MAYO CLINIC

ENDOCRINOLOGY UPDATE

ENDOCRINOLOGY NEWS FROM MAYO CLINIC

volume 1
number 1
2006

Inside This Issue

Clinical Management of Persistent and Recurrent Primary Hyperparathyroidism

"For more than 3 decades, it has been the policy at Mayo Clinic to advise cervical exploration for patients with primary hyperparathyroidism [HPT]. Such advice seems justified because eucalcemia is restored in at least 95% of patients, mortality is nearly nil, and morbidity is less than 1% when the operation is performed by an experienced surgeon," says Clive S. Grant, MD, of the Department of Surgery at Mayo Clinic in Rochester. The success of initial cervical exploration depends on 2 elements: a correct diagnosis and a qualified surgeon. Confident that the diagnosis is accurate, the surgeon almost invariably can locate the enlarged, possibly elusive parathyroid gland (Figures 1 and 2).

But Dr Grant cautions, "In contrast, reoperative parathyroid surgery is far more complex, requiring a number of considerations both before and during the procedure." In addition to an accurate diagnosis and surgical expertise, the patient's perspective must be appreciated. Disappointed with initial failure to cure the disease, the patient faces the continued threat of disease complications or the possibility of another operation. Reoperation, the patient learns, bears higher risk, limited likelihood of success, and the potential need for lifelong medication. All this, and it will cost at least 2 or 3 times as much as the first operation, not to mention time lost and money spent for repeat preoperative testing and postoperative hospitalization.

Clive S. Grant, MD, and Bart L. Clarke, MD

Indications for reoperation include renal stones or nephrocalcinosis, bone disease (as evident by x-ray or, more commonly, bone mineral density), severe symptoms of hypercalcemia, associated neuromuscular or psychiatric symptoms, and worrisome hypercalcemia. The prerequisite for complications or troublesome symptoms as indications for reoperation may be relaxed when the enlarged parathyroid gland has been localized.

Recurrent disease, defined as return of hypercalcemia after 6 months of eucalcemia following initial cervical exploration, is far more likely in patients with the multiple endocrine neoplasia type 1 or familial HPT than in patients with single adenomas. In genetically transmitted disease, either the remnants of parathyroid glands remaining after subtotal parathyroidectomy or the fragments of parathyroid autotransplanted after total parathyroidectomy may enlarge and cause recurrent HPT.

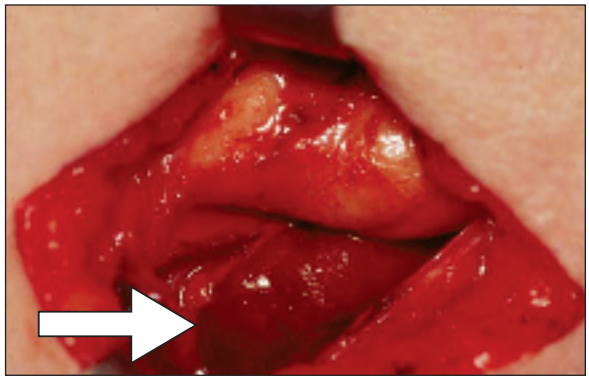


Figure 1. Close-up view of the brownish-red parathyroid adenoma (arrow) before its removal.

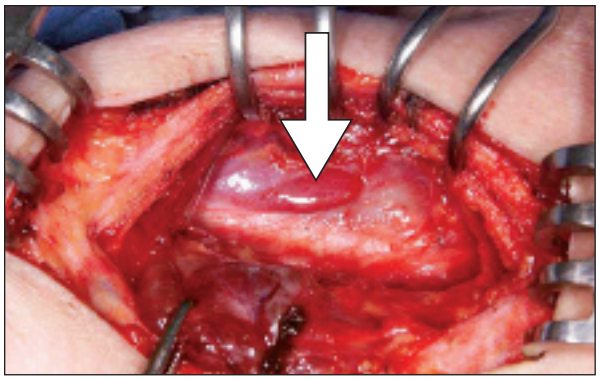


Figure 2. Example of a fifth parathyroid gland adenoma (arrow) located in the left carotid sheath (intraoperative photo).

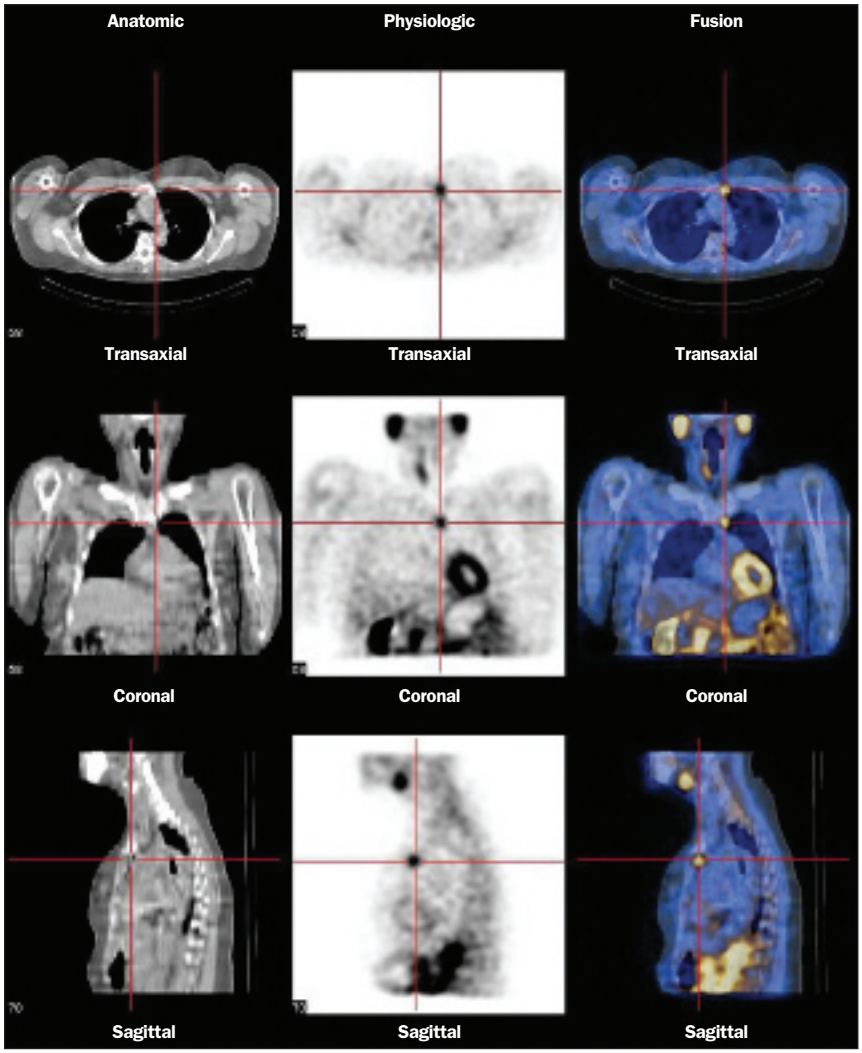


Figure 3. Upper mediastinal parathyroid adenoma localized by fusion CT-SPECT sestamibi scan; the adenoma was removed through a collar incision.

Bart L. Clarke, MD, an endocrinologist at Mayo Clinic in Rochester, says, "The ideal test to localize the hyperplastic parathyroid gland would be noninvasive, inexpensive, sensitive and specific, safe, quick, accurate, independent of operator expertise, and readily available to be performed preoperatively." In spite of intense efforts, such a localization test has yet to be developed. Nevertheless, meaningful advances have occurred, and the use of sestamibi radioscintigraphy appears to be the most sensitive and specific. In marked contrast to the 1970s, when preoperative localization was inconsistent, almost all patients undergoing parathyroid reoperation today have positive preoperative localization.

Unfortunately, in patients with multiple gland disease, precisely the clinical situation when localization would be most helpful, success in identifying a single enlarged gland is decreased. Patients with multiple gland disease remain the most challenging to cure.

If reexploration can be scheduled within approximately 7 days of the initial exploration, the postoperative inflammation will usually be acceptable. Most times, however, 4 to 6 months must elapse to allow safe dissection.

Sestamibi radioscintigraphy has become the localization test of choice at Mayo Clinic for both initial and repeat exploration for primary HPT. The sensitivity is 89%, and the positive predictive value is 91%. A double isotope technique is used, with technetium sestamibi and computer subtraction of a radiolabeled thyroid scan, incorporating oblique views and single photon emission computed tomographic (SPECT) images (Figure 3). In contrast to ultrasonography, there are no blind spots such as behind the sternum or in the tracheoesophageal groove.

Ultrasonography is limited by and critically dependent on the diligence and experience of the radiologist performing the scan. Moreover, blind spots are caused by overlying bone of the clavicle or sternum or air in the trachea. Ultrasound-directed fine-needle aspiration for histology or parathyroid hormone determination adds to the precision of ultrasound.

Because postoperative hypoparathyroidism is not merely a nuisance, efforts have been made to address this clinical challenge. Permanent hypocalcemia necessitates periodic monitoring of serum calcium, frequently requires daily medication, and potentially exacerbates renal stone disease—ironically the very problem that stimulates many patients to undergo the initial cervical exploration. Immediate autotransplantation of fresh parathyroid tissue into the patient's forearm has been used successfully.

A Practical Approach to Management of Hyperglycemia in Hospitalized Patients

Diabetic patients often require hospitalization with longer than average hospital stays and have poor outcomes and high mortality rates.

The 1997 DIGAMI (Diabetes mellitus, Insulin Glucose infusion in Acute Myocardial Infarction) trial in diabetic patients with acute myocardial infarction and the 2001 study by Van den Berghe and colleagues of intensive insulin therapy in predominantly nondiabetic patients demonstrated that intensive treatment of hyperglycemia with intravenous insulin reduced mortality by roughly one-third. These and other recent studies have transformed clinical practice, and intensive regimens for glucose control are now used routinely in the intensive care and coronary care units of many hospitals.

John M. Miles, MD, from the Mayo Clinic Division of Endocrinology in Rochester, notes, "Attempting to improve glycemic control in hospitalized patients is not a trivial undertaking." Patient safety is paramount, and the risk of hypoglycemia when attempting near-normalization of blood glucose is considerable. Protocols for treatment of both hyperglycemia and hypoglycemia and fully trained staff to implement them are essential. Avoiding adverse outcomes related to hypoglycemia is particularly difficult because of constantly changing circumstances during hospitalization, including delay or omission of meals because of procedures, use of drugs such as corticosteroids, and interpretation of blood glucose data out of context. An example of the latter problem is insulin supplementation or dose adjustment in response to isolated hyperglycemia without knowledge of a recent snack or intravenous medication delivered in 5% dextrose. The practice of managing hyperglycemia from afar without knowledge gleaned at the bedside is unacceptable.

M. Molly McMahon, MD, and John M. Miles, MD

In most diabetic patients, blood glucose monitoring should be done a least 4 times a day. For the patient who is eating, this monitoring is generally done before meals and at bedtime. M. Molly McMahon, MD, from the Mayo Clinic Division of Endocrinology in Rochester, notes, "It is important to recognize that some patients who are not known to have diabetes, including individuals receiving excess calories from parenteral or enteral nutrition support or patients receiving high-dose corticosteroids for an illness (eg, asthma), may be at risk for developing hyperglycemia and should also be monitored." Some of the factors that can affect glucose levels are shown in Table 1.

Table 1. Factors That Can Raise Plasma Glucose Levels

Nutrition

- Food intake
- Nutritional support (enteral or parenteral)
- Dextrose-containing intravenous fluids (continuous or as vehicle for medications)
- Peritoneal dialysis
- Propofol (formulated in lipid emulsion)

Infection/Inflammation and Medications

- Corticosteroids
- Sympathomimetics
- Immunosuppressants

Temporary discontinuation of oral medications for glycemic control may be necessary in patients who have been doing well on them at home. Metformin has a good safety record; the risk of lactic acidosis with this agent is overstated. However, people who are unable to eat or can eat only small amounts may have difficulty with gastrointestinal adverse effects of metformin if the medication is continued under these circumstances. Sulfonylurea and related medications often induce hypoglycemia in patients who are not eating well and may be insufficient to control hyperglycemia in others because of the degree of stress, nutritional support, and other circumstances. In spite of these limitations, some patients, especially if they are alert and eating well, can be best managed by continuing an oral agent.

Insulin is the mainstay of management of inpatient hyperglycemia in situations ranging from treatment of diabetic ketoacidosis to improved glucose control in patients receiving parenteral nutrition. For patients with hyperglycemia

exacerbated by dextrose-containing intravenous fluids, the addition of 0.1 unit of insulin per gram of dextrose to the intravenous fluids is an effective starting dose, with virtually no risk of hypoglycemia in patients with normal or near-normal renal function. It is often necessary to increase the amount of insulin "coverage" to 0.15 or 0.2 unit of insulin per gram of dextrose. The advantage of this approach is that the dextrose and insulin infusions are linked; that is, if the infusion is interrupted for any reason, administration of both dextrose and insulin is stopped. A separate infusion of insulin may be necessary because of glycemic instability or marked insulin resistance.

Insulin infusion should generally be avoided in favor of subcutaneous insulin when patients are consuming meals. For patients who are eating, single-injection insulin regimens are usually not sufficient. At least 2 injections per day, often consisting of intermediate insulin alone or mixed with soluble insulin (either regular insulin or a fast-acting analog such as lispro or aspart), are required to achieve adequate control of hyperglycemia. Regimens consisting of 3 and 4 injections (eg, fast-acting insulin before meals and a long-acting basal insulin such as glargine) have more flexibility and may be useful alternatives, although little has been published concerning their use in hospitalized patients. With any regimen, a good starting dose is 0.3 to 0.5 unit of insulin per kilogram daily, with dose adjustment based on diurnal glucose patterns. Patients on intermittent tube feedings do well on insulin regimens similar to those used in people who are eating, whereas patients on continuous tube feedings can be managed satisfactorily with NPH given every 8 hours or regular insulin given every 6 hours. Although long-acting analogs are attractive in tube-fed patients, it is best to avoid them because of the frequency of abrupt, unexpected interruption of feeding. Pharmacologic options for treating hyperglycemia are shown in Table 2.

Some patients who are doing well on intensive outpatient regimens (4-injection programs or an insulin pump) can continue to manage insulin themselves in the hospital, provided they are alert and eating. These patients can usually make a better decision about insulin dosing, based on their experience and training. However, in some instances, hospital regulations prohibit patient self-medication. In these cases, the patient can serve in a consultative role in insulin management.

Supplemental insulin is frequently required to correct hyperglycemia in patients on scheduled insulin. It should be given at mealtime only and in addition to, not instead of, the scheduled insulin. The use of insulin solely to correct hyperglycemia but not to prevent it (commonly referred to as the "sliding scale" approach) should be discouraged, because it rarely produces adequate control of hyperglycemia and often induces hypoglycemia.

Diet therapy for hospitalized diabetic patients is a difficult area because intercurrent illness and procedures often result in variable food intake and missed meals. Moreover, the trend toward "room service" in many hospitals often results in a situation where food intake is constantly changing. The use of snacks is a time-honored method to manage glucose intake, but it lacks scientific support. The key principle of successful inpatient diet management is that meals should be consistent in carbohydrate content and in timing. Generally, meals should not be given at less than 4-hour intervals.

Hospital management of hyperglycemia is more challenging than ever because of the nature of modern hospital care. It is also more imperative than ever, in view of the strong relationship between glucose control and improved outcomes.

Table 2. Tools for the Management of Hyperglycemia in Hospitalized Patients

For Patients Who Are Not Eating by Mouth:

Parenteral nutrition
- Regular insulin added to PN infusion, 0.1-0.2 unit per gram of dextrose
- Separate intravenous insulin infusion, if required

Enteral tube feeding
- Subcutaneous insulin twice daily (intermittent feeds)
- Subcutaneous insulin every 6-8 hours (continuous feeds)

For Patients Who Are Eating:
- Oral diabetic agents
- Split doses of NPH ± short-acting insulin
- Preprandial short-acting insulin plus once-daily insulin glargine
- Insulin pump

Endocrinology Update

Endocrinology Update
Produced by
Mayo Clinic
200 1st Street SW
Rochester, MN 55905

Medical Editor
William F. Young, Jr, MD

Editorial Board
M. Regina Castro, MD
Bart L. Clarke, MD
Maria L. Collazo-Clavell, MD
Clive S. Grant, MD

Publication Manager
Elizabeth M. Rice

Art Director
Ron O. Stucki

Production Designer
Connie S. Lindstrom

Manuscript Editor
Jane C. Wiggs

Media Support Services Contributing Artist
Richard D. Madsen

Hypothyroidism Poses Risks During Pregnancy

Thyroid disease may affect both the expectant mother and her unborn child. Robert C. Smallridge, MD, from the Division of Endocrinology at Mayo Clinic in Jacksonville, says, "Unrecognized hypothyroidism in the mother increases health risks of the pregnancy. Several recent studies have suggested it may also impair fetal brain development and reduce IQ in the offspring."

The maternal thyroid axis is influenced routinely by normal endogenous changes and is at risk from nutritional deficiencies and from underlying thyroid abnormalities. The fetal hypothalamic-pituitary-thyroid axis develops throughout pregnancy, and it is believed that, until mid gestation, the fetal brain is dependent solely on placental transfer of L-thyroxine (L-T_4) for certain critical maturation processes. If a pregnant woman is hypothyroid, particularly early in pregnancy, then fetal neuronal development may be impaired.

Robert C. Smallridge, MD

Thyroid Tests

What is normal? Total T_4, free T_4, and thyroid-stimulating hormone (TSH) levels vary throughout pregnancy because of the endogenous and nutritional changes described above. Unfortunately, many commercial assays have not established trimester-specific laboratory values. TSH remains the most sensitive test and is also not method-specific, but it does require trimester-specific normal ranges.

Etiology

Thyroid autoimmunity in young women is common, with thyroid antibodies detected in approximately 11% of pregnant women. The presence of maternal hypothyroidism, a reflection of thyroid autoimmunity and manifested by an elevated TSH, is about 1.7%.

Risk Factors of Thyroid Disease During Pregnancy: *Who Should Be Tested?*

- **Personal history of thyroid disease**
- **Family history of thyroid disease**
- **Goiter**
- **Type I diabetes mellitus**
- **Recurrent miscarriages**

Physical Effects

Hypothyroidism can be detrimental to both mother and fetus. Early studies indicated that maternal risks of preeclampsia and abruptio placentae were increased not only in overt, but also in subclinical hypothyroidism (elevated TSH, normal T_4 levels). However, the pregnant women classified as having subclinical disease had mean TSH levels of 28 to 37 mIU/L, much higher than the levels usually detected in women with subclinical disease. Two other recent reports have not confirmed this association in women whose mean TSH levels were in the range of 6 to 11 mIU/L.

Fetal Loss

The role of thyroid disease in fetal loss has received increased attention and has been proposed as another reason for universal screening of pregnant women. However, there is increasing evidence that thyroid autoimmunity per se is associated with fetal loss. In 6 studies comprising 3,814 women, the risk of miscarriage was 2½-fold greater in thyroid peroxidase (TPO) antibody–positive women (24.0% vs 10.1%). In women who had recurrent miscarriages, the risk of a subsequent miscarriage also more than doubled if they were TPO antibody positive. Several years ago, a study claimed that late fetal death was due to hypothyroidism, but a subsequent report failed to confirm this finding. Another study has suggested that TPO positivity is also associated with fetal deaths.

IQ Development

Early studies showed that children had a decrease in IQ if their mothers had a low butanol-extractable iodine (a precursor to the T_4 test) during pregnancy. Haddow and colleagues retrospectively measured TSH in approximately 25,000 women in the second trimester of pregnancy. They found a reduction in average IQ at age 7 to 9 years in children whose mothers had an elevated TSH.

Another study reported delayed psychomotor development in infants whose mothers had the lowest free T_4 levels (despite normal TSH) in early pregnancy. Recent preliminary results from a Centers for Disease Control and Prevention workshop found that subclinical hypothyroidism was associated with prematurity and that prematurity may contribute to a reduced IQ. At present, there is no prospective study showing that L-T_4 prevents any of these effects.

Iodine Status

Iodine deficiency is a major problem in developing countries, and some European countries (those that do not systematically fortify their food supply) have areas of mild to moderate iodine deficiency. Iodine deficiency has not been a problem in the United States, ever since iodine was added to table

salt many decades ago. However, the 1994 National Health and Nutrition Examination Survey showed that a small percentage of pregnant women as well as young nonpregnant women had a low random urinary iodine compared with a study done 2 decades earlier. More recently, a survey of dietary iodine in pregnant women in Boston found 9% with median urinary iodine less than 50 μg/L, and 49% were less than the RDA (220 μg of iodine daily).

Thyroid Therapy

Three of 5 women taking thyroid hormone require an approximate 30% increase in their dosage during pregnancy. The reasons for this increased L-T_4 requirement include increased thyroxine-binding globulin, increased plasma volume, and increased placental deiodination. Recent information indicates this increased demand occurs in the first trimester, and athyreotic women require a larger adjustment than those with thyroid autoimmunity.

Magnitude of Hypothyroidism During Pregnancy

4 million births annually in the United States

↓

432,000 (10.8%) women at risk (TPO positive)

Specific Recommendations

A woman taking thyroid hormone should have her TSH measured before a planned pregnancy or immediately after learning that she is pregnant. Ideally, TSH should be monitored every 4 to 6 weeks during the first half of pregnancy and maintained at or below 2 mIU/L.

The Knowledge and Encounter Research (KER) Unit: Translational Science for Evidence-Based Endocrine Care

The Mayo Clinic KER unit is a knowledge synthesis laboratory that produces systematic reviews and meta-analyses of the best available evidence. Endocrinologist Victor M. Montori, MD, says, "These documents—rigorous protocol-driven efforts that try to eliminate bias as results are pooled—can then serve to support evidence-based clinical guidelines."

This is exactly why the Endocrine Society decided to contract with the KER unit to produce evidence syntheses. KER unit investigators thoroughly search for and gather the totality of the available research that addresses a pertinent question (a procedure called "systematic review"). Researchers can then summarize the results from each study included in this unbiased collection; when they do so using statistical methods to weigh each study, the procedure is called "meta-analysis." For the first guideline, on the use of testosterone in men, the KER unit team produced 6 systematic reviews and meta-analyses focusing on the effects of testosterone on quality of life, sexual function, cardiovascular risk, bone health, cognition, and depression. The same team is producing evidence summaries of studies of interventions to prevent and treat obesity in children and adolescents and of interventions to enhance adherence to such interventions. Dr Montori notes, "Our team of reviewers always includes both clinical content and methodologic experts working together with Patricia J. Erwin, the Mayo Medical Library head of reference and a KER unit collaborator."

Victor M. Montori, MD, and Audrey J. Weymiller

The KER unit not only produces evidence summaries to support guideline development; more than 16 reviews are under way. These reviews lay the groundwork for research proposals because they clearly identify knowledge gaps in the literature. Finally, these reviews provide content for patient education material and for evidence-based resources for practicing clinicians. KER unit investigators are working on other endocrine-related reviews, including the definition of the metabolic syndrome and its relation to cardiovascular risk and diabetes, the safety of statins in patients with diabetes mellitus, the use of renin-angiotensin-aldosterone blockers in the perioperative period, and the use of DHEA for women with adrenal insufficiency.

The KER unit also studies the clinical encounter and seeks to optimize it to enable appropriate care choices. "For us, wiser choices are decisions made consistent with the best available evidence and with the values and preferences of the informed patient," says Audrey J. Weymiller, a coinvestigator and

Mayo Clinic Knowledge and Encounter Research Team

nurse practitioner at Mayo Clinic in Rochester. Dr Montori notes, "In particular, we produce and test decision aids. These tools offer personalized and evidence-based information about the options and their characteristics for patients to take part, to the extent desired, in clinical decision making. For example, we have produced decision aids in diabetes; we are completing efficacy testing of a decision aid to help diabetic patients decide to take statins [shown below]; and we are testing the prototype of a new decision aid to help patients with type 2 diabetes mellitus decide on second-line anti-hyperglycemic therapy. We are exploring other endocrine conditions, such as testosterone deficiency in men, adrenal insufficiency in women, and osteoporosis treatment discontinuation in women.

"To develop and test our decision aids, we have 2 invaluable resources," according to Dr Montori. First is the SPARC Innovation Program, Mayo Clinic's service and patient experience laboratory. SPARC stands for **s**ee, **p**lan, **a**ct, **r**efine, and **c**ommunicate, an acronym that describes the methods used to develop and test decision aids and other innovations. The clinical offices at SPARC hosted the Metabolic Clinic (focused on diabetes and lipid disorders) for 3 months. During this time, clinicians and patients met in rooms with video cameras, which allowed the evaluation of how clinicians and patients made decisions about statins with and without a decision aid.

A second critical and invaluable resource is the Patient Advisory Group. The Patient Advisory Group consists of 10 community patients with diabetes who meet monthly to review progress in the KER unit's work, offer ideas for and discuss future directions and research questions, and review and comment on patient contact material and the decision aids. This group ensures that the KER unit research agenda remains patient-centered.

The KER unit is one of the most innovative endocrine research laboratories in the country, advancing the translational science of knowledge synthesis and optimizing clinical decision making through the use of decision aids. The KER unit summaries and decision aids are anticipated to have a positive impact on the way endocrinologists and general internists help patients with endocrine problems make better choices.

Prepared exclusively for patient

1 What is your risk of having a heart attack in the next 10 years?

Using information about your health we've estimated that you have a **15-30%** chance of having a heart attack sometime in the next 10 years. This table shows you how we estimated this risk.

In addition you are lowering your cardiovascular risk by regularly using **metformin and gemfibrozil (Lopid)**.

Your Risk	< 15%	15–30%	> 30%
Gender	woman	man	man
Age	60 or younger	60-75	75 or older
Had diabetes for	less than 10 yrs	less than 10 yrs	10 or more yrs
Have protein in urine	no	no	yes
Latest A1c	< 6%	6–7%	<7%
Usual blood pressure	< 120	120–140	> 140
Total/HDL cholesterol	< 4	4–6	> 6
Smoking	non-smoker	ex-smoker	smoker

WHAT DOES THIS ESTIMATE MEAN?
It means that out of 100 people like you, about 20 will have a heart attack in the next 10 years, and about 80 will not.

Keep in mind that we do not know what will happen **to you**; if you were to have a heart attack we cannot tell **when** this will happen.

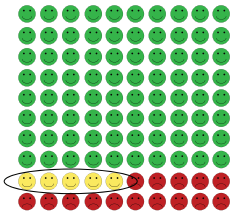
2 What benefit can you expect from taking statins compared to not taking statins?

NO STATIN

Our guess of what will happen to 100 people like you if they were to decide NOT to take statins; out of 100 people like you, about 20 will have a heart attack in the next 10 years, and about 80 will not.

YES STATIN

Our guess of what will happen to 100 people like you if they were to decide to take statins; out of 100 people like you, about 15 will have a heart attack in the next 10 years and about 85 will not. About 5 people will avoid a heart attack by taking statins; about 95 did not change their outcome by taking statins.



had a heart attack
avoided a heart attack
didn't have a heart attack

ATTENTION!
If you were to decide to take statins, we will not know if you would be among those who would not benefit (either by having a heart attack or by having one despite taking statins regularly) or those who would benefit (by avoinding a heart attack by taking a statin.)

3 What downsides can you expect from taking statins compared to not taking statins?

- Statins need to be taken daily for years.
- Some statins may cost less to you depending on your drug plan.
- **Common side effects** : nausea, diarrhea, constipation (most patients can tolerate)
- **Muscle aching/stiffness:** 5 in 100 patients (some need to stop statins because of this)
- **Liver enzymes go up** (no pain, no permanent liver damage): 2 in 100 patients (some need to stop statins because of this)
- **Muscle and kidney damage:** 1 in 20,000 patients (requires patients to stop statins)

4 What do you want to do now?

- ☐ Take (or continue to take) statins
- ☐ Not take (or stop taking) statins
- ☐ Discuss with your clinician today
- ☐ Discuss with your clinician in the future
  When?_____
- ☐ Discuss with others
  Who?_____

Education Opportunities

Please call 800-323-2688 or visit www.mayo.edu/cme/endocrinology.html for more information about these courses or to register.

Ninth Mayo Clinic Endocrine Course—An Intensive Review of Endocrinology for the Clinician, June 2-4, 2006, Rochester, Minnesota
This course, created for endocrinologists and interested internists and surgeons, will present the latest material on the diagnosis and treatment of endocrine disorders. Through short lectures, case-based debates, clinicopathologic sessions, clinical pearls sessions, and small group discussions with experts, content will span the full spectrum of endocrinology.

Mayo Clinic Nutrition in Health and Disease
This course will be held September 28-29, 2006, in Minneapolis. The course covers ambulatory and hospital nutrition topics.

The 2005 Department of Medicine Recognition Awards were presented November 18, 2005, by Nicholas F. LaRusso, MD, chair of the Department of Medicine at Mayo Clinic in Rochester. Honored from the Division of Endocrinology were (left to right) Daniel L. Hurley, MD, who received the Henry S. Plummer Distinguished Physician Award; Todd B. Nippoldt, MD, who received the Laureate Award; K. Sreekumaran Nair, MD, who received the Landmark Contribution to Literature Award; and Norman L. Eberhardt, PhD, who received the Research Career Achievement Award.

Endocrinology Research at Mayo Clinic

Endocrinologist Robert A. Rizza, MD, is the director for research, and Sundeep Khosla, MD, is the chair of endocrine research at Mayo Clinic in Rochester.

Mayo Clinic College of Medicine has campuses in Scottsdale and Phoenix, Arizona, Jacksonville, Florida, and Rochester, Minnesota, where biomedical research and education are translated into the highest-quality compassionate patient care. Endocrine research at Mayo Clinic is supported through highly competitive grants from the National Institutes of Health (~$12 million/year) as well as funds from foundations, grateful patients, and the health care industry.

To make an appointment for a patient through the Referring Physicians Service, use these toll-free numbers:

Mayo Clinic Rochester
800-533-1564

Mayo Clinic Arizona
866-629-6362

Mayo Clinic Jacksonville
800-634-1417

MC5810

MAYO CLINIC

200 First Street SW
Rochester, Minnesota 55905
www.mayoclinic.org

NON-PROFIT
ORGANIZATION
U.S. POSTAGE PAID
ROCHESTER, MN
PERMIT NO. 259