clear way to substantially reduce the incidence of type 2 diabetes is to significantly reduce risks among selected high risk populations. By preventing progression to type 2 diabetes among women with a history of GDM, major reductions in diabetes prevalence could be realized. Follow-up glucose testing could identify women at risk for type 2 diabetes and practitioners could play a significant role in subsequent risk reduction, referral and overall intervention effectiveness. Despite the important public health implications, post-GDM blood glucose testing is seldom practiced among today’s OB/GYN and Family Practitioners. In the absence of even the most basic assessments, it follows that effective intervention strategies designed to motivate high risk women to reduce risks for progression to type 2 diabetes are also lacking. Although major professional organizations such as ACOG, AHQR, and ADA provide clear care guidelines for physicians working with women who have a history of GDM, these guidelines appear to be largely ignored. Increasing the adherence to guidelines will be an important step in the fight against type 2 diabetes.

One surprising result of this study was the portion of physicians that identified follow-up testing as a priority. Sixty-two percent said that follow-up testing was a *somewhat high* or *very high priority*. Yet, contrary to this indicator of prioritization, only a small percent have actually taken action in support of their beliefs. Future research needs to explore educational, financial, social, environmental, and physical constraints that may be contributing to this failure to act. This research should

examine the conditions under which physicians work and do follow-up care, staffing needs, other clinical barriers, and external factors that may influence standards of care. A careful examination of actual standards of care in the place of work/practice and an analysis of "who" is setting practice standards and monitoring compliance is in order. Do research and best–practice guidelines set the standard for care or is it some other entity in today's tightly controlled physician/patient interactions? Do specific clinical policies, reimbursement mechanisms, time constraints, staffing and other barriers make Post-GDM care prohibitive? What actions can be taken to insure that the next decade of GDM patients will have the quality of care necessary to significantly reduce the epidemic grown of type 2 diabetes among women in their most productive years? These questions must be addressed in order to improve the quality of care given to women in the most productive years of life.

References

1. King H, Aubert RE, Herman WH. Global Burden of Diabetes, 1995-2025. Prevalence, numerical estimates, and projections. Diabetes Care. 1998; 21:1414-1431.
2. CDC. Twin Epidemics of Diabetes and Obesity Continue to Threaten the Health of Americans CDC Says. 2001. Available online http://www.cdc.gov/od/oc/media/pressrel/r010911.htm
3. Ngo, Duyen and Leman, Richard. 2005. Oregon Overweight, Obesity, Physical Activity, and Nutrition. Department of Human Services, 800 NE Oregon Street, Suite 730, Portland, OR 97232.
4. Center for Disease Control and Prevention. Obesity Trends. 2005. Accessed September 14, 2006. Available online: http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/index.htm
5. American Diabetes Association: Gestational diabetes mellitus. Diabetes Care. 2000; 23(Suppl 1):S77-S79.
6. Jovanovic L, Pettitt D: Gestational diabetes mellitus. JAMA 2001; 286:2516-2518.
7. Metzger BE, Coustan DR. Summary and recommendations of the Fourth International Workshop-Conference on Gestational Diabetes Mellitus: the Organizing Committee. Diabetes Care. 1998; 21:B161-B167.
8. Flegal KM. The obesity epidemic in children and adults: current evidence and research issues. Med Sci Sports Exerc 1999; 31 (Suppl. 11):S509-S514.

9. Department of Human Services. Ordered via U.S. mail 2005 from DHS Health Services Section. 800 NE Oregon Street PO Box 14450 Portland, OR 97293.
10. Oregon Diabetes Coalition . Oregon Progress Report on Diabetes. Department of Human Services, Health Services, Oregon Diabetes Prevention and Control Program, Portland, Oregon, 2006.
11. CDC Behavioral Risk Factor Surveillance Survey. 2005. Available online: http://apps.nccd.cdc.gov/brfss/Trends/trendchart.asp?qkey=10010&state=OR
12. CDC Pregnancy Nutrition Surveillance. 2004. Table 16D. Summary of Trends in Maternal Health Indicators. Available online: <cdc.gov/pednss/pnss_tables_tables_health_indicators.htm#Maternal%20Health>
13. National Diabetes Education Program. Available online: http://www.ndep.nih.gov/diabetes/prev/prevention.htm Accessed 1/12/2007.
14. Kjos, Siri. Postpartum Care of the Woman with Diabetes. Clinical Obstetrics and Gynecology. 2000; 43(1): 75-86.
15. Langer, Oded. Management of Gestational Diabetes. Clinical Obstetrics and Gynecology. 2000; 43(1): 106-115.
16. Kim C, Newton K, Knopp R. Gestational Diabetes and the Incidence of Type 2 Diabetes Diabetes Care. 2002;25:1862-1868.
17. Henry, OA, Bleischer NA. Long-term implications of gestational diabetes for the mother. Ballieres Clin Obstet Gynaecol.1991;5:461-83.
18. Cheung NW and Byth K. Population Health Significance of Gestational Diabetes Diabetes Care. 2003; 26: 2005-2009.
19. O' Sullivan JB. Diabetes after GDM. Diabetes. 1991;40(Suppl 2):131-135.
20. Mestman JH, Anderson GV, and Guadalupe V. Follow-up studies of 360 subjects with abnormal carbohydrate metabolism during pregnancy. Obstet Gynecol. 1972;39:421-425.
21. Persson B, Hanson U, Hartling SG, Binder . Follow-up of women with previous GDM: Insulin, C-peptide, and proinsulin responses to oral glucose load. Diabetes. 1991; 40 (Suppl 2): 136-141.
22. Damm P, Kuhl C, Bertelsen A, Molsted-Pedersen L. Predictive factors for the development of diabetes in women with previous gestational diabetes mellitus. Am J Obstet Gynecol. 1992:167:607-616.
23. Metzger BE, Cho NH, Roston SM, Rodvany R. Prepregnancy weight and antepartum insulin secretion predict glucose tolerance five years after gestational diabetes mellitus. Diabetes Care. 1993;16:1598-1605.
24. Coustan DR, Carpenter MW, O'Sullivan PS, Carr SR. Gestational diabetes: Predictors of subsequent disordered glucose metabolism. Am J Obstet Gynecol. 1993; 168:1139-1145.
25. Kjos SL, Peters RK, Xiang A, Henry OA, Montoro MN, Buchanan TA. Predicting future diabetes in Latino women with gestational diabetes: Utility of early postpartum glucose tolerante testing. Diabetes. 1995;44:586-591.
26. Thomas RJ, Kottke TE, Brekke MJ, Brandel CL, Aase LA, DeBoer SW. Attempts at changing dietary and exercise habits to reduce risk of cardiovascular disease: who's doing what in the community? Prev Cardiol 2002; 5:102-108.

27. O' Connor PJ, Rush WA, Prochaska JO, Pronk NP, Boyle RG. Professional advice and readiness to change behavioral risk factors among members of a managed care organization. Managed Care. 2001; 7: 125-130.
28. Galuska DA, Will JC, Serdula MK, Ford ES. Are health care professionals advising obese patients to lose weight? JAMA. 1999; 282: 1576-1578.
29. Diabetes Prevention Program Research Group: Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002; 346:393-403.
30. Pan XR, LiGW, Hu YH, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Jiu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH, Howard BV: Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study. Diabetes Care. 1997; 20: 537-544.
31. Tuomilehto J, Jindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, Keinanen-Kiukaanniemi S, Laakso M, Louheranta A, Rastas M, Salminen V, Uusitupa M. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001; 344: 1343-1350.\
32. Edelstein SL, Knowler WC, Bain RP, Andres R, Barrett-Connor EL, Dowse GK, Haffner SM, Pettitt DJ, Sorkin JD, Muller DC, Collins VR, Hamman RF. Predictors of progression from impaired glucose tolerance to NIDDM: an analysis of six prospective studies. Diabetes. 1997; 46:701-710.
33. Manson JE, Spelsberg A: Primary prevention of non-insulin-dependent diabetes mellitus. Am J Prev Med 1994; 10:172-184.
34. Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS Jr. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. N Engl J Med. 1991; 325:147-152.
35. Frisch RE,Wyshak G, Albright E, Albright NL, Schiff I. Lower prevalence of diabetes in female former college athletes compared with nonathletes. Diabetes. 1986; 35: 1101-1105.
36. Manson JE, Rimm EB, Stampfer MJ, Colditz GA, Willett WC, Krolewski AS, Rosner B, Hennekens CH, Speizer FE. Physical activity and incidence of non-insulin dependent diabetes mellitus in women. Lancet. 1991; 338: 774-778.
37. Perry IJ, Wannamethee M, Walker MK, Thomson AG, Whincup PH, Shaper AG. Prospective study of risk factors for development of non-insulin-dependent diabetes in middle aged British men. BMJ. 1995; 310:560-564.
38. Kohl HW, Gordon NF, Villegas JA, Blair SN. Cardiorespiratory fitness, glycemic status, and mortality risk in men. Diabetes Care 1992; 15:185-192.
39. Smith BJ, Cheung NW, Bauman AE, Zehle K, McLean M. Postpartum Physical Activity and Related Psychosocial Factors Among Women With Recent Gestational Diabetes Mellitus. Diabetes Care. 2005; 28:2650-2654.
40. Symons Downs D and Ulbrecht JS. Understanding Exercise Beliefs and Behaviors in Women With Gestational Diabetes Mellitus. Diabetes Care. 2006; 29:236-240.
41. Morrato EH, Hill JO, Wyatt HR, Ghushchyan V, Sullivan PW. Are Health Care Professionals Advising Patients With Diabetes or At Risk for Developing Diabetes to Exercise More? Diabetes Care. 2006: 29: 543-548.

42. Navarez, Holly Clements. A cross cultural examination of factors influencing exercise during pregnancy. 2006.
43. American College of Obstetrics and Gynecology. Exercise During Pregnancy. Available online< http://www.acog.org/publications/patient_education/bp119.cfm> Accessed January 31, 2007.
44. Rogers EM. Diffusion of Innovations (3rd ed). New York: Free Press, 1983.
45. Orlandi MA, Landers C, Weston R, and Haley N. "Diffusion of Health Promotion Innovations." In Glanz, Lewis, Rimer (eds), Health Behavir and Health Education: Theory, Research, and Practice. San Fransico: Jossey-Bass, 1990.
46. Pathman D, Konrad TR, Freed GL, Freeman VA, Koch GG. The Awareness-to-Adherence Model of the Steps to Clinical Guideline Compliance: The Case of Pediatric Vaccine Recommendations. Medical Care. 1996; 34:873-889.
47. Hunsberger M and Donatelle RJ. Gestational Diabetes Mellitus (GDM) Practice Patterns, Challenges, and Future Directions. In review. 2007.
48. A clinical practice guideline for treating tobacco use and dependence: a US Public Health Service report. JAMA 2000; 283: 3244-54.
49. Fiore MC, Bailey WC, Cohen SJ, et al. Treating tobacco use and dependence. Rockville, Md.: Department of Health and Human Services, Public Health Service, 2000. Available online:
<http://www.surgeongeneral.gov/tobacco/treating_tobacco_use.pdf>
50. Lancaster T, Stead L, Silagy C, Sowden A. Effectiveness of interventions to help people stop smoking: findings from the Cochrane Library. BMJ 2000; 321: 355-358.
51. Rigotti, NA. Treatment of Tobacco Use and Dependence. N Engl J Med. 2002; 346: 506-512.
52. Gorin S. S. and J. E. Heck. Meta-Analysis of the Efficacy of Tobacco Counseling by Health Care Providers. 2004; 13: 2012-2022.
53. Surgeon General. Available online:
www.surgeongeneral.gov/tobacco/treating_tobacco_use.pdf
54. Donatelle RJ & Hudson. New Smoking Cessation Interventions for Pregnant Women: Do they work? Panel Presentation with: Rigotti NA, Donatelle RJ, Gaffney CA, Barker DC. National Conference on Tobacco or Health annual meeting in Chicago, IL, May 5, 2005. Abstract ID#12460. The abstract is available online at http://ncth.confex.com/ncth/2005/techprogram/paper_12460.htm.
55. Donatelle RJ and Hudson D. Using 5 A's and Incentives to Promote Prenatal Smoking Cessation. Presentation to the National Conference on Tobacco Health, San Francisco, California, November 20, 2002.
56. Glasgow RE, Funnell MM, Bonomi AE, et al. Self-management aspects of the improving chronic illness care breakthrough series: implementation with diabetes and heart failure teams. Ann Behav Med. 2002; 24: 80-87.
57. Whitlock EP, Orleans CT, Pender N, Allan J. Evaluation primary care behavioral counseling interventions: an evidence-based approach. Am J Prev Med. 2002; 22:267-284.
58. CDC. 1998. U.S. Preventive Services Task Force: Recommendations for Physical Exercise in Primary Prevention.
<http://wonder.cdc.gov/wonder/prevguid/p0000060/p0000060.asp#head001000000000000>

59. King AC, Haskell WL, Taylor CB, et al. Group vs home-based exercise training in healthy older men and women: a community-based trail. JAMA 1991; 266:1535-1538.
60. Piette J. Enhancing support via interactive technologies. Curr Diab Rep. 2002: 2:160-165.
61. Glasgow RE, Bull SS. Making a difference with interactive technology: considerations in using and evaluating computerized aids for diabetes self-management education. Diabetes Spectrum. 2001; 14:99-106.
62. O'Connor PG and Schottenfeld, RS. Patients with Alcohol Problems. N Engl J Med 1998; 338: 592-602.
63. Bien TH, Miller WR, Tonigan JS. Brief interventions for alcohol problems: a review. Addiction 1993; 88:315-335.
64. Miller WR, Rollnick S. Motivational interviewing: preparing people to change addictive behavior. New York: Guilford Press, 1991.
65. WHO Brief Intervention Study Group. A cross-national trail of brief interventions with heavy drinkers. Am J Public Health 1996: 86:949-955.
66. Fleming MF, Barry KL, Manwell LB, Johnson K, London R. Brief physician advice for problem alcohol drinkers: a randomized controlled trail in community-based primary care practices. JAMA 1997; 277: 1039-1045.
67. Fiore MC et al. Treating Tobacco Use and Dependence. A Quick Reference Guide for Clinicians. Department of Health and Human Services. Public Health Service. Rockville, MD. 2000.
68. Oregon Center for Health Statistics, 2001. Available online: http://oregon.gov/DHS/ph/chs/index.shtml
69. University of British Columbia. Department of Statistics. Power Calculator available online: www.stat.ubc.ca/~rollin/stats/ssie/b2.html.
70. Kellerman SE, Herold J. Physician Response to Surveys. Am J Prev Med 2001; 20: 61-67.
71. Maue SK, Segal R, Kimberlin CL, Lipowski EE. Predicting Physician Guideline Compliance: An Assessment of Motivators and Perceived Barriers. Am J Manag Care. 2004; 10:383-391.

ARTICLE 3: **Gestational Diabetes Mellitus (GDM) Practice Patterns, Challenges, and Future Directions**

Objectives: To describe GDM screening in Oregon, examine current and future challenges, and make recommendations for practitioners. We also describe various professional organization guidelines used for diagnosing GDM, examine inconsistencies in these guidelines and the use of specific guidelines in clinical practice. We also describe physician referral patterns to diabetes specialists for women with GDM and clinician practice patterns during the postpartum period in Oregon.

Methods: We surveyed a random sample of Oregon physicians in Family Practice and Obstetrics and Gynecology. The random sample was drawn from a list of physicians that held active licenses with the Oregon Board of Medical Examiners.

Results: Physicians are using a myriad of testing procedures to diagnose GDM during gestation. Only 31% of physicians in this sample said they refer women to a diabetes specialist when they have GDM. The same physicians that report always testing for GDM during gestation rarely test in the postpartum period for glucose intolerance. Only 19% of Oregon physicians who reported testing for GDM during gestation report that they test for glucose intolerance in the postpartum period, McNemar χ^2=132.66, $p < .001$.

Conclusions: There are inherent problems with using guidelines that have established different cut of values for a diagnosis of GDM. Criteria that require higher blood glucose levels for diagnosis may be misclassifying women as having normal blood glucose, when another guideline would classify the same case as hyperglycemic. Once diagnosed with GDM, there is a low referral rate to diabetes specialists. In the

postpartum period clinical practice does not follow established care guidelines. In the future, a universal approach to diagnosing GDM should be achieved, meaning all clinicians would diagnose GDM using the same test criteria. Further research should investigate why physicians fail to follow established practice guidelines for postpartum care.

Introduction

The increasing prevalence of obesity in the western world has led to a dramatic increase in type 2 diabetes. Diabetes, including Gestational Diabetes Mellitus (GDM) has more than doubled over a ten year period. [1, 2] Each year approximately 4 million women give birth in the United States and gestational diabetes mellitus (GDM) affects between 1% and 14% of these pregnancies. [1, 3, 4,5] More than 135, 000 women will be diagnosed with GDM in the United States in 2007.[6]

Importantly, type 2 diabetes is a preventable disease and GDM is a major risk factor for its development.[7,8, 9, 10] Women who have a history of GDM are significantly more likely to progress to type 2 diabetes. A systematic review of GDM patients from 1965-2001 found the cumulative incidence of type 2 diabetes increased markedly in the first 5 years after a GDM pregnancy.[7] In a review of 28 studies of post-GDM women, subsequent type 2 diabetes cumulative incidences ranged from 2.6% to over 70% with the large variation attributed to study length and to racial and ethnic variations. [7,8] There is a notable opportunity for improved quality of life and health care savings if GDM related risks are prevented or identified early in the GDM to diabetes progression.

An extensive review of the literature reveals that screening for GDM is routine in clinical practice settings in the United States.[11,12, 13,14] Our findings support this treatment pattern and indicate that 95% of physicians always screen for GDM and the others screen most of the time. Specific details are described in a related publication[15]. While screening is almost universal, the criteria used to diagnose GDM are not consistent. Inconsistent testing protocols may be underestimating the number of women with GDM. For example, two women could have the same blood glucose level at testing and under one guideline they would be diagnosed with GDM and under another guideline they would have "normal" blood glucose and a diagnosis would not be made. Importantly, women with high blood glucose levels will go undiagnosed and unknowingly be at increased risk for type 2 diabetes.

Part of the reason for inconsistency in diagnosis may be directly attributed to the wide variety of diagnostic criteria guidelines available to practitioners today. Although the first guidelines for testing GDM were proposed approximately 40 years ago, a common standard for diagnosis of GDM, has yet to be reached. In 1964 the first screening guidelines for gestational diabetes were proposed by O'Sullivan and Mahan.[16] Currently, there are a number of professional organizations that recommend various testing criteria in diagnosing GDM including the National Diabetes Data Group (NDDG), Carpenter and Coustan, American Diabetes Association, World Health Organization, American College of Obstetrics and Gynecologist, and Family Practice Guidelines. [17-23] One of the limitations in assessing the rate of GDM is the number of screening tests in use. For a summary of the main criteria see Table 1.

Table 1: Criteria for the Diagnosis of Gestational Diabetes Mellitus

	National Diabetes Data Group	***Carpenter and Coustan and American Diabetes Association***	***American Diabetes Association †***	***American Diabetes Association***	***World Health Organization***
Glucose Load and Time of Measure	**100-gram oral glucose tolerance**	**100- gram oral glucose tolerance**	**50-gram glucose challenge**	**75-gram oral glucose tolerance**	**75-gram oral glucose tolerance**
Fasting	105	95	NA	95	126
1 hour	190	180	140	180	NA
2 hour	165	155	NA	155	NA
3 hour	145	140	NA	NA	NA

*All data are mg/dL, unless indicated otherwise. To convert mg/dL to mmol/L, multiply by 0.555. Two or more concentrations as high as or higher than those shown (National Diabetes Data Group and American Diabetes Association) and 1 or more concentrations as high or higher than those shown (World Health Organization) make the diagnosis of gestational diabetes. NA indicates time points not preformed.
†50 g oral glucose challenge is a screening tool. A positive test is followed by an oral glucose challenge test. [17-22]

Both the American College of Obstetrics and Gynecology (ACOG) and the American Academy of Family Physician offer publications that summarize both the NDDG criteria and the Carpenter and Coustan criteria. The diagnostic criteria from Carpenter and Coustan set a cutoff for normal that is much lower than others which effectively means that many more women will be diagnosed with GDM; in fact, as many as 54% more women will be diagnosed with GDM using the Carpenter and Coustan criteria.[23] The American Diabetes Association supports the use of the Carpenter and Coustan criteria, as can be seen in table 1. The most recent ACOG bulletin (2001) supports the use of both Carpenter and Coustan criteria or NDDG

criteria leaving these decisions to practicing physicians.[5] As such, the potential for diagnostic errors increases and the incidence of GDM is under reported.

Little is known about the specific criteria for GDM diagnosis that individual physicians use in their practice. Due to the potential variability in GDM criteria measures, we asked Oregon physicians to identify which criteria they used for diagnosing GDM in their practice. An explanation of methodology and sampling procedures is described elsewhere.[15] Physicians were provided a list of potential guidelines and were asked to indicate with a YES or NO response whether or not they were currently using specific guidelines. Respondents could respond yes or no to more than one guideline; the answers were not mutually exclusive. Physicians also had the option of selecting "unknown" or "other" if they did not know which guideline they use or if they believed another guideline was being used in their practice. Chi-square analysis was used to examine differences in guideline use by specialty for each guideline listed. The survey results are provided in Table 2.

Table 2: Physician Identified Guidelines used for Glucose Testing (N=163)

	Percent of total that use Guideline	Response Family Practice	Response Ob/Gyn	Total Number that use	Chi-square differences between FP and OB/GYN χ^2
National Diabetes Data Group	17%	8 (28.6%)	20 (71.4%)	28 (100%)	**2.93, 0.23**
Carpenter Coustan	16.9%	3 (11.1%)	24 (88.9%)	27 (100%)	**22.79, 0.00**
America Diabetes Association	22%	24 (66.7%)	12 (33.3%)	36 (100%)	**15.74, 0.00**
World Health Organization	5.5%	7 (77.8%)	2 (22.2%)	9 (100%)	**6.19, 0.05**
American College Ob/Gyn	83%	46 (33.8%)	90 (66.2%)	136 (100%)	**29.11, 0.00**
Family Practice Guidelines	20.9%	33 (97%)	1 (3%)	34 (100%)	**61.81, 0.00**
Unknown	19%	19 (61.3%)	12 (38.7%)	31(100%)	**7.01, 0.03**
Other	3%	4 (80%)	1 (20%)	5 (100%)	**4.35, 0.36**

Note: All yes responses recorded. Physicians could respond yes or no to more than one set of criteria. A total of 163 physicians responded to this question.

Physician responses were significantly different by practice specialty (Ob/Gyn and Family Practice) for all of the guidelines listed, $p<.05$, with the exception of National Diabetes Data Group, $p=.23$ and "other", $p=.36$. However, eighty-three percent of all physicians (N=163) reported using the American College of Obstetrics and Gynecology guidelines. This finding is consistent with focus groups conducted in Atlanta by researchers at the Center for Disease Control and Prevention in 2006.[24] CDC researchers found that ACOG was the most frequently cited source followed by ADA.[24] As stated earlier, ACOG endorses both NDDG and Carpenter and Coustan.

Identifying ACOG may indicate that the physicians do not know if they use NDDG or Carpenter and Coustan guidelines for diagnosing GDM. Obstetrics/Gynecology physicians identified the use to of the ACOG guidelines more often than family practice physicians (χ^2=29.11, p<0.001). Twenty-eight physicians (17%) from both specialties reported using the NDDG guidelines and 31 (19%) physicians reported using the Carpenter and Coustan guidelines. More OB/Gyn physicians than family practice reported using Carpenter and Coustan (χ^2=22.79 (1), p=0.00). Thirty-six physicians (22%) reported using the American Diabetes Association guidelines with a greater number of family practice physicians using these guidelines. Only nine physicians (5.5%) stated that they used the World Health Organization criteria. Thirty-four physicians (21%) indicated that they follow criteria published by Family Practice Therapeutics Guidelines published by the American Academy of Family Practice, thirty-three of which are in family practice. The American Academy of Family Practice publication, like ACOG, accepts both NDDG and Carpenter and Coustan guidelines. Finally, thirty-one (19%) physicians reported that they did not know which guidelines they use in their practice.

These findings demonstrate that there are many guidelines for physicians to choose from, with huge variability in cut-off values for diagnosis of GDM. The use of many different guidelines may lead to under diagnosing and reporting of GDM. There are indicators that such inconsistent guideline utilization may be more pervasive than reflected in Oregon. In 2006, focus groups conducted in Atlanta, Georgia by the Center for Disease and Prevention found that physicians cited the use of several guidelines, including: ACOG, ADA, informal guidelines, and internal checklists.[24]

Regardless of diagnostic guidelines used, once a woman is diagnosed with GDM, it is essential that she receive follow-up care during pregnancy and in the postpartum period. During the prenatal period, the goal is to normalize blood glucoses. Often dietary changes and physical activity will be enough to normalize blood glucoses during pregnancy. Ideally, she would be referred to a diabetes specialist, namely a registered dietitian, for specific counseling about how to best achieve and maintain normal blood glucose levels during pregnancy and beyond. In women with GDM, medical nutrition therapy is the primary intervention strategy for managing blood glucose.[25] The American Diabetes Association recommends that all women with GDM receive nutrition counseling by a registered dietitian when possible.[26] Referral to a specialist can be an important step in educating patients about lifestyle changes that could protect them from diabetes in the future. Nationally, little is known about GDM referral rates. In the past, physicians identified cost and lack of insurance coverage as major barriers to referral.[25] In our sample of Oregon physicians we found only 31% (N=188) are referring patients to a diabetes specialist "all or most of the time".

Recommendations for the Postpartum Period

After gestation women with a history of GDM should receive postpartum care to reduce risk of progression to type 2 diabetes and its complications. Established guidelines recommend screening for impaired glucose tolerance and offering diet and physical activity counseling following a GDM pregnancy. [5, 27, 28] Glucose intolerance screening would allow for early identification of women at risk for type 2 diabetes. Since screening for impaired glucose tolerance (IGT) is not routinely practiced in the

general population, it is difficult to identify individuals at risk for type 2 diabetes. Women with GDM represent a unique subset of the population because GDM is almost universally screened for and a history of GDM identifies women at risk for IGT. [5, 27] Identification of women at risk for type 2 diabetes has been called "a unique window of opportunity" for a woman's "physician to institute health habits and medical therapy that ultimately may have far-reaching effects on her quality of life and on any subsequent pregnancies".[28] The best predictor of progressing to type 2 diabetes following a GDM pregnancy is impaired glucose tolerance in the postpartum period. [29] Screening for glucose intolerance in the postpartum period and educating women with a history of GDM would capture a group with an established risk for type 2 diabetes. The Agency for Health Research and Quality (AHRQ), the American College of Obstetrics and Gynecologists (ACOG), and the American Diabetes Association (ADA) recommend reclassifying maternal glycemic status within 6 weeks after delivery. [5, 27, 28]

In addition to glucose intolerance screening, guidelines suggest lifestyle changes, including moderate exercise and adoption of healthy dietary practices [5, 27, 28.] The Diabetes Prevention Program demonstrated that lifestyle interventions could delay or prevent the development of type 2 diabetes in people with impaired glucose tolerance. [30] In a study of lifestyle interventions that targeted obese individuals and women with previous GDM, the lifestyle interventions were effective. [31] Physicians in our study reported offering dietary counseling "most of the time/always" 76% (N=253) of the time. In addition, physicians reported counseling women with a history of GDM to exercise regularly "most of the time/always" 84% (N=251) of the

time. Our findings indicate that doctors rarely conduct follow-up glucose intolerance tests but they are offering dietary and physical activity advice.

Despite published guidelines, screening following a GDM pregnancy is not commonly practiced. Kim et al studied a cohort of women with GDM using patient medical records at the University of Michigan Healthcare System and found rates of glucose testing after delivery were low; glucose testing was preformed after only 23% of deliveries.[9] A study of rural women with a history of GDM found that 40% did not receive glucose testing in the 5 years following delivery.[32] For those who received glucose testing, health care providers initiated glucose testing only 60% of the time; patients may need to advocate for themselves.[32]

We found a large discrepancy between gestation and postpartum blood glucose testing. We analyzed doctors that said they "always" do glucose screening during gestation for their practices in the postpartum period using McNemar's. Few of the doctors that reported "always" screening during gestation reported doing so in the postpartum period, McNemar's $\chi^2(1)=137.11$, $p=0.00$, shown in Table 9. Only 19% of the physicians that "always" screen during gestation are "always" screening blood glucose levels postpartum.

Table 3: Always Screen during Gestation Compared with Postpartum Period (N=189)

	All Screen During Gestation		
All Screen Post	**Yes**	**No**	**Total**
Yes	36	143	179
No	2	8	10
Total	38	151	189

Notes: Responding "yes, yes" represents the physicians that always test pre and always test in the postpartum period. The analysis was conducted only on respondents that answered both the questions about testing for glucose intolerance.

Opportunities exist for improving the health of women and decreasing the incidence of diabetes but there are challenges that must be addressed. The challenges include inconsistent guidelines for diagnosing GDM, low referral rates to diabetes specialists, and low rates of follow-up glucose intolerance screening.

Discussion

Standardized guidelines for diagnosing GDM are needed in Oregon and across the nation. Oregon physicians are using a variety of differing guidelines to diagnose GDM. Our survey found that physicians identified six different guidelines in Oregon along with physicians identifying "other" and "unknown". Five physicians selected "other" testing criteria; two physicians included a written response. One physician stated, "the criteria of our hospital lab" and the other stated, "1 hour OTT". Inconsistent guidelines create an epidemiological problem; women with GDM may go undiagnosed which underestimates the prevalence of GDM. Universal testing with a standard guideline could identify additional women that are at risk for future type 2 diabetes. [33] Standardized universal testing across the nation would offer an accurate measure of GDM prevalence and allow for early intervention and prevention of type 2 diabetes.

Standardized universal testing requires consensus on which guideline to use in diagnosing GDM. Carpenter and Coustan criteria identify a greater number of women with GDM. Women identified by the Carpenter and Coustan guidelines have the same risk and risk factors for later development of diabetic abnormality compared with patients who are gestational diabetes using the National Diabetes Data Group

guidelines.[34] Unfortunately, these criteria have not been universally agreed upon and adopted.

Some positive findings from our research include nearly universal testing for GDM during gestation and high rates of dietary and physical activity advice from physicians. However, Oregon physicians are neglecting to do follow-up screening for impaired glucose tolerance in the postpartum period. The few studies that have examined GDM postpartum care, including this study, have found that few physicians follow clinical guidelines that indicate glucose tolerance testing postpartum.[9, 32] The challenge is to determine why physicians are not following clinical guidelines and to implement strategies designed to motivate physicians to take action.

Motivating physicians to offering follow-up glucose testing offers an opportunity for health care savings. The Center for Disease Control and Prevention (CDC) estimates the average medical expenditure for a person with diabetes was $13,243 per year in 2002.[35] The direct and indirect costs for a person with diabetes is 5.2 times greater than the costs for a person without diabetes. In 2002, 11% of the national health care expenditure went to diabetes.[35] It would be cost effective for cities, states, and the nation to prevent cases of diabetes. In order to reduce the incidence of diabetes physicians may need incentives and/or reminders to implement follow-up with post-GDM women into their practice.

A lesson in implementation may be taken from New York City. New York City is progressively taking steps to promote the health of women who have a history of GDM. The City of New York is using birth certificate records to find women with GDM pregnancies and send notice to their physician. The letter reads as follows,

> "Dear Doctor:
> As noted on her baby's birth certificate, your patient had gestational diabetes (GDM) during her recent pregnancy. This is a reminder to do a fasting plasma glucose 6 weeks post-partum and periodically thereafter. Please discuss with your patient her increased risk for developing gestational diabetes in future pregnancies (75%), her increased risk of type 2 diabetes, and the higher chance of her child becoming overweight or obese, or developing glucose intolerance or type 2 diabetes in early adolescence.
>
> Healthy lifestyle changes, including more physical activity, better food choices, and weight loss, cut in half the risk of type 2 diabetes in patients with "pre-diabetes."
>
> For free information on gestational and type 2 diabetes for clinicians and patients, call 311 or visit nyc.gov/health/diabetes".[36]

This letter reinforces three key issues: 1) GDM is not a transient metabolic condition, 2) Physicians should closely monitor patients and their offspring for glucose intolerance, and 3) lifestyle changes can reduce women's risk of type 2 diabetes.

In order to halt increasing rates of diabetes consistent testing criteria and strategies to support physicians in aiding their patients make behavior changes must be put into effect. GDM diagnostic criteria are inconsistent and follow-up care is almost non-existent.

Conclusions

Every time a woman is diagnosed with GDM, there is an opportunity for physicians to play a key role in helping that patient receive diabetes education and care that can have a long-term impact on her health. There are missed opportunities for improving women's health due to inconsistent diagnostic guidelines, with significant variable in cut off values for diagnosis of GDM, lack of referral to a diabetes specialist during pregnancy, and a lack of follow-up in the post-GDM period.

The medical community should work to reach consensus on testing criteria that will best identify women with gestational diabetes and risk for future type 2 diabetes. Women who are diagnosed with GDM should be referred to a diabetes specialist; a registered dietitian when possible, for medical nutrition therapy. In the postpartum period, women should receive follow-up testing for impaired glucose tolerance.

Following a GDM pregnancy, women have a 75% lifetime likelihood of advancing to type 2 diabetes.[10] Lifestyle changes including more physical activity, better food choices, and weight loss, can cut a woman's risk for type 2 diabetes in half.[30, 37] Despite the threat of type 2 diabetes, physicians are not adhering to guidelines published by professional organizations, including The Agency for Health Research and Quality (AHRQ), The Family Practice Therapeutic Guidelines, The American Collge of Obstetrics and Gynecologists (ACOG) and the American Diabetes Association (ADA). Leading health organizations recommended screening for glycemic status in the postpartum period.[3,5, 23, 27, 28] Unfortunately, the majority of physicians are not taking this necessary step to reduce type 2 diabetes. Professional organizations, health care provider groups, insurers, and the general public must take positive action to reverse this trend.

These questions remain: 1) Can the medical community reach consensus on testing criteria? and 2) How can physicians be motivated to refer women to a diabetes specialist during gestation? and 3) How can physicians be motivated to screen for impaired glucose tolerance in women with a history of GDM?

Recently, Senator Hillary Rodham Clinton proposed a Gestational Diabetes Act (GEDI Act) that would provide $8,000,000 for fiscal year 2007[38]. The GEDI

Act would improve and expand research into this serious condition and identify ways to lower the incidence of type 2 diabetes associated with GDM. The bill would also provide funding for demonstration programs to reduce the incidence of gestational diabetes. This act specifically calls for the development of standardized diagnostic criteria [38]. Funding the GEDI Act could lead to agreement on diagnostic criteria that would improve the identification and diagnosis of women with GDM. In addition, Senator Clinton's proposal calls for state surveillance and health professional training. This act calls for states to report surveillance findings to the CDC for accurate assessment of GDM incidence.

Finally, doctors may need support to insure that women know their risks and are motivated to return to the office for testing. Support may need to come from health insurance plans, the Department of Health Services or other healthcare professionals that comprise a medical practice. Physicians may need the support of health plans in reimbursing for follow-up testing and behavioral counseling. In addition, health plans may need to reimburse for referral to other professionals, such as registered dietitians, who can help a patient make dietary choices that will reduce their disease risk. The Department of Health Services could offer support by sending reminds to both women with a history of GDM and their clinicians. In doing this, both the patient and the physician would receive a reminder to do follow-up blood glucose test. As physicians move to electronic systems, flagging charts with electronic reminders may be a cost effective way to deliver reminders. Alternatively, other medical professionals could assist in sending patient reminders and/or flagging charts to remind the physician to do follow-up testing and counseling.

Most importantly clinical trials are needed to examine the efficacy of physician directed lifestyle interventions in women with a history of GDM. With the concurrent increase in obesity and diabetes an urgent need for system-based intervention exists.

References

1. Kaaja RJ and Greer IA. Manifestations of Chronic Disease During Pregnancy. JAMA; 2005; 294: 2751-57.
2. Lauenborg J, et al. Increasing Incidence of Diabetes After Gestational Diabetes. 2004; 27; 1194-1199.
3. Sutton PD and Matthews TJ. National Center for Health Statistics. National Vital Statistics Report. Trends in Births by State. 2004. <http://www.cdc.gov/nchs/data/nvsr/nvsr52/nvsr52_19.pdf>
4. Ferrara A, Kahn HS, Quensenberry CP, Riley C, Hedderson MM. An Increase in the Incidence of Gestational Diabetes Mellitus: Northern California, 1991-2000. Obstet Gynecol. 2004; 103: 526-33.
5. American College of Obstetricians and Gynecologists Committee on Practice Bulletins. ACOG Practice Bulletin. Clinical Management Guidelines for Obstetrician-Gynecologists. Number 30, September 2001. Gestational diabetes. Obstet Gynecol. 2001; 98: 525-534.
6. American Diabetes Association. Gestational Diabetes. Available online: <http://www.diabetes.org/gestational-diabetes.jsp> Accessed 12/27/2006.
7. Kim C, Newton KM, Knopp RH. Gestational Diabetes and the Incidence of type 2 diabetes: a systematic review. Diabetes Care 2002; 25: 1862-1868.
8. Dyck R, Turnell RW, Klomp H, Boctor MA, Tan LK. A Comparison of Rates, Risk Factors and Outcomes of Gestational Diabetes Between Aboriginal and Non-Aboriginal Women in the Saskatoon Health District. Diabetes Care. 2002; 25: 487-493.
9. Kim C, Tabaei BP, Burke R, McEwen LN, Lash RW, Johnson SL, Schwartz K, Bernstein SJ, Herman WH. Missed Opportunities for Type 2 Diabetes Mellitus Screening Among Women With a History of Gestational Diabetes Mellitus. 2006; 96:xxx-xxx. Doi: 10.2105/AJPH. 2005.065722
10. Langer O. Screening for Gestational Diabetes. The Diabetes in Pregnancy Dilemma. 2006. University Press of America, Inc. p 432. Edited by Oded Langer.
11. Kjos, S. Maternal Implications of Gestational Diabetes. Seminars in Perinatalogy 1994; 18 (5): 470-474.
12. Landon MS and Gabbe et al. Management of diabetes mellitus and pregnancy: a survey of obstetricians and maternal-fetal specialists. Obstet Gynecol. 1990; 75(4): 635-640.
13. Bloomgarden Z. American Diabetes Association 60th Scientific Sessions, 2000-Pregnancy and Diabetes. Diabetes Care. 2000; 23(11) 1169-1702.
14. Dabelea D, Snell-Bergeion JK, Hartsfield CL, Bischoff KJ, Hamman RF, McDuffie RS. Increasing Prevalence of GDM Over Time and by Birth Cohort. Diabetes Care. 2005; 28:579-584.
15. Hunsberger ML. Thesis 2007.

16. O'Sullivan JB. Criteria for Oral Glucose Tolerance Test in Pregnancy. Diabetes 1964;13(3): 278-285.
17. National Diabetes Data Group. Classification and Diagnosis of Diabetes Mellitus and Other Categories of Glucose Intolerance. Diabetes. 1979; 28:1039-1057.
18. Carpenter and Coustan. Criteria for Screening Tests for Gestational Diabetes. Am J Obst Gynecol. 1982; 144: 768.
19. World Health Organization. Definition, Diagnosis, and Classifications of Diabetes Mellitus and Its Complications. 1999. Geneva, World Health Organization. Available online: <whqlibdoc.who.int/hq/1999/WHO_NCD_NCS_99.2.pdf>
20. World Health Organization. Laboratory Diagnosis and Monitoring of Diabetes Mellitus. 2002. Available online: <whqlibdoc.who.int/hq/2002/9241590483.pdf>
21. American Diabetes Association. Gestational Diabetes. Diabetes Care. 2004; 27 (Supplement 1).
22. Jovanovic L and Pettitt D. Gestational Diabetes Mellitus. JAMA. 2001; 286(20): 2516-2518.
23. Turok DK, Ratcliffe SD, Baxley EG. Management of Gestational Diabetes. Am Fam Physician 2003; 68:1767-72, 1775-6.
24. Collier, Sarah. Atlanta Health Care Providers' and Women's Perceived Barriers to the Management of Gestational Diabetes Mellitus. Presented at the 12th Annual Maternal and Child Health Epidemiology Conference. Atlanta, GA. December 6-8, 2006.
25. Metzger B and Coustan D. Summary and Recommendations of the Fourth International Workshop-Conference on Gestational Diabetes Mellitus. Diabetes Care. 1998; 21: Supplement 2) B161-167.
26. American Diabetes Association. Gestational Diabetes Mellitus. Diabetes Care (Supplement 1) 2004.
27. American Diabetes Association. Gestational Diabetes Mellitus Position Statement. Diabetes Care. 2000; 23(suppl 1): S77-S79.
28. AHRQ Clinical Prevention Program. Screening for Gestational Diabetes Mellitus: Recommendations and Rationale. US Preventive Services Task Force 2003; 101: 393-395.
29. Kjos S. Postpartum Care of the Woman with Diabetes. Clinical Obstetrics and Gynecology. 2000; 43: 75-86.
30. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with life style intervention or metformin. N Engl J Med . 2002; 346: 393-403.
31. Seagl L, Dalton AC, Richardson J. Cost-effectiveness of the primary prevention on non-insulin-dependent diabetes mellitus. Health Promotion Int. 1998; 13:197-209.
32. Kaufmann RC, Smith T, Bochantin T, Khardori R, Evans MS, Steahly L. Failure to obtain follow-up testing for gestational diabetes in a rural population. Obstet Gynecol . 1999; 93: 734-737.
33. Mazze R. The Diabetes in Pregnancy Dilemma. 2006. University Press of America, Inc. Lanham, Maryland. Edited by Oded Langer.

34. Kaufmann RC, Schleyhahn FT, Huffman DG, Amankwah KS. Gestational diabetes diagnostic criteria: Long-term maternal follow-up. Am J Obstet Gynecol. 1995; 172:621-625
35. Center for Disease Control and Prevention. 2005. Diabetes Disabling, Deadly and on the Rise. Available online: www.cdc.gov/diabetes.
36. New York City Department of Health and Mental Hygiene. 2006. Letter to Doctors. <http://www.nyc.gov/html/doh/html/diabetes/diabetes-gestational-packet.shtml>
37. Tuomilehto J, Lindstrom J, Ercksson JG, et al, for the Finnish Diabetes Prevention Group. Prevention of type 2 diabetes mellitus by changes in lifestyle amoung subjects with impaired glucose tolerance. N Engl J Med. 2001; 344:1343-50.
38. Gestational Diabetes Act of 2006. 109th CONGRESS
2d Session S. 3914 To establish an Advisory Committee on Gestational Diabetes, to provide grants to better understand and reduce gestational diabetes, and for other purposes. IN THE SENATE OF THE UNITED STATES September 20, 2006. Available online http://www.theorator.com/bills109/s3914.html.

CHAPTER 5- DISCUSSION, CONCLUSIONS, AND DIRECTIONS

DISCUSSION

The findings of this study contribute to the medical, public health and health education literature by examining rates and predictors for GDM in a state wide sample of postpartum women. Additionally, we explored physician practice patterns during gestation and in the postpartum period following a GDM pregnancy. Focusing on these two populations allowed the researchers to examine prevalence and risk factors for GDM and analyze physician practice patterns and factors that influence the nature and extent of care offered to women with a history of GDM in Oregon. Information from these two sub-studies allowed us to view GDM in its contextual framework of etiology and current provider behaviors designed to reduce progression of GDM to type 2 diabetes. After discussion of key findings and potential areas for improved clinical practice, we recommend strategies likely to have an impact in reducing risk for future type 2 diabetes in high risk, GDM women.

GDM Risk Factor Findings

Consistent with other studies, data from this study indicate several consistent factors that influence GDM risks (Morrato, 2006, Dyck, 2002, Berkowitz, 1992, Xiong, 2001). In this study, the most significant risk for GDM is maternal overweight or obesity at the onset of pregnancy, as indicated by pre-pregnancy BMI>25 kg/m^2 (Morrato, 2006, ADA, 2006). Being overweight or obese increased a women's risk for GDM by greater than 2.5 times (Sebire, 2001). Racial and ethnic minority group members had a 1.26 fold increase for GDM, or a 26% greater risk over non-Hispanic Whites (Berkowitz, 1992, Morrato, 2006). We found significant

racial/ethnic disparities in the prevalence of GDM in Oregon. In this sample Asian/Pacific Islanders and Hispanics had the greatest incidence of GDM. This is consistent with previous findings that indicate Asian, Hispanic, Indian and Middle East women have excess risk for Gestational Diabetes compared to white non-Hispanic women (Dabelea, 2005, Berkowitz, 1992, Ferrara, 2004).

Advancing maternal age also increased the risk for GDM. We examined GDM by age group and found that women under 20 years of age had diagnosed GDM in less than 1% of their pregnancies. Women 20-24 years of age had a slight increase, with 2% of pregnancies complicated by GDM. In women 25-34 years of age the incidence increased significantly, 5.5% of pregnancies were complicated by GDM. The women age 35 and up had the greatest incidence of GDM with 7.5% of pregnancies complicated by GDM. This is consistent with previous research (Dyck, 2006, Ben-Haroush, 2003, Jovanovic 2001, Kjos, 1999). In Saskatoon, Canada, Dyck et al studied aboriginal and non-aboriginal women and found that maternal age ≥33 years was an important risk factor for aboriginal women, while age ≥38 was a strong predictor for GDM in non-aboriginal women (Dyck, 2006). The American Diabetes Association reports age over 25 years of age is an important risk factor for GDM (ADA, 2006). Our research supports the American Diabetes Association finding that maternal age >25 is a significant risk for GDM.

Physician Practice Patterns During Gestation

Physicians almost universally reported that they screen all women for GDM between 24-28 weeks gestation. Greater than 95% of physicians surveyed reported always screening for GDM. However, there are many different screening guidelines

used to make a diagnosis in this geographic sample. Physicians that responded to our survey identified the use of guidelines published by ADA, ACOG, NDDG, Carpanter and Coustan, Family Practice Guidelines, and other guidelines unique to their organization. Many physicians indicated they used more than one set of guidelines, which may indicate that they did not know which set they use. Some physicians reported they did not know which guidelines they use in practice and in written comment stated they felt embarrassed by their lack of knowledge regarding screening protocol. Our findings are consistent with focus group research conducted with in Atlanta, Georgia in 2006. Atlanta physicians participated in focus groups and identified the use of several different guidelines, including ACOG, ADA, American Council of Endocrinologists (ACE), American Diabetes Educator guidelines, and their own internal guidelines (Collier, 2006).

The current practice guidelines use differing blood glucose levels for diagnosing GDM. Since the guidelines lack consistency it is difficult to determine the incidence of GDM either statewide or nationally. Until a standard screening guide is agreed upon and adhered to women with GDM may go undiagnosed and opportunities for preventing type 2 diabetes will be missed.

Another area that we believe to be problematic in standard GDM treatment is a lack of patient referral to a diabetes specialist. Our results indicated that only thirty-one percent of physicians referred GDM women to a diabetes specialist. Diabetes specialists, in particular registered dietitians, are trained to counsel patients about dietary choices and meal planning that will allow them to maintain normal blood glucose levels, ideally without the use of insulin. Dietary counseling during

pregnancy can assist women in making healthy choices that will impact their health and the health of their unborn child both during the pregnancy and in the future. Widespread failure to refer GDM patients to clinicians trained to intervene is a serious "opportunity lost" in our estimation.

Physician Practice Patterns After Gestation

We found that the gender of the physician was a significant influence on post-GDM care. Female physicians reported giving adequate care more often than male physicians in the postpartum period. It may be that female clinicians are more aware of the health risks of their female patients. We did not find any significant differences in the level of care by specialty, years of practice, practice setting, or geographic placement of the practitioner. Few studies have examined physician practice patterns postpartum. Two other studies examining practice patterns, Kim et al. and Kaufmann et al. found no significant differences by health care provider specialty (Kim, 2005, Kaufmann, 1999).

Post-GDM Care

Physicians identified a low level of follow-up blood glucose testing in this statewide geographic sample. Physicians universally comply with testing for GDM during gestation. However, it is important to note that only 19% of those who test for GDM during pregnancy do so in the postpartum period. Similar findings have been reported in the limited numbers of studies that have investigated postpartum follow-up care (Kim, 2005, Kaufmann, 1999 and Kaufmann 1995). Kaufmann et al. found only forty percent of women who delivered in the early 1990s received blood glucose testing at all in the five years after delivery (Kaufmann, 1999). Kim et al found testing

that conformed to the established guidelines was performed after twenty-three percent of deliveries (Kim, 2005). Although testing in the post-GDM period ranged from 19-41%, we believe that anything less than 100% testing reflects a serious breakdown in the health care system; one that ultimately will be costly for the patient and entities charged with paying for excess costs of preventable disease.

Interestingly, the only factor that was predictive of glucose testing in our survey was a belief that postpartum blood glucose testing is done by peers. Physicians who believed follow-up glucose testing after a GDM pregnancy to be the norm were more likely to do so themselves. The importance of "subjective norms" in motivating individuals and systems to adopt specific behaviors has been widely supported in the extant literature. Simply stated, "subjective norm" theorists postulate that people are more likely to perform behaviors if relevant others are doing so. In this study, we assessed whether physicians who believed that their peers were delivery post-GDM care would be more likely to do so themselves.

More than half of the physicians in this sample believed follow-up care was not typically provided by their colleagues and tended to not do so themselves. As shown in other research physicians appear to practice in a fairly homogenous way, following the "norms" of their profession and the dictates of specific guidelines and reporting systems. There seems to be little support for the established postpartum guidelines in the medical community at this time. This may be due to a lack of knowledge or it may be that other barriers prevent physicians from offering follow-up care more consistently. There is little known about why physicians fail to follow recommended GDM follow-up care guidelines. However, studies of other physician

practice guidelines have uncovered a myriad of reasons why clinical guidelines may not be adopted into clinical practice (Glasgow, 2003, Berwick, 2006, Cabana 2006, Lenfant, 2003, Elltrodt, 1995).

Typical reasons why clinical research guidelines do not make it into clinical practice include: implementation issues, health care system inefficiency, severity of the illness, lack of time, insufficient training, research fails to make it into clinical settings, and physician behavior (Yarnell, 2003, Ellrodt, 1995, Orlandi, 1987, Glasgow, 2003, Lenfant, 2003). It is likely that these are some of the reasons physicians do not follow established guidelines for post-GDM follow-up care. In the future barriers specific to post-GDM care should be explored.

Surprisingly, when we asked physicians if they view GDM as a transient metabolic condition the majority did not. We found that 31% strongly disagreed, 41% somewhat disagreed, and the remaining 28% somewhat agreed or strongly agreed. Approximately two-thirds of survey respondents do not believe GDM is a transient metabolic condition. Ironically, beliefs that GDM is not a transient metabolic condition would imply a belief that further health care is necessary. It is surprising that beliefs about potential risks to patients did not motivate more follow-up glucose testing in this group of practitioners.

If GDM testing is routinely practiced and physicians acknowledge the future risk profile for their patients, a careful analysis of the reasons why so many physicians fail to act is warranted. Is this failure to act due to pressing immediate clinical priorities that overshadow this seemingly distant threat? Are physicians so pressed for time that adding one more task to the myriad of duties they are asked to perform may

be too much? Is post-GDM screening a habit that must be mandated in clinical practice in order to motivate change? Studies have shown that like many other professionals, physicians are reluctant to change their practice if what they are doing works for them (Berwick, 2006).

When physicians are asked to make changes or incorporate innovations into their routine practice patterns, three influences on the rate of diffusion of innovations within an organization. These include: 1) the perceptions of the innovation, 2) the characteristics of the individuals who may adopt the change, and 3) the contextual and managerial factors within the organization (Berwick, 2006). Perceptions of an innovation can predict the rate of spread. Rogers found 49%-87% of the variance in the rate at which people adopt new innovations is due to their perceptions (Rogers, 1995). Perceptions about an innovation are influenced by several factors, including the perceived benefit of changing, compatibility with held values, beliefs and past history, and current needs of the individual adopters, complexity, trialability, and observability (Rogers, 1995). Physician beliefs, attitudes, priorities and subjective norms need to be considered when encouraging physicians to adopt GDM guidelines.

CONCLUSIONS

In summary, this research provides a foundation of information about the prevalence of GDM in Oregon women, the factors that increase the risk for GDM and at the same time explores physician practice patterns. The prevalence of GDM is rising concurrently as obesity rates soar in the United States (CDC, 2005). Physicians are the gatekeepers for adequate medical care for women with GDM. They are also in a unique position to emphasize behavior changes women can make to minimize heath

risks; motivate patients; refer women to diabetes specialists and endocrinologists; and remind them when it is appropriate to get follow-up examinations. In short, the continuum of care for the GDM patient should not stop once the patient leaves the doctors office.

Every time a woman is diagnosed with GDM, there is an opportunity for physicians to play a key role in helping that patient receive diabetes education and care that can have a long-term impact on her health. There are missed opportunities for improving women's health due to inconsistent diagnostic guidelines, lack of referral to a diabetes specialist, and a lack of follow-up glucose testing in the post-GDM period.

Following a GDM pregnancy, women have a 70% lifetime likelihood of advancing to type 2 diabetes (Langer, 2006). Lifestyle changes including more physical activity, better food choices, and weight loss, can cut a woman's risk for type 2 diabetes in half (Knowler, 2002, Tuomilehto, 2001). Despite the threat of type 2 diabetes, physicians are not adhering to guidelines published by professional organizations, including The Agency for Health Research and Quality (AHRQ), The Family Practice Therapeutic Guidelines, The American Collge of Obstetrics and Gynecologists (ACOG) and the American Diabetes Association (ADA). Leading health organizations recommended screening for glycemic status in the postpartum period (ACOG, 2001, ADA, 2006, Turok, 2003, AHRQ, 2003, ADA, 2000). Unfortunately, the majority of physicians are not taking the necessary steps to reduce type 2 diabetes.

DIRECTIONS

Future Directions

These questions remain: 1) Can the medical community reach consensus on testing criteria?, 2) How can physicians be motivated to refer women to a diabetes specialist during gestation?, and 3) How can physicians be motivated to screen for impaired glucose tolerance in women with a history of GDM?

Efficacy trials are needed to demonstrate the effectiveness of postpartum screening and lifestyle counseling that are unique to post-GDM women. Public health professionals must be able to demonstrate to physicians that their efforts in working with post-GDM women will prevent the incidence of type 2 diabetes. The Diabetes Prevention Program demonstrated that lifestyle interventions are effective in reducing the incidence of type 2 diabetes yet we lack clinical trails specific to prevention of type 2 diabetes following GDM (Diabetes Prevention Program Research Group, 2002).

Promising Directions

Recently, Senator Hillary Rodham Clinton proposed a Gestational Diabetes Act (GEDI Act) that would provide $8,000,000 for fiscal year 2007 (GEDI Act, 2006). The GEDI Act would improve and expand research into this serious condition and identify ways to lower the incidence of type 2 diabetes associated with GDM. The bill would also provide funding for demonstration programs to reduce the incidence of gestational diabetes. This act specifically calls for the development of standardized diagnostic criteria (GEDI, 2006). Funding the GEDI Act could lead to agreement on diagnostic criteria that would improve the identification and diagnosis of women with

GDM. In addition, Senator Clinton's proposal calls for state surveillance and health professional training. This act calls for states to report surveillance findings to the CDC for accurate assessment of GDM incidence.

The New York City Department of Health and Mental Hygiene serves a model for another promising direction. The Department is sending notes to physicians reminding them to do postpartum glucose testing when a woman has had a GDM pregnancy (NYC Department of Health and Mental Hygiene, 2006). Another promising direction includes South Dakota's Gestational Diabetes Care Guidelines that address screening and recommend using the Carpenter and Coustan standards for the 3-hour 100-gram oral glucose tolerance test. These guidelines also recommend postpartum glucose screening (South Dakota Department of Health Diabetes Prevention and Control Program in cooperation with the CDC, 2003).

BIBLIOGRAPY

Aday L. (1996). Designing and Conducting Health Surveys 2nd Ed. Jossey-Bass Publishers.

AHRQ (1998) Clinician's Handbook of Preventive Services, 2nd Edition, [available online] www.vnh.org/PreventionPractice/chII.html or by calling 1-800-358-9295.

AHRQ (2006) The Guide to Clincal Preventative Services, 3rd Edition, [available online]. www.ahrq.gov/clinic/poketgd.pdf

AHRQ Clinical Prevention Program. (2003). Screening for Gestational Diabetes Mellitus:Recommendations and Rationale. US Preventive Services Task Force 101: 393-395.

Albareda, M, Caballero, A, Badell, G, Piquer, S, Ortiz, A, De Leiva, A, Corcoy, R. Diabetes and Abnormal Glucosa Tolerante in Women with Previous Gestational Diabetes. Diabetes Care 26 (4): 1199-1205.

Ali Z, Alexis SD. (1990). Occurrence of diabetes Mellitus after gestational diabetes in Trinidad. Diabetes Care 13:527-529.

American Association of Clinical Endocrinologists. (2002). Medical Guidelines for the Treatment and Management of Diabetes Mellitus. [available online] http://www.aace.com/clin/guidelines/diabetes_2002.pdf Retrieved June 11,2005

American College of Obstetricians and Gynecologists (2001) ACOG Practice Bulletin: Assessment of risk factors for preterm birth: clinical management guidelines for obstetrician-gynecologists. Obstet Gynecol 2001; 98 (no31):709-716.

American College of Obstetricians and Gynecologists Committee on Practice Bulletins. (2001). ACOG Practice Bulletin. Clinical Management Guidelines for Obstetrician-Gynecologists. Gestational diabetes. Obstet Gynecol. 98 (30) 525-538.

American Diabetes Association. (2002). Meet the Researcher. Hillier, Teresa, MD. Clinical Research Project. Project Duration: 07/01/2002-9/30/2006. [available online]. http://www.diabetes.org/diabetes-research/researcherinfo. Retrieved January 19, 2005.

American Diabetes Association National Diabetes Fact Sheet. (2002). [Article online] Available from <http://www.diabetes.org/utils/printthispage.jsp?PageID=STATISTICS_233193>

American Diabetes Association. (2006). About Diabetes. Available online http://www.diabetes.org/about-diabetes.jsp

American Diabetes Association. (2004) Gestational Diabetes Mellitus. Diabetes Care 27: S88-90.

American Diabetes Association. (2005) The Dangerous Toll of Diabetes. [Article online] Available from <http://www.diabetes.org/diabetes-statistics/dangerous-toll.jsp>

American Diabetes Association: Gestational diabetes mellitus. (2000) Diabetes Care. 23(Suppl 1):S77-S79.

American Diabetes Association. (2002). National Diabetes Fact Sheet. [available online] http://www.diabetes.org/utils/printthispage.jsp?PageID=STATISTICS_233193

American Diabetes Association. (2004). Gestational Diabetes Mellitus Position Statement. Diabetes Care 27 (Suppl. 1): S88-90.

American Diabetes Association (2003). Gestational Diabetes Mellitus Position Statement. Diabetes Care 26 (Suppl. 1): S103-105.

American Diabetes Association (2000). Gestational Diabetes Mellitus Position Statement. Diabetes Care (Suppl. 1): S77-79.

American Diabetes Association (2005). Diabetes Statistics. [available online] http://www.diabetes.org/diabetes-statistics/prevalence.jsp Retrieved March 8, 2006.

American Diabetes Association (2005). The Dangerous Toll of Diabetes. [available online] http://www.diabetes.org/diabetes-statistics/dangerous-toll.jsp Retrieved March 8, 2006.

American Diabetes Association. (2005). Diabetes Statistics in Women. http://www.diabetes.org/gestational-diabetes.jsp. Retrieved April 19, 2005.

American Diabetes Association. (2005). Gestational Diabetes. [available online]. http://www.diabetes.org/gestational-diabetes.jsp Retrieved January 11, 2005.

Behavioral Risk Factor Surveillance System. (2003) [available online] http://apps.nccd.cdc.gov/brfss/ Retrieved April 13, 2005.

Ben-Haroush A, Yogev Y, Hod M. (2004). Epidemiology of gestational diabetes mellitus and its association with Type 2 diabetes. Diabetetic Medicine 21:103-113.

Berkowitz GS, Lapinski RH, Wein R, Lee D. (1992). Race/Ethnicity and Other Risk Factors for Gestational Diabetes. Am J Epidemiol 135:965-73.

Berwick DM. (2006). Disseminating Innovations in Health Care. JAMA 289:1969-1975.

Bien TH, Miller WR, Tonigan JS. (1993). Brief interventions for alcohol problems: a review. Addiction 88:315-335.

Bottalico, JN. (2001). Diabetes in Pregnancy. JAOA 101(2): S10-S13

Burack RC. (1989). Barriers to clinical preventive medicine. Prim Care. 16:245-250.

Cabana, M, Rand, SA, Powe, NR, Wu, AW, Wilson, MH, Abboud, PC, Rubin, H. (1999). Why Don't Physicians Follow Clinical Practice Guidelines? A Framework for Improvement.

Carpenter M, Coustan D. (1982). Criteria for screening tests for gestational diabetes. Am J Obstet Gynecol 144:768-773.

Catalano PM, Vargo KM, Bernstein IM, Amini SB (1991) Incidence and risk factors associated with abnormal postpartum glucose tolerance in women with gestational diabetes. Am J Obstet Gynecol 165:914-19.

Center for Disease Control and Prevention. (2005). Physical Activity Recommendations. [available online] www.cdc.gov/ Retrieved May 29, 2005.

Center for Disease Control and Prevention (2005). National Diabetes Fact Sheet. [available online] www.cdc.gov/diabetes/pubs/pdf/ndfs_2005.pdf Retreived March 13, 2006.

Center for Disease Control and Prevention (2006). SEARCH for Diabetes in Youth Fact Sheet. [available online] www.cdc.gov/diabetes/pubs/pdf/search.pdf Retrieved March 8, 2006.

Centers for Disease Control and Prevention. (2002) National diabetes fact sheet: general information and national estimates on diabetes in the United States. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2003.

CDC Behavioral Risk Factor Surveillance Survey. (2005). Available online: <http://apps.nccd.cdc.gov/brfss/Trends/trendchart.asp?qkey=10010&state=OR>

CDC Pregnancy Nutrition Surveillance. (2004). Table 16D. Summary of Trends in Maternal Health Indicators. Available online: <cdc.gov/pednss/pnss_tables_tables_health_indicators.htm#Maternal%20Health>

Center for Disease Control and Prevention. (2005). Diabetes Disabling, Deadly and on the Rise. Available online: www.cdc.gov/diabetes.

CDC. (1998). U.S. Preventive Services Task Force: Recommendations for Physical Exercise in Primary Prevention. <http://wonder.cdc.gov/wonder/prevguid/p0000060/p0000060.asp#head001000000000000>

Center for Disease Control and Prevention. (2005). Obesity Trends. Accessed September 14, 2006. Available online: http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/index.htm.

Centers for Disease Control and Prevention. (2006). Diabetes and women's health across the life stages: a public health perspective. Available at: http://www.cdc.gov/diabetes/pubs/pdf/women.pdf. Accessed May 8, 2006.

Clark HD, Van Walraven C, Code C, Karovitch A, Keely E. (2003). Did Publication of a Clinical Practice Guideline Recommendation to Screen for Type 2 Diabetes in Women With Gestational Diabetes Change Practice? Diabetes Care 26(2):265-268.

Clinton HR. Gestational Diabetes Act, Senate Bill 3914. September 20th, 2006. 109th Congressional Session. IN THE SENATE OF THE UNITED STATES. Available online: http:www.theorator.com/bills109/s3914.html.

Cheung, N.W., Byth, K. (2003). Population Health Significance of Gestational Diabetes. Diabetes Care 26 (7): 2005-2009.

Conway D, Langer O. (1999). Effects of new criteria for type 2 diabetes on the rate of postpartum glucose intolerance in women with gestational diabetes. Am J Obstet Gynecol 181:610-614.

Coustan DR, Carpenter MW, O'Sullivan PS, Carr SR (1993). Gestational Diabetes: Predictors of subsequent disordered glucose metabolism. Am J Obstet Gynecol 168:1139-1145.

Csorba TR and Edwards AL. (1995). The Genetics and Pathophysiology of Type II and Gestational Diabetes. Critical Reviews in Clinical Laboratory Sciences 32(5):509-550.

Dabelea D, Snell-Bergeon JK, Hartsfield CL, Bischoff KJ, Hamman RF, McDuffie RS. (2005). Increasing Prevalence of Gestational Diabetes Mellitus (GDM) Over Time and by Birth Cohort. Diabetes Care 28(3); 579-584.

Damm P. (1998). Gestational diabetes mellitus and subsequent development of overt diabetes mellitus. Danish Medical Bulletin 45(5):495-509.

Damm P, Kuhl C, Bertelsen A, Molsted-Pedersen L. (1992). Predictive factors for the development of diabetes in women with previous gestational diabetes mellitus. Am J Obstet Gynecol. 1992:167:607-616.

Davidson, M (2003). The Case for "Outsourcing" Diabetes Care. Diabetes Care 26(5): 1608-1612.

Diabetes Prevention Program Research Group. (2002). The Diabetes Prevention Program (DPP) Description of lifestyle intervention. Diabetes Care 25(12):2165-2171.

Diabetes Prevention Program Research Group (2002). Reduction in the Incidence of Type 2 Diabetes With Lifestyle Intervention of Metformin. N Engl J Med 346(6): 393-403.

Donatelle RJ & Hudson. New Smoking Cessation Interventions for Pregnant Women: Do they work? Panel Presentation with: Rigotti NA, Donatelle RJ, Gaffney CA, Barker DC. National Conference on Tobacco or Health annual meeting in Chicago, IL, May 5, 2005. Abstract ID#12460. The abstract is available online at http://ncth.confex.com/ncth/2005/techprogram/paper_12460.htm.

Donatelle RJ and Hudson D. Using 5 A's and Incentives to Promote Prenatal Smoking Cessation. Presentation to the National Conference on Tobacco Health, San Francisco, California, November 20, 2002.

Dörner G and Plagemann A. (1994). Perinatal hyperinsulinism as possible predisposing factor for diabetes mellitus, obesity, and enhanced cardiovascular risk in later life. Horm Metab Res. 1994; 26:213-221.

Dörner G, Plagemann A, Neu A, Rosenbauer J. (2000). Gestational diabetes as possible risk factor for Type I childhood-onset diabetes in offspring. Neuroendocrinology Letters 21:355-359.

Dörner G, Plagemann A. (1994). Perinatal hyperinsulinism as possible predisposing factor for diabetes mellitus, obesity and enhanced cardiovascular risk in later life. Horm Metab Res 26:213-221.

Dornhorst A, and Frost, G (2002). The principles of dietary management of gestational diabetes: reflection on current evidence. J Hum Nutr Dieter 15:145.

Dornhorst A, and Rossi M. (1998). Risk and Prevention of Type 2 Diabetes in Women with Gestational Diabetes. Diabetes Care 21 (Suppl. 2): B43-B49.

Dyck R, Turnell RW, Klomp H, Boctor MA, Tan LK. (2002). A Comparison of Rates, Risk Factors, and Outcomes of Gestational Diabetes Between Aboriginal and Non-Aboriginal Women in the Saskatoon Health District. Diabetes Care 25:487-493

Edelstein SL, Knowler WC, Bain RP, Andres R, Barrett-Connor EL, Dowse GK, Haffner SM, Pettitt DJ, Sorkin JD, Muller DC, Collins VR, Hamman RF. (1997)

Predictors of progression from impaired glucose tolerance to NIDDM: an analysis of six prospective studies. Diabetes. 46:701-710.

Edwards P, Roberts I, Clarke M, DiGuiseppi C, Pratap S, Wentz R, Kwan I. (2002) BMJ 324:1183-92.

Ellrodt AG, Conner L, Riedinger M, Weingarten S. (1995). Measuring and Improving Physician Compliance with Clinical Practice Guidelines. Ann Intern Med. 122:277-282.

Executive office of the President and Health and Human Services. (2005). HealthierUS. [available online] http://www.healthierus.gov/dietaryguidelines/

Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. (2003). Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 26(1):S5-S20.

Ferrara A, Kahn, HS, Quesenberry CP, Riley C, Hedderson MM. (2004). An increase in the incidence of gestational diabetes mellitus: Northern California, 1991-2000. Obstetrics & Gynecology 103(3):526-533.

Fiore MC, Bailey WC, Cohen SJ, et al. (2000). Treating Tobacco Use and Dependence. Quick Reference Guide for Clinicians. Rockville, MD: US Department of Health and Human Services. Public Health Service. October 2000. (Available online: http://www.surgeongeneral.gov/tobacco/treating_tobacco_use.pdf)

Fisbein M, Ajzen I. (1975). Belief, Intention, and Behavior: An Introduction to Theory and Research. Reading, Mass: Addison-Wesley.

Flegal KM (1999). The obesity epidemic in children and adults: current evidence and research issues. Med Sci Sports Exerc 31 (Suppl. 11):S509-S514.

Fleming MF, Barry KL, Manwell LB, Johnson K, London R. (1997). Brief physician advice for problem alcohol drinkers: a randomized controlled trial in community-based primary care practices. JAMA 277: 1039-1045.

Franz MJ, Bantle JP, Beebe CA, Brunzell JD, Chiasson JL, Garg A, Holzmeister LA, Hoogwerf B, Mayer-Davis E, Mooradian AD, Purnell JQ, Wheeler M. (2002) Evidence-Based Nutrition Principles and Recommendations for the Treatment and Prevention of Diabetes and Related Complications. Diabetes Care. 25:148-198.

Frisch RE,Wyshak G, Albright E, Albright NL, Schiff I. (1986). Lower prevalence of diabetes in female former college athletes compared with nonathletes. Diabetes. 35: 1101-1105.

Galuska DA, Will JC, Serdula MK, Ford ES. (1999). Are health care professionals advising obese patients to lose weight? JAMA. 282: 1576-1578.

Garcia-Patterson, Apolonia Martin, Esther Ubeda, Justa Maria, Miguel Angel de Leiva, Alberto Corcoy, Rosa (2001). Evaluation of Light Exercise in the Treatment of Gestational Diabetes. Diabetes Care 24: 2006.

Glanz K, Lewis FM, Rimer B. (1997). Health Behavior and Health Education, Theory, Research, and Practice. Jossey-Bass Inc. San Francisco, CA.

Glasgow RE, Lichtenstein E, Marcus AC. (2003) Why Don't We See More Translation of Health Promotion Research to Practice? Rethinking the Efficacy-to-Effectiveness Transition. Am J Public Health. 93:1261-1267.

Glasgow RE, Bull SS. (2001). Making a difference with interactive technology: considerations in using and evaluating computerized aids for diabetes self-management education. Diabetes Spectrum. 14:99-106.

Glasgow RE, Funnell MM, Bonomi AE, et al.(2002). Self-management aspects of the improving chronic illness care breakthrough series: implementation with diabetes and heart failure teams. Ann Behav Med. 24: 80-87.

Gregory KD, Kjos SL, Peters RK. Cost of Non-Insulin-Dependent Diabetes in Women With a History of Gestational Diabetes: Implications for Prevention. Obstetrics & Gynecology 8:782-786

Gorin S. S. and J. E. Heck. (2004). Meta-Analysis of the Efficacy of Tobacco Counseling by Health Care Providers. Cancer Epidemiol Biomarkers Prev 13: 2012-2022.

Hanna F, Peters J. (2002). Screening for gestational diabetes; past, present, and future. Diabetic Medicine, 19, 351-358.

Harris SB, Caulfield LE, Sugamori ME, Whalen EA and Henning B.(1997) The epidemiology of diabetes in pregnant Native Canadians. Diabetes Care. 20(9):1422-1425.

Heller, RF, Buchan, I, Edwards, R, Lyratzopoulos, G, McElduff, P, Leger, Selwyn. Communicating risk at the population level: application of population impact numbers. BMJ 2003 (327): 1162-1165.

Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS. (1991)Physical activity and reduced occurrence of non-insulin dependent diabetes mellitus. N Engl J Med 325:147-52.

Henry OA, Bleischer NA. (1991). Long-term implications of gestational diabetes for the mother. Ballieres Clin Obstet Gynaecol. 5:461-83.
Jang HC, Cho NH, Min YK, Han IK, Jung KB, and Metzger BE. (1997). Increased macrosomia and perinatal morbidity independent of maternal obesity and advanced age in Korean women with GDM. Diabetes Care. 20(10):1582-1588.

Jarvela IY, Juutinen J, Koskela P, Hartikainen A, Kulmala P, Knip M, Tapanainen JS. (2006) Gestational Diabetes Identifies Women at Risk for Permanent Type 1 and Type 2 Diabetes in Fertile Age. Diabetes Care 29: 607-612.

Jazayeri A, Contreras D. (2004). Macrosomia. [article online] Available from http://www.emedicine.com/med/topic3279.htm

Jovanovic L and Pettitt D. (2001). Gestational diabetes mellitus. JAMA 286:2516-2518.

Kaaja RJ and Greer IA. (2005). Manifestations of Chronic Disease During Pregnancy. JAMA 294: 2751-57.

Kaufmann RC, Schleyhahn F, Huffman D, Amankwah K. (1995)Gestational diabetes diagnostic criteria: long-term maternal followup. Am J Obstet Gynecol. 172: 621-625.

Kaufmann RC, Smith T, Bochantin T, Khardori R, Evans MS, Steahly L. (1999). Failure to obtain follow-up testing for gestational diabetes in a rural population. Obstet Gynecol 93: 734-737.

Kellerman SE, Herold J. (2001). Physician Response to Surveys. Am J Prev Med 20: 61-67

Kim C, Newton K, Knopp R. (2002) Gestational Diabetes and the Incidence of Type 2 Diabetes Diabetes Care. 25:1862-1868.

Kim C, Tabaei BP, Burke R, McEwen LN, Lash RW, Johnson SL, Schwartz K, Bernstein SJ, Herman WH. (2005). Missed Opportunities for Type 2 Diabetes Mellitus Screening Among Women With a History of Gestational Diabetes Mellitus. 96:xxx-xxx. Doi: 10.2105/AJPH. 2005.065722

King AC, Haskell WL, Taylor CB, et al. (1991). Group vs home-based exercise training in healthy older men and women: a community-based trail. JAMA 266:1535-1538.

King H, Aubert RE, Herman WH. (1998) Global Burden of Diabetes, 1995-2025. Prevalence, numerical estimates, and projections. Diabetes Care. 21:1414-1431.

Kjos SL, Buchanan TA. (1999). Gestational diabetes mellitus. New Engl J Med. 341:1749-1756.

Kjos SL, Henry O, Lee RM, Buchanan TA, Mishell DR Jr. (1999) The effect of lactation on glucose and lipid metabolism in women with recent gestational diabetes. Obstet Gynecol. 82:451-455.

Kjos SL. (1994). Maternal Implications of Gestational Diabetes. Seminars in Perinatology 18(5): 470-474.

Kjos SL, Buchanan TA, Greenspoon JS, Montoro M, Bernstein GS, Mestman JH (1990). Gestational diabetes mellitus: The prevalence of glucose intolerance and diabetes mellitus in the first two months postpartum. Am J Obstet Gynecol 163:93-98.

Kjos SL, Peters RK, Xiang A, Henry OA, Montoro MN, Buchanan TA. (1995) Predicting future diabetes in Latino women with gestational diabetes: Utility of early postpartum glucose tolerante testing. Diabetes. 44:586-591.

Kjos SL.(2000). Postpartum care of the women with diabetes. Clin Obstet Gynecol. 43: 75-86.

Kleinfield, N.R. (2006). Diabetes is seen as a Rising Risk in Mothers-to-Be. New York Times, February 18, 2006.

Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. (2002). Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with life style intervention or metformin. N Engl J Med . 346: 393-403.

Kohl HW, Gordon NF, Villegas JA, Blair SN. (1992). Cardiorespiratory fitness, glycemic status, and mortality risk in men. Diabetes Care 15:185-192.

Kottke TE, Brekke ML, Solberg LI. (1993). Making “time” for preventive services. Mayo Clin Proc. 68:785-791.

Lancaster T, Stead L, Silagy C, Sowden A. (2000). Effectiveness of interventions to help people stop smoking: findings from the Cochrane Library. BMJ 321: 355-358.

Langer, Oded. (2000) Management of Gestational Diabetes. Clinical Obstetrics and Gynecology. 43(1): 106-115.

Langer O. (2006). Screening for Gestational Diabetes. The Diabetes in Pregnancy Dilemma. University Press of America, Inc. p 432. Edited by Oded Langer.

Lao TT, Ho L, Chan BCP, Leung WC. (2006) Maternal Age and Prevalence of Gestational Diabetes Mellitus. Diabetes Care. 29:948-949.

Larme, AC, Pugh, JA. (2001). Evidence-Based Guidelines Meet the Real World. Diabetes Care 24(10): 1728-1733.

Lauenborg J, Hansen T, Jensen DM, Vestergaard H, Molsted-Pedersen L, Hornees P, Locht H, Pedersen O, Damm P. (2004) Increasing Incidence of Diabetes After Gestational Diabetes. Diabetes Care 27(5): 1194-1199.

Lee A, Moretti ME, Collantes A, Chong D, Mazzotta P, Koren G, Merchant SS, Ito S. (2000). Choice of Breastfeeding and Physicians' Advice: A Cohort Study of Women Receiving Propylthiouracil. Pediatrics 106:27-30.

Leemakers EA, Anglin K, Wing RR. (1998) Reducing postpartum weight retention through a correspondence intervention. International Journal of Obesity 22:1103-1109.

Lenfant C. (2003). Clinical Research to Clinical Practice-Lost in Translation? N Engl J Med 349:868-74.

Lerner H. (2004). Shoulder Dystocia. [available online] http://shoulderdystociainfo.com/index.htm

Lovelady CA, Garner KE, Moreno KL, Williams JP (2000) The effect of weight loss in overweight, lactating women on growth of their infants. NEJM 342:449-453.

Luna B, Feinglos M. (2001). Oral Agents in the Management of Type 2 Diabetes Mellitus. American Family Physician 63(9): 1747-1756

Magee MS, Walden CE, Benedetti TJ, Knopp RH. (1993). Influence of Diagnostic Criteria on the Incidence of Gestational Diabetes and Perinatal Morbidity. JAMA 269(5):609-615.

Manson JE, Rimm EB, Stampfer MJ, Colditz GA, Willett WC, Krolewski AS, Rosner B, Hennekens CH, Speizer FE. (1991). Physical activity and incidence of non-insulin dependent diabetes mellitus in women. Lancet. 338: 774-778.

Manson JE, Spelsberg A. (1994). Primary prevention of non-insulin-dependent diabetes mellitus. Am J Prev Med 10:172-184.

Marrero DG, Moore P, Langefeld C, Golichowski A, Clark CM. (1992). Care of Diabetic Pregnant Women by Primary-Care Physicians. Diabetes Care 12(1):101-107.

Maue SK, Segal R, Kimberlin CL, Lipowski EE. (2004). Predicting Physician Guideline Compliance: An Assessment of Motivators and Perceived Barriers. Am J Manag Care. 10:383-391.

Mazze R. The Diabetes in Pregnancy Dilemma. 2006. University Press of America, Inc. Lanham, Maryland. Edited by Oded Langer.

McPhee SJ, Richard RJ, Solkowitz SN. (1986). Performance of cancer screening in a university general internal medicine practice: comparison with the 1980 American Cancer Society Guidelines. J Gen Intern Med. 1:275-281.

Mestman JH, Anderson GV, and Guadalupe V. (1972) Follow-up studies of 360 subjects with abnormal carbohydrate metabolism during pregnancy. Obstet Gynecol. 39:421-425.

Mestman JH (1987). Follow-up studies in women with gestational diabetes mellitus. The experience at Los Angeles County/University Southern California Medical Center, in Weiss PA, Coustan DR (eds): Gestational Diabetes. New York, NY, Springler-Verlag, 1987.

Metzger B, Cho N, Roston S, Radvany R. (1993) Prepregnancy weigth and antepartum insulin secretion predict glucose tolerance in five years after gestational diabetes mellitus. Diabetes Care. 16:1598-1605.

Metzger BE, Coustan DR. (1998) Summary and recommendations of the Fourth International Workshop-Conference on Gestational Diabetes Mellitus: the Organizing Committee. Diabetes Care. 21:B161-B167.

Miller WR, Rollnick S. (1991). Motivational interviewing: preparing people to change addictive behavior. New York: Guilford Press.

Moore D, Gaudino J, deHart P, Cheadle A, Martin D. (2001). Physician Response in a Trial of High-Priority Mail and Telephone Survey Mode Sequences. In: Cynamon ML, Kulka RA, eds. Seventh Conference on Health Survey Research Methods. Atlanta, Ga: US Depertment of Health and Human Services, CDCP, National Center for Health Statistics 2001: 149-154 DHHS Publication (DHS) 01-1013.

Morrato EH, Hill JO, Wyatt HR, Ghushchyan V, Sullivan PW. (2006). Are Health Care Professionals Advising Patients With Diabetes or At Risk for Developing Diabetes to Exercise More? Diabetes Care. 29: 543-548.

Moses R, Knights S, Lucas E, Moses M, Russell K, Coleman K, Davis W. (2000). Gestational Diabetes: Is a Higher Cesarean Section Rate Inevitable? Diabetes Care 23(1):15-17.

National Committee for Quality Assurance. (2006) Prenatal and Postpartum Care. HEDIS Measures of Care. Available online <www.ncqa.org>

National Diabetes Data Group. (1979). Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 28 (7):1039-1057.

National Guideline Clearinghouse. Gestational Diabetes Mellitus. (2000). Available online <http: www.guideline.gov>.
National Guideline Clearinghouse. (2004).Gestational Diabetes Mellitus. Diabetes Care 27(Supple1):S 88-90.

National Institute of Diabetes & Digestive & Kidney Disease (2005). National Diabetes Data Group [available online]
<http://www.niddk.nih.gov/fund/divisions/dem/nddg.htm> Retrieved May 2, 2005.

Nevarez HC. A cross cultural examination of factors influencing exercise during pregnancy. Thesis. 2006. Article in Review.

New York City Department of Health and Mental Hygiene, 2006.

O'Connor PG, Schottenfeld RS. (1998). Patients with Alcohol Problems. N Engl J Med 338: 592-602.

O' Connor PG, Rush WA, Prochaska JO, Pronk NP, Boyle RG. (2001). Professional advice and readiness to change behavioral risk factors among members of a managed care organization. Managed Care. 7:125-130.

O'Sullivan J. (1991). Diabetes Mellitus After GDM. Diabetes 29(2): 131-135

O'Sullivan JB, Mahan CM. (1964). Criteria for the Oral Glucose Tolerance Test in Pregnancy. Diabetes 13(3):278-285.

O'Toole ML, Sawicki MA, Artal R (2003). Structured diet and physical activity prevent postpartum weight retention. Journal of Women's Health 12(10):991-998.

Oregon Center for Health Statistics. (2001). Available online:
http://oregon.gov/DHS/ph/chs/index.shtml

Oregon Center for Health Statistics Birth Data. (2006) [available online]
http://oregon.gov/DHS/ph/chs/data/birth/birthdata.shtml

Oregon Center for Health Statistics. (2005). Available online:
http://www.oregon.gov/DHS/ph/chs/order/index.shtml

Oregon Department of Human Services Health Services. Personal Communication with Lynda Jackson (503)-731-3392. Sent historical GDM tables via mail in July 2005.

Oregon Diabetes Coalition .(2006) Oregon Progress Report on Diabetes. Department of Human Services, Health Services, Oregon Diabetes Prevention and Control Program, Portland, Oregon.

Oregon Pregnancy Risk Assessment Monitoring System. [available online] http://www.oshd.org/pch/prams/index.cfm

Orlandi MA. (1987) Promoting health and preventing disease in health care settings: an analysis of barriers. Prev Med. 16:119-130.

National Committee for Quality Assurance. Prenatal and Postpartum Care. The state of health care quality 2006. Hedis Measures of Care. Available online: www.ncqa.org/communications. Accessed January 2006.

New York City Department of Health and Mental Hygiene. 2006. Letter to Doctors. http://www.nyc.gov/html/doh/html/diabetes/diabetes-gestational-packet.shtml Accessed December 28, 2006.

New York State Strategic Plan for the Prevention and Control of Diabetes. Available online http://www.health.state.ny.us/diseases/conditions/diabetes/docs/stateplandiabetes.pdf Accessed January 31, 2006.

Pan XR, LiGW, Hu YH, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Jiu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH, Howard BV. (1997). Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study. Diabetes Care. 20: 537-544.

Pathman D, Konrad TR, Freed GL, Freeman VA, Koch GG. (1996). The Awareness-to-Adherence Model of the Steps to Clinical Guideline Compliance: The Case of Pediatric Vaccine Recommendations. Medical Care.34:873-889.

Peace Health.http://www.peacehealth.org/kbase/topic/medtest/hw8252/descrip.htm (accessed August 2, 2005)

Peters RK, Kjos SL, Xiang A, Buchanan (1996) Long-term diabetogenic effect of single pregnancy in women with previous gestational diabetes mellitus. Lancet 347:227-30.

Perry IJ, Wannamethee M, Walker MK, Thomson AG, Whincup PH, Shaper AG. (1995). Prospective study of risk factors for development of non-insulin-dependent diabetes in middle aged British men. BMJ. 310:560-564.

Persson B, Hanson U, Hartling SG, Binder. (1991). Follow-up of women with previous GDM: Insulin, C-peptide, and proinsulin responses to oral glucose load. Diabetes 40 (Suppl 2): 136-141.

Piette J. Enhancing support via interactive technologies.(2002). Curr Diab Rep. 2:160-165.

Prochaska, JO and Norcross JC. (1998) Systems of Psychotherapy : A Transtheoretical Analysis. (4th ed). Pracific Grove, Calif.:Brooks-Cole (Originally Published 1979).
Rigotti NA. (2002) Treatment of Tobacco Use and Dependence. N Engl J Med 346: 506-512.

Rogers. (1975). A protection motivation theory of fear appeals and attitude change. The Journal of Psychology. 91:93-114.

Rogers EM. (1995). Diffiusion of Innovations (4th Ed.). New York, NY: Free Press.

Rosenblatt B (2002). Adult obesity in Colorado: results from the behavioral risk factor surveillance system [article online] Health Watch 48. Available from http://www.cdphe.state.co.us/hs/Briefs/obesity2002.pdf

Salant P and Dillman D. (1994). How to Conduct Your Own Survey. John Wiley & Sons, Inc.

Schaefer-Graf, UM, Pawliczak, J, Passow, D, Hartmann, R, Rossi, R, Buhrer, C, Harder, T, Plagemann, A, Vetter, K, Kordonouri, O. (2005). Birth Weight and Parental BMI Predict Overweight in Children From Mothers With Gestational Diabetes. Diabetes Care 28 (7): 1745-1750.

Seagl L, Dalton AC, Richardson J. Cost-effectiveness of the primary prevention on non-insulin-dependent diabetes mellitus. Health Promotion Int. 1998; 13:197-209.

Sebire NJ, Jolly M, Harris JP, Wadsworth J, Joffe M, Beard RW, Regan L, and Robinson S. (2001). Maternal obesity and pregnancy outcome: a study of 287,213 pregnancies in London. International Journal of Obesity: 25, 1175-1182.

Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. (2006). Physicial Activity/Exercise and Type 2 Diabetes. Diabetes Care: 29; 1433-1438.

Silverman BL, Metzger BE, Cho NH, Loeb CA. Impaired glucose tolerance in adolescent offspring or diabetic mothers. Relationship to fetal hyperinsulinism. Diabetes Care 1995; 18: 611-617.

Smith BJ, Cheung NW, Bauman AE, Zehle K, McLean M. (2005). Postpartum Physical Activity and Related Psychosocial Factors Among Women With Recent Gestational Diabetes Mellitus. Diabetes Care. 28:2650-2654.

Smolin, LA and Grosvenor, MB. Nutrition Science and Applications. Fourth Ed. John Wiley & Sons, Inc. 2003

South Dakota Department of Health Diabetes Prevention and Control Program in cooperation with the CDC, 2003.

Spitz MR, Chamberlain RM, Sider JG, Fueger JJ. (1992). Cancer prevention practices among Texas primary care physicians. J Cancer Educ. 7:55-60.

Surgeon General. (2005). Recommendations from the office of the Surgeon General. [available online] http://www.surgeongeneral.gov/ Retrieved May 29, 2005.

Surgeon General. (2000). Available online: www.surgeongeneral.gov/tobacco/treating_tobacco_use.pdf

Sutton PD and Matthews TJ. National Center for Health Statistics. National Vital Statistics Report. Trends in Births by State. 2004. http://www.cdc.gov/nchs/data/nvsr/nvsr52/nvsr52_19.pdf

Symons Downs D and Ulbrecht JS. (2006). Understanding Exercise Beliefs and Behaviors in Women With Gestational Diabetes Mellitus. Diabetes Care. 29:236-240.

Tabachnick B, Fidell L. (2001) Using Multivariate Statistics 4th Ed. Allyn and Bacon.

Thomas, A. and Gutierrez, Y. (2005). American Dietetic Association guide to gestational diabetes mellitus. American Dietetic Association

Thomas RJ, Kottke TE, Brekke MJ, Brandel CL, Aase LA, DeBoer SW. (2002). Attempts at changing dietary and exercise habits to reduce risk of cardiovascular disease: who's doing what in the community? Prev Cardiol. 5:102-108.

Thorpe, LE, Berger D, Ellis JA, Bettegowda VR, Brown G, Matte T, Bassett M, Frieden TR. (2005). Trends and Racial/Ethnic Disparities in Gestational Diabetes Among Pregnant Women in New York City, 1990-2001. Am J Public Health. 95:1536-1539.

Tuomilehto J., Lindstrom J., Eriksson J., Valle T., Hamalainen H., Ilanne-Parikka P., Keinamen-Kiukaanniemi S., Laakso M., Lauheranta A., Rastas M., Salminen V., Uusitupa M. (2001). Prevention of Type 2 Diabetes Mellitus by Changes in Lifestyle Among Subjects with Impaired Glucose Tolerance. N Engl J Med 344(18): 1343-1350.

Turok DK, Ratcliffe SD, Baxley EG. (2003). Management of Gestational Diabetes Mellitus. Am Fam Physician 68:1767-1772.

USDHHS Centers for Disease Control and Prevention (2001). Diabetes Rates Rise Another 6 Percent in 1999. http://www.cdc.gov/diabetes/news/docs/010126. Retrieved January 28, 2005.

U.S. Public Health Service (2000). A clinical practice guideline for treating tobacco use and dependence: A US Public Health Service Report. JAMA 283:3244-54.

U. S. Preventive Services Task Force Staff (2002) Guide to Clinical Preventative Services, 3rd Edition Recommendations. International Medical Publishing (January 1, 2002) ISBN: 1883205131

U.S. Preventative Task Force. Screening for Gestational Diabetes Mellitus: Recommendations and Rationale. Obstetrics and Gynecology 101(2):393-395.

Vazirani S. (2003). Oral Therapy in Gestational Diabetes?-Not Yet a Standard of Care. Clinical Commentary Published April 13, 2003. [available online] http://www.med.ucla.edu/modules/wfsection/article.php?articleid=61 Retrieved May 23, 2005.

Vohr B, McGarvey S, Tucker R. (1999). Effects of Maternal Gestational Diabetes on Offspring Adiposity at 4-7 Years of Age. Diabetes Care 22(8): 1284-1292

Wee CC, McCarthy EP, Davis RB, Phillips RS. (1999). Physician Counseling About Exercise. JAMA 282: 1583-1588.

Weijers RNM, Bekedam DJ, Smulders YM. (2002) Determinants of Mild Gestational Hyperglycemia and Gestational Diabetes Mellitus in a Large Dutch Multiethnic Cohort. Diabetes Care. 25: 72-77.

Wender RC. Cancer screening and prevention in primary care. (1993). Obstacles for physicians. Cancer. 72(3 suppl):1093-1099.

Whitlock EP, Orleans CT, Pender N, Allan J. (2002). Evaluation primary care behavioral counseling interventions: an evidence-based approach. Am J Prev Med. 22:267-284.

Wild S, Roglic G, Green A, Sicree R, King H. (2004). Global Prevalence of Diabetes. Estimates for the year 200 and projections for 2030. Diabetes Care 27:1047-1053.

Wilkins-Haug L, Horton JA, Cruess DF, Frigoletto FD. (1996). Antepartum Screening in the Office-Based Practice: Findings From the Collaborative Ambulatory Research Network. Obstetrics & Gynecology 88(4): 483-489.

Wing RR. (1989). Behavioral strategies for weight reduction in obese type II diabetic patients. Diabetes Care 12:139-44

World Health Organization Study Group (1980). Prevention of diabetes mellitus. Geneva, World Health Organization. 1980. (Tech. Rep. Ser., no. 844).

World Health Organization Brief Intervention Study Group (1996). A cross-national trail of brief interventions with heavy drinkers. Am J Public Health 86:949-955.

World Health Organization (1999). Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. A Report of a WHO Consultation. [available online] http://whqlibdoc.who.int/hq/1999/WHO_NCD_NCS_99.2.pdf Retrieved May 11 2005.

World Health Organization. (2002). Laboratory Diagnosis and Monitoring of Diabetes Mellitus. [available online]. http://whqlibdoc.who.int/hq/2002/9241590483.pdf Retrieved May 11, 2005.

Yarnell KSH, Pollak KI, Ostbye T, Krasue KM, Michener JL. Primary Care: Is There Enough Time for Prevention? Am J Public Health. 2003; 93:635-641.

.

APPENDIX

Gestational Diabetes Mellitus Care Survey

A statewide survey by: Monica Hunsberger PhD candidate and
Rebecca J. Donatelle PhD, Associate Professor, Oregon State University

Q1. Please indicate your primary specialty (*circle <u>one</u> number*)?

1 Family Practice
2 Ob/Gyn
3 Other_____(please specify)

Q2. For how many years have you practiced under the specialty you indicated in question one?_____Years

Q3. Which one of the following best describes your practice? (*Circle <u>one</u> number)*

1 An HMO (Health Maintenance Organization)
2 A solo or two-physician private practice
3 A private group practice with more than two physicians
4 A public health department
5 A community or neighborhood clinic
6 A hospital
7 A university-based practice
8 Other (*Describe*_____)

Q4. Please describe the town/city in which your practice is located. (*Circle <u>one</u> number*)

1 Population less than 1,000
2 Population 1,000-4,999
3 Population 5,000-9,999
4 Population 10,000-19,999
5 Population 20,000-49,999
6 Population 50,001-100,000
7 Population greater than 100,000

Q5. Would you describe the patient base you serve as mostly urban, suburban or rural? (*Circle <u>one</u> number*)

1 Urban
2 Suburban
3 Rural

Q6. What is your gender?

1 Male
2 Female

Q7. Do you have pregnant women as patients?

1 Yes
2 No **Skip to Q 12 on page 3**

Q8. Approximately how many <u>new</u> pregnancies do you personally see in a <u>typical</u> month?

1 1-5 pregnancies
2 6- 10 pregnancies
3 11-20 pregnancies
4 21 or more pregnancies

Q9. The following statements are about pregnancy and GDM. Please indicate your routine practice patterns by circling one number for each statement.

	Never	Rarely	Some of the time	Most of the time	Always
	▼	▼	▼	▼	▼
a. I routinely screen all pregnant women for (GDM)	**1**	**2**	**3**	**4**	**5**
b. I screen pregnant women for GDM when they are overweight	**1**	**2**	**3**	**4**	**5**
c. I screen pregnant women for GDM if they have a family history of diabetes	**1**	**2**	**3**	**4**	**5**
d. I screen pregnant women for GDM if they have had GDM in a prior pregnancy	**1**	**2**	**3**	**4**	**5**
e. I screen pregnant women for GDM if they are members of a high risk ethnic group	**1**	**2**	**3**	**4**	**5**
f. I screen pregnant women for GDM if they've had a macrosomic infant (large-for-gestational age) in the past	**1**	**2**	**3**	**4**	**5**
g. I screen for GDM in the first trimester	**1**	**2**	**3**	**4**	**5**
h. I screen for GDM in the second trimester	**1**	**2**	**3**	**4**	**5**
i. I screen for GDM in the third trimester	**1**	**2**	**3**	**4**	**5**
j. If a women has GDM I refer them to a diabetes specialist	**1**	**2**	**3**	**4**	**5**

Q10. Please indicate if you use a one step or two step testing approach for diagnosing GDM.

1 One step approach
2 Two step approach

Q11. Please indicate whether or not your practice uses each of the following criteria when you diagnosis GDM *(Indicate YES or NO by circling one number for each*

	Yes	No
a. National Diabetes Data Group	1	2
b. Carpenter and Coustan	1	2
c. American Diabetes Association	1	2
d. World Health Organization	1	2
e. ACOG Guidelines	1	2
f. Family Practice Guidelines	1	2
g. I don't know	1	2
h. Other _____	1	2

Q12. The following statements are about postpartum care following a GDM pregnancy. Please indicate your routine practice patterns by circling one number for each statement.

	Never	Rarely	Some of the time	Most of the time	Always
	▼	▼	▼	▼	▼
a. I schedule women for a postpartum visit by week 10	**1**	**2**	**3**	**4**	**5**
b. I routinely screen for glucose intolerance at the first postpartum visit	**1**	**2**	**3**	**4**	**5**
c. After delivery, I screen women for glucose intolerance if they are overweight or obese at the first postpartum visit	**1**	**2**	**3**	**4**	**5**
d. After delivery, I screen women for glucose intolerance if they have a family history of diabetes at the first postpartum visit	**1**	**2**	**3**	**4**	**5**
e. After delivery, I screen women for glucose intolerance if they have had more than one GDM pregnancy at the first postpartum visit	**1**	**2**	**3**	**4**	**5**
f. After delivery, I screen women for glucose intolerance if they are members of a high risk ethnic group at the first postpartum visit	**1**	**2**	**3**	**4**	**5**
g. After delivery, I screen women that are over 35 years of age for glucose intolerance	**1**	**2**	**3**	**4**	**5**
h. I counsel post-GDM women about dietary choices	**1**	**2**	**3**	**4**	**5**
i. I counsel post-GDM women to exercise regularly.	**1**	**2**	**3**	**4**	**5**
j. I refer post-GDM women to a diet support group like Weight Watchers or Jenny Craig	**1**	**2**	**3**	**4**	**5**
k. I tell post-GDM women that they are at an increased risk for Type 2	**1**	**2**	**3**	**4**	**5**

Q13. The following statements will help us understand your thoughts and opinions on GDM. Please indicate how much you agree or disagree with each statement by circling one number for each.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
	▼	▼	▼	▼
a. GDM is a condition that should be treated to improve the mom's health	**1**	**2**	**3**	**4**
b. GDM is a condition that should be treated to improve the baby's health	**1**	**2**	**3**	**4**
c. In general, all pregnant women should be screened for GDM	**1**	**2**	**3**	**4**
d. After lactation a post-GDM woman should be screened for glucose intolerance	**1**	**2**	**3**	**4**
e. After a GDM pregnancy, women should be screened annually for glucose intolerance	**1**	**2**	**3**	**4**
f. After a GDM pregnancy, women should be screened every 2 to 3 years for glucose intolerance	**1**	**2**	**3**	**4**
g. Testing post-GDM women annually is a form of cost-effective primary prevention of Type 2 diabetes	**1**	**2**	**3**	**4**
h. Over 50% of women with a GDM pregnancy will progress to Type 2 diabetes within 10 years	**1**	**2**	**3**	**4**
i. I feel that adequate patient education materials are readily available through my practice for working with post-GDM patients	**1**	**2**	**3**	**4**
j. I feel that GDM is a transient metabolic condition of pregnancy	**1**	**2**	**3**	**4**
k. Most physicians provide follow-up glucose testing after a GDM pregnancy	**1**	**2**	**3**	**4**

Q14. To what extent is screening post-GDM women a priority in your practice?

1 Very low priority
2 Some what low priority
3 Some what high priority
4 Very high priority

Q15. Thank you for taking the time to fill out this questionnaire. If you have any comments about this survey or GDM Care please write them in the space below.