Recent discussions about the burden of diabetes in sub-Saharan Africa have focused on the growing epidemic in urban centers, where prevalence has reached as high as 8% in adult populations. The International Diabetes Federation (IDF) has outlined excellent practice guidelines for the African region, and the IDF’s Life for a Child program has begun to make medications and supplies freely available to children and young adults around the world.

This handbook chapter is based on our experience with a cohort of around 250 patients with diabetes in rural Rwanda. It focuses on integration of diabetes services (including insulin therapy) for predominantly rural populations living on less than a dollar a day. In these populations, diabetes still remains relatively uncommon. The management of these patients is complex, since many of them require insulin. Although successful decentralization of oral therapy for diabetes is increasing in sub-Saharan Africa and other very low-income settings, management of insulin outside of referral centers remains a major challenge.

Surveys conducted in rural sub-Saharan Africa over the past 30 years have consistently found a diabetes prevalence of around 1% in those over 15 years old. Type 1 diabetes accounts for a very small portion of this burden, with an estimated 0.01% prevalence. Of course, among subsistence farmers with low body weight, type 2 diabetes as it is known in urbanized populations is uncommon. Type 1 diabetes may also be slightly less common in rural Africa than in Europe and the United States; however, the very high mortality and misdiagnosis of these patients likely also contributes to its low prevalence.

The causes of diabetes in places like rural Rwanda are often different than in industrialized regions. In some cases, malnutrition leads to a unique and poorly understood type of diabetes, characterized by impaired insulin secretion without ketosis. In West Africa, another variant has been described as ketosis-prone type 2 diabetes. Patients with this disease do not have circulating islet cell antibodies; however, they can develop transient ketosis requiring admission and insulin therapy. Once stabilized, these patients can later be managed well with oral medications alone. This diabetes variant has recently been linked to human herpesvirus 8 (HHV-8). Another subset of rural African patients develop glucose intolerance as a side effect of antiretroviral (ARV)
therapy, particularly stavudine (d4T).\textsuperscript{28,29} Pregnancy can also result in a state of insulin resistance. Hyperglycemia during pregnancy can result in a large fetus prone to complications at the time of delivery. Gestational diabetes is uncommon among young women and among those with low BMIs and is therefore likely to be uncommon in rural Rwanda. We discuss issues of gestational and pre-existing diabetes in pregnancy below (see \textbf{SECTION 7.7}).

This chapter focuses on the management of diabetes in predominantly rural, subsistence-farming populations. Diabetes care is especially challenging in these settings due to lack of food, systems to monitor glucose, refrigeration for insulin storage, and common knowledge of the disease. An integrated NCD program is well suited to address this complex, yet relatively low-prevalence disease.

In Rwanda, the impact of diabetes on the lives of afflicted individuals is enormous. Although chronic care services for HIV have been decentralized rapidly to the district and health-center level, most diabetes care in Rwanda still occurs at referral centers. The MOH NCD initiative is an effort to remedy this situation. Prior to 2006, Rwandans had already organized a Rwanda Diabetes Association, which receives support from the World Diabetes Foundation, among other philanthropies. The group holds educational workshops for physicians and nurses and sponsors patient associations. The MOH NCD clinic has extended this group’s initiatives by integrating tailored protocols for diabetes into the training of NCD providers and other chronic care workers. The number of patients followed by the NCD clinics has grown, and patients with diabetes are now seen on specific days of the week. This has allowed for group education and also made it possible for specialists from referral centers to make supervisory visits on a regular basis.

Management of patients with diabetes who can be controlled with oral hypoglycemics is relatively inexpensive and straightforward. However, approximately 50% of patients in our cohort require insulin. Their management can become costly, largely because of the price of finger-stick glucose testing (see \textbf{APPENDIX B.7}). Moreover, optimal insulin regimens, such as glargine (Lantus) and lispro (Humalog), are still patented. Our approach attempts to minimize cost while achieving reasonable glucose control and avoiding hypoglycemia. Efforts to make patented insulins more widely available and to reduce the cost of finger-stick monitoring may allow for more intensive management and better outcomes as these programs develop.
7.1 Opportunistic Identification and Screening for Diabetes in Acute Care Health Center Clinics

As with other chronic diseases, most patients with diabetes initially present to outpatient acute care clinics. A certain percentage of these arrive very ill with severe hyperglycemia or with diabetic ketoacidosis and require immediate hospitalization. Other patients may have more indolent signs of hyperglycemia. Patients with such signs or symptoms require screening for diabetes. We urge all primary and urgent care health workers to consider diabetes in any patient that presents with polyuria, polydipsia, unexplained weight loss, or dehydration. Diabetes should also be considered in those patients with unexplained renal failure, neuropathy, or blindness, as these entities can be manifestations of prolonged hyperglycemia. All health centers should have the ability to check blood glucose (see Protocol 7.1).

As with other chronic conditions, such as tuberculosis, programs to combat diabetes should be designed to ensure good outcomes for patients with symptoms (passive case-finding) before searching for asymptomatic patients (active case-finding). Once a program feels comfortable with its diabetes management, initial routine screening might be considered for particular high-risk groups. Traditional risk factors for diabetes include hypertension, age, and overweight. In Rwanda, we have begun by screening all adults with stage 1 hypertension and a BMI ≥ 25 kg/m², or stage 2 hypertension, with a random urine glucose. Data from rural Gambia suggest that in those with this cluster of risk factors, diabetes prevalence is between 4%–6% compared with 1% in the general population. Carried out comprehensively, this approach would lead us to screen roughly 1% of the adult population. The sensitivity of this method of screening is between 20%–40% with a specificity of 95%. Patients with any glycosuria then undergo confirmatory testing with either a fasting blood glucose or hemoglobin A1c measurement (see Table 7.1). In our clinics, adults with hypertension greater than 160/100 mmHg already get regular urine dipsticks to check for proteinuria, and therefore this screening strategy does not add much in terms of cost to the program.

Our protocols use urine glucose as a first-pass screening test for hyperglycemia. Studies have shown that this method will pick up roughly 93% of people with blood glucose levels greater than 200 mg/dL. This form of screening has the advantage of very low cost and universal availability at health center level. It will miss the majority of patients with diabetes who have lower levels of random hyperglycemia (roughly 60%–80% of patients with diabetes), but it should catch those at highest risk of complications.
More aggressive (and more resource-intensive) screening strategies would include random finger-stick blood glucose testing with cut-offs between 110 mg/dL (80% sensitivity) and 150 mg/dL (50% sensitivity) followed by confirmatory fasting blood glucose, HbA1c testing, or an oral glucose tolerance test (see TABLE 7.1). Because of the logistical difficulty of glucose tolerance testing, this method is not used frequently in clinical practice. We currently do not perform any of these more intensive screening strategies in our outpatient clinics.

Our protocol for diabetes screening in asymptomatic adults with hypertension can be found in CHAPTER 8 (PROTOCOL 8.2 and PROTOCOL 8.4). PROTOCOL 7.1 addresses diabetes diagnosis in patients who present to health centers with symptoms of hyperglycemia. It is important to avoid misdiagnosis of diabetes in acutely ill patients. While diabetes is one cause of hyperglycemia, it should be noted that patients may develop mild to moderate hyperglycemia with severe illness of any kind.

**TABLE 7.1  Diabetes Diagnosis: Blood Sugar Measurement and Symptoms**

<table>
<thead>
<tr>
<th>Blood sugar</th>
<th>≥ 126 mg/dL (7 mmol/L) fasting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>≥ 200 mg/dL (11 mmol/L) random with symptoms</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>≥ 200 mg/dL (11 mmol/L) with an oral glucose tolerance test</td>
</tr>
<tr>
<td>Glycosylated hemoglobin (HbA1c)</td>
<td>≥ 6.5% (using a point-of-care device)</td>
</tr>
<tr>
<td>Symptoms of chronic hyperglycemia</td>
<td>Polyuria (excessive urination)</td>
</tr>
<tr>
<td></td>
<td>Polydipsia (excessive thirst)</td>
</tr>
<tr>
<td></td>
<td>Weight loss</td>
</tr>
</tbody>
</table>
Present to acute care clinic with any of the following symptoms:
1. Dehydration
2. Frequent urination
3. Thirst
4. Increased appetite
5. Weight loss or gain

Check a urine dipstick

Any glycosuria OR unable to check

Hyperglycemia unlikely to be cause of symptoms. Consider other etiologies

NO

Check a finger stick blood glucose

Blood sugar ≥ 150 mg/dL (8.3 mmol/L)

YES

Blood sugar ≥ 400 mg/dL (22 mmol/L)?

NO

Any warning signs:
1. Slow, deep breathing
2. "Fruity" breath
3. Abdominal pain, nausea, vomiting
4. Sleepy, not responding
5. Blood pressure ≤ 90/60 mmHg in an adult OR < normal range for age in a child (see Appendix E)

YES

Blood sugar 200–400 mg/dL (11–22 mmol/L)?

NO

Consider other causes of the patient's symptoms AND transfer to hospital

YES

Likely type 1 diabetes mellitus, refer to district hospital for inpatient confirmation of diagnosis AND likely initiation of insulin therapy

NO

Likely type 2 or mixed diabetes mellitus, refer to district NCD clinic for confirmation of diagnosis and initiation of oral hypoglycemics (Protocol 7.2)

YES

Age ≤ 18

NO

1. Adults: give 500 ml normal saline (NS) bolus, then continue NS at 250 cc/hour.
2. Children ≤ 12 years old: give 20 ml/kg NS bolus, then continue at maintenance dose
3. Give 0.2 U/kg (or 10 units for an adult) SC of regular insulin
4. Check blood sugar every hour AND give additional insulin until transfer (Table 7.3)

Immediate transfer to hospital
7.2 Recognition and Treatment of Emergency States (Hyperglycemia and Hypoglycemia)

Providers at all levels in the health system should be aware of danger signs of both hyperglycemia and hypoglycemia. Patients with these signs or symptoms should be treated and referred, if necessary, to the nearest inpatient facility.

7.2.1 Hyperglycemia

The risks associated with hyperglycemia increase in proportion to the degree of glucose elevation. In general, mild to moderate hyperglycemia is not life-threatening (125–199 mg/dL or 6.9–11 mmol/L). However, higher blood glucose levels (≥ 200 mg/dL or 11.1 mmol/L), and the resulting electrolyte shifts, dehydration, and hypovolemia can be very dangerous. Patients with blood sugar greater than 200 mg/dL (11.1 mmol/L) who also have any danger signs of hyperglycemia (see TABLE 7.2) should be treated aggressively with fluids and insulin and transferred to the district hospital for admission. Patients with blood sugars greater than 400 mg/dL should always be admitted regardless of symptoms, because at this level of hyperglycemia, dangerous complications are very likely to occur.

<table>
<thead>
<tr>
<th>TABLE 7.2 Danger Signs in Hyperglycemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early findings</td>
</tr>
<tr>
<td>Signs of dehydration</td>
</tr>
<tr>
<td>Hypotension</td>
</tr>
<tr>
<td>Slow, deep breathing</td>
</tr>
<tr>
<td>Abdominal pain, nausea and vomiting</td>
</tr>
<tr>
<td>Fruity breath</td>
</tr>
<tr>
<td>Late findings (neurological)</td>
</tr>
<tr>
<td>Focal motor deficits</td>
</tr>
<tr>
<td>Altered mental status</td>
</tr>
</tbody>
</table>

Various stressors can increase the amount of insulin needed to transfer glucose out of the bloodstream and into cells. These include infection, trauma, intoxication, and poor medication compliance. As a patient’s cells become starved of glucose, they switch to burning fat for fuel (ketosis), leading to an acidosis. This condition is called diabetic ketoacidosis, or DKA. Many patients with type 1 diabetes will present in DKA at the time of diagnosis. Another related condition is called hyperosmolar non-ketotic coma (HONKC), which occurs when blood sugars reach very high levels (usually greater than 800 mg/dL or 44 mmol/dL). These
lead to hyperosmolality and very dangerous fluid shifts. If left untreated, mortality probably approaches 100%.

Our algorithms do not attempt to differentiate between DKA and HONKC. Our algorithms also do not use blood pH, anion gap or osmolality measurement in the diagnosis or triage of hyperglycemic states. Even at district hospital level, these labs, as a rule, are either unavailable or inaccurate. Therefore, we rely on symptoms, urine dipstick, and finger-stick blood glucose.

**TABLE 7.3 Insulin Therapy of Patients with Hyperglycemia (≥ 250 mg/dL) and Danger Signs Awaiting Transfer**

<table>
<thead>
<tr>
<th>Blood sugar</th>
<th>Regular insulin dose (given subcutaneously)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For children (≤ 40 kg)</td>
</tr>
<tr>
<td>Initial bolus</td>
<td>0.2 units/kg x 1</td>
</tr>
<tr>
<td>Recheck blood glucose every hour</td>
<td></td>
</tr>
<tr>
<td>≥ 250 mg/dL (13 mmol/L)</td>
<td>0.1 unit/kg/hour</td>
</tr>
<tr>
<td>150–249 mg/dL (8-13 mmol/L)</td>
<td>0.05 unit/kg/hour</td>
</tr>
<tr>
<td>&lt; 150 mg/dL (&lt; 8 mmol/L)</td>
<td>Stop insulin, continue normal saline or lactated ringers</td>
</tr>
</tbody>
</table>

In our algorithms, any patient with a blood sugar greater than 200 mg/dL (11.1 mmol/L) with danger signs of hyperglycemia, or any patient with a blood sugar greater than 400 mg/dL (18 mmol/L) with or without danger signs, should be hospitalized and given IV fluids and intensive insulin therapy. Treatment with subcutaneous insulin should begin immediately at the health-center level and continue until the patient is transferred. The most important initial step in management of these patients is to establish IV access and begin immediate infusion of normal saline or lactated Ringers. Patients with high levels of hyperglycemia will often be liters of water dehydrated as a result of a hyperglycemic diuresis, and this dehydration is often the most dangerous aspect of the condition.

In addition to giving IV fluids, health center practitioners should give subcutaneous insulin if this medication is available. If transport is to happen immediately, the health center nurse should give a single bolus dose of insulin. If transport is delayed, the clinician should continue to check glucose on an hourly basis and give insulin according to the schedule in **TABLE 7.3**, which outlines insulin therapy in patients with hyperglycemia and danger signs who are awaiting transfer to inpatient district hospital care.
7.2.2 Hypoglycemia

The most dangerous side effect of treatment with either insulin or sulfonylureas (e.g., glibenclamide) is low blood sugar or hypoglycemia. Diabetic patients who don’t have enough to eat are at very high risk of developing hypoglycemia and should be identified as particularly vulnerable. Solutions to chronic lack of food are not simple. In the short term, these patients may need direct provision of food. In the medium term, they need social services to help them grow more of their own food, or earn income to buy it reliably.

Kidney or liver problems can also put patients at risk of hypoglycemia. If the cause of the hypoglycemia is ambiguous, these possibilities should be considered and creatinine should be checked. Liver disease usually causes hypoglycemia only in its end stages.

Hypoglycemic symptoms can come in two varieties (see TABLE 7.4). One variety is essentially neurological; patients who are not getting enough glucose to their brains can become dizzy, tired, confused, or nauseated. They can also develop seizures or lose consciousness. The other complex of symptoms can result from the body’s stress response to low blood sugar. These symptoms include sweating, shaking, palpitations, and anxiety.

Treatments for hypoglycemia are listed in TABLE 7.4. Patients with symptoms of hypoglycemia should improve almost immediately with administration of glucose. This should be given orally if the patient is awake and able to swallow. Currently IV glucose (50% solution) is only available in Rwanda at the district and referral level. Note that this is an inappropriate concentration of glucose for IV use in children. The approach to treatment of hypoglycemia following initial resuscitation with glucose depends on the medication at fault. Hypoglycemia can recur until the medication has worn off. The half-life of insulin is relatively short, and patients who have received too much insulin may only require several hours of observation. However, oral hypoglycemics such as sulfonylureas have longer half-lives. Patients who have become hypoglycemic from excessive intake of these medications should be observed for at least 12 hours and receive finger-stick checks every few hours.
TABLE 7.4  Diagnosis and Treatment of Hypoglycemia

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somnolence or agitation</td>
<td>Correctable:</td>
</tr>
<tr>
<td>Confusion</td>
<td>Overdose of medication (insulin or orals)</td>
</tr>
<tr>
<td>Lethargy</td>
<td>Increased exercise</td>
</tr>
<tr>
<td>Dizziness, nausea</td>
<td>Skipped meals</td>
</tr>
<tr>
<td>Seizures</td>
<td></td>
</tr>
<tr>
<td>Stroke-like symptoms</td>
<td></td>
</tr>
<tr>
<td>Sweating</td>
<td></td>
</tr>
<tr>
<td>Tremors</td>
<td></td>
</tr>
<tr>
<td>Palpitations, anxiety</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Causes</td>
<td>Not (easily) correctable:</td>
</tr>
<tr>
<td></td>
<td>Reduced renal function (diminished clearance of hypoglycemic agents)</td>
</tr>
<tr>
<td></td>
<td>Liver failure (inability to produce glycogen to correct serum hypoglycemia)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
</tr>
<tr>
<td>Juice, soft drink, sugar water (if able to follow commands)</td>
<td></td>
</tr>
<tr>
<td>In adults IV glucose 50% solution (if unable to follow commands)</td>
<td></td>
</tr>
<tr>
<td>In children ≤ 12 give glucose 50% solution by nasogastric tube (if unable to follow commands)</td>
<td></td>
</tr>
<tr>
<td>3-12 hours of frequent finger-stick checks</td>
<td></td>
</tr>
</tbody>
</table>

7.3  Principles and Initial Management of Diabetes

Patients with diabetes in Rwanda will require different levels of care for management. All should be initially referred to the district-level clinic for confirmation of the diagnosis and for initiation of therapy. An intake form should also be filled out (see APPENDIX D) and all patients should be screened for renal failure with a creatinine. The majority of patients will be managed with oral medications and can be followed at the health center clinics after the initial diagnosis has been established. These patients will still require occasional visits to the district NCD clinic for yearly creatinine measurement and for opthalmic evaluation every three years. Those patients who require insulin therapy, either because they have failed oral therapy or because they have a history of dangerous hyperglycemia, will be managed initially at the district-hospital level. As health centers gain more experience with integrated chronic care, they can also follow patients on stable regimens of insulin.

For all patients, blood glucose should be checked during each visit. A hemoglobin A1c (HbA1c) test that measures the average level of glycemia over the past 3 months should also be administered every 6 months. While this test is more expensive than a finger-stick, the information
gained can help tremendously in management, especially in a setting in which patients are not able to check blood glucose regularly. Point-of-care tests for HbA1c can be inaccurate if the patient has a hemoglobinopathy such as sickle cell anemia or active malaria.\textsuperscript{36,37} Rwanda has relatively low prevalence of hemoglobinopathies.\textsuperscript{38,39} Furthermore, point-of-care HbA1c machines such as the ones used in Rwanda’s NCD clinics are less affected by hemoglobinopathies. However, in other settings with higher prevalence of sickle cell trait, it may be reasonable to examine patients for conjunctival pallor.

\textbf{TABLE 7.5} outlines glucose control goals. Initially, we aim to keep patients at the higher end of the spectrum so as to avoid problems with hypoglycemia if they are using insulin or a sulfonylurea. Recent studies call into question the benefits of tighter glucose control relative to potential increase in hypoglycemia and death.\textsuperscript{40-43} We feel that initial management should aim for an HbA1c between 7.5% and 8%. This corresponds to an average glucose between 170 and 185 mg/dL (9.4–10.5 mmol/L) and pre-meal glucose levels between 150 and 180 mg/dL (8.3–10 mmol/L). More intensive glucose control reduces the risk of blindness, kidney failure, and neuropathy in both patients with type 1 and type 2 diabetes.\textsuperscript{44,45} For this reason, if patients are doing well on initial therapy, it makes sense to pursue a more aggressive target HbA1c of 7.0%–7.5%. HbA1c testing should be carried out twice a year. HbA1c testing is not generally the major driver of cost of care for patients with diabetes in resource-limited settings. However, in patients whose finger-stick blood glucose is routinely above 200 mg/dl (11 mmol/L), HbA1c probably adds little useful information.\textsuperscript{46}

\begin{table}[h]
\centering
\begin{tabular}{|l|c|c|}
\hline
 & Reasonable control & More intensive control \\
\hline
Pre-meal and pre-bedtime glucose & 150–180 mg/dL (8.3–10 mmol/L) & 120–150 mg/dL (6.7–8.3 mmol/L) \\
\hline
Hemoglobin A1c & 7.5%–8%: average blood glucose of 170–185 mg/dL (9.4–10.5 mmol/L) & 7.0%–7.5%: average blood glucose of 154–170 mg/dL (8.6–9.4 mmol/L) \\
\hline
\end{tabular}
\caption{Glucose Control Goals}
\end{table}

7.3.1 Oral Hypoglycemic Agents

Even in low-income, low-BMI settings, many patients with diabetes will respond well to oral hypoglycemic medications. These medicines are dramatically cheaper than insulin, easier to use, and less dangerous. Unless the patient is under 18 years old or has had ketoacidosis, oral agents should be tried first. Although their use is likely to be safe, most experts do not recommend use of oral therapy in pregnancy pending
further study. **PROTOCOL 7.2** outlines the approach to oral therapy of diabetes.

**PROTOCOL 7.2** Treatment of Diabetes with Oral Hypoglycemic Agents (in Adults)
There are two oral hypoglycemic agents available in Rwanda: glibenclamide and metformin. The majority of patients with diabetes in Rwanda have low or normal body weight (BMI ≤ 25 kg/m²). For these patients, glibenclamide should be the first oral therapy used. This medication, a sulfonylurea, works by increasing pancreatic insulin output. In our experience, most patients with diabetes with normal to low body weight have impaired insulin secretion. However, there is a risk of hypoglycemia with this medication. Dosing for glibenclamide is outlined in **TABLE 7.6**.

For patients who are overweight (BMI ≥ 25 kg/m²), metformin is a good first choice. This medicine works in part by increasing glucose uptake into cells in response to endogenous insulin. Metformin rarely causes hypoglycemia. However, it can result in stomach upset. When it is administered in low doses and gradually titrated up, stomach side effects can sometimes be avoided. **TABLE 7.6** also shows dosing for metformin. Due to the rare risk of lactic acidosis, most endocrinologists do not recommend the use of metformin in patients with renal failure. In our clinics, patients should have a creatinine checked at the district-level clinic upon confirmation of their diagnosis and then yearly thereafter. We do not use metformin in patients with a creatinine ≥ 150 µmol/L.

It is generally preferable to use the maximum dose of a single agent before adding a second. When a single oral agent is insufficient for maintaining glycemic control (**TABLE 7.5**), adding the second agent, or adding insulin therapy, should be considered. The maximum oral regimen is glibenclamide 10 mg twice per day and metformin 1000 mg twice per day.

**TABLE 7.6  Oral Hypoglycemic Therapy**

<table>
<thead>
<tr>
<th>Steps</th>
<th>Metformin</th>
<th>Glibenclamide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 a.m.</td>
<td>7 p.m.</td>
</tr>
<tr>
<td>1</td>
<td>500 mg</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>500 mg</td>
<td>500 mg</td>
</tr>
<tr>
<td>3</td>
<td>1000 mg</td>
<td>500 mg</td>
</tr>
<tr>
<td>4</td>
<td>1000 mg</td>
<td>1000 mg</td>
</tr>
<tr>
<td>5</td>
<td>Add glibenclamide</td>
<td>Add metformin</td>
</tr>
</tbody>
</table>

**7.3.2 Patient Education**

Education is an essential aspect of diabetes care. Group classes can be a useful way to educate patients with diabetes in their own self-care. Diabetes visits are organized in groups that allow similar patients (e.g., children, adults on oral therapy, adults on insulin) to get educated while they are awaiting their clinic visits. Sessions are run by the nurse clinicians.
Patients are given lessons in the storage of insulin, in proper injection technique, and in the recognition of symptoms of hypoglycemia (see TABLE 7.7 for common causes of hyperglycemia in patients on insulin). Other topics include the importance of foot care, appropriate diet, and physical activity.

**TABLE 7.7 Common Causes for Hyperglycemia in Patients on Insulin**

<table>
<thead>
<tr>
<th>Situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems with insulin injection and mixing technique</td>
</tr>
<tr>
<td>Problems with insulin storage or expiration</td>
</tr>
<tr>
<td>Unusual dietary excess</td>
</tr>
<tr>
<td>Active infection (e.g., malaria, urinary, skin, or pulmonary)</td>
</tr>
</tbody>
</table>

A frequent misconception among patients is the need to limit how much they eat. Partially as a result of this, patients often present in a malnourished state. Even though most patients consume high-carbohydrate diets, dietary counseling should focus on the need for regular meals rather than on specific restrictions. In the rare case of a patient who is overweight (more common in the urban areas of Rwanda), weight loss and diet modification should be encouraged. Exercise frequently improves blood glucose and should be recommended to all patients, irrespective of weight. However, increases in exercise can result in hypoglycemia if insulin or glibenclamide are being administered. Patients should be made aware of this issue, and practitioners should keep this risk in mind when adjusting drug regimens. Whenever available, community health workers should be used to improve therapeutic adherence and to provide social support.

### 7.4 Management of Diabetes with Insulin Therapy

Many patients with diabetes—in our cohort, approximately half of patients—need insulin therapy. TABLE 7.8 lists the indications for insulin. Successful initiation of insulin therapy requires extensive patient counseling (see SECTION 7.3.2). We refer all patients in need of insulin to the district hospital for admission. The main goals of hospitalization are patient education and also treatment and prevention of dangerous levels of hyperglycemia. We do not attempt to establish tight control of blood glucose. Insulin requirements in the hospital may differ substantially from those in the community. Food provision in-hospital is variable. Some hospitals in Rwanda provide meals to patients, but most do not. Therefore, patients may be receiving more or less food than they would at home. Often levels of physical activity are also altered in the hospital setting. As a result of these variables, it is safer to discharge patients on the minimum amount of insulin necessary to prevent life-threatening hyperglycemia and titrate their dose afterward. To this end, all patients
should be assigned a community health worker (CHW) prior to discharge. The CHW will perform daily home visits to help with insulin administration and documentation of glucose levels. NCD clinicians then review this information at weekly district NCD clinic visits and make adjustments accordingly. This process continues until a stable insulin regimen is established, usually within several weeks. **PROTOCOL 7.3** outlines the steps taken in initiation and adjustment of insulin therapy.

**TABLE 7.8  Indications for Insulin Therapy**

<table>
<thead>
<tr>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 diabetes</td>
</tr>
<tr>
<td>Failed maximum oral therapy</td>
</tr>
<tr>
<td>Pregnancy</td>
</tr>
<tr>
<td>Creatinine ≥ 150 mmol/L (1.6 mg/dL) (which prevents use of metformin), and unable to control glucose with glibenclamide alone</td>
</tr>
<tr>
<td>History of diabetic ketoacidosis</td>
</tr>
<tr>
<td>Child ≤ 18 years of age</td>
</tr>
</tbody>
</table>
PROTOCOL 7.3  Initiation and Adjustment of Insulin Regimens

**Diabetes mellitus**

**AND**

- Already on insulin
- Has new indication for insulin therapy (see Table 7.8)

---

1. Any warning signs (see Table 7.2)
2. Glucose ≥ 200 mg/dl (11 mmol/l)
3. Glucose ≥ 400 mg/dl (22.2 mmol/l)

---

**If on oral medications:**

1. Stop glibenclamide.
2. Continue metformin if creatinine ≤ 150 µmol/L

---

**Screen for complications:**

1. Check renal function (creatinine on first visit and then once yearly, proteinuria every 6 months at health center)
2. Perform foot exam (every visit) AND monofilament testing (once yearly)
3. Refer for ophthalmic evaluation (once every 3 years, at district-level clinic)

---

**First visit for insulin**

**NO**

- Refer to hospital for admission.

---

**YES**

- Glucose control at goal? (see Table 7.5)
  
  **NO**
  
  - Identify insulin regimen (started as inpatient)

---

**YES**

- Continue current diabetes medications. Follow-up 4-8 weeks at district NCD clinic

---

**Hypoglycemia?**

**YES**

1. Start Normal Saline at 250 cc/hour
2. Give 0.2 U/kg (or 10 units for an adult) SC of regular insulin if glucose ≥ 250 mg/dl (13 mmol/L)
3. Check blood sugar 1-4 hours AND give additional insulin until transfer (see Table 7.3)

---

**Correctable cause of hyperglycemia?**

(see Table 7.7)

**NO**

- Treat infection, OR change insulin batch, OR ensure good insulin storage and injection techniques

---

**Increase insulin** (see Table 7.10)

**NO**

- Correctable cause of hyperglycemia? (see Table 7.4)

---

**Decrease insulin** (see Table 7.10)

- Correctable cause of hyperglycemia? (see Table 7.4)

---

**Follow-up 2-4 weeks at district NCD clinic**

---

**Ensure access to regular meals/snacks. Nutritional support as needed.**
7.4.1 Initiation of Insulin Therapy

Once the decision to start insulin has been made, patients should be referred to the district hospital for admission. In the hospital, the following steps will be taken:

- **Change in oral medication regimen if already on maximum dose.**

- **Stop glibenclamide.** Since glibenclamide stimulates insulin secretion by the pancreas, its continued use in the setting of insulin therapy can increase the risk of hypoglycemia. For this reason, glibenclamide should be discontinued in all patients on insulin.

- **Continue metformin unless creatinine ≥ 150 µmol/L (1.6 mg/dL).** Metformin should be continued in patients who are beginning insulin therapy. Metformin causes the body's tissues to better respond to insulin, resulting in decreased hepatic glucose output. Metformin may lower insulin dose requirements.

- **Start insulin.** In the hospital, patients will be started on an insulin regimen that is appropriate for them (see SECTION 7.4.2).

- **Provide patient education.** While hospitalized, patients should be given education regarding the appropriate injection of insulin and the importance of regular meals.

- **Ensure good outpatient follow-up plan.** At discharge, a community health worker should be assigned to the patient. This community health worker will visit the patient daily and, during the first 2–3 weeks, check and record daily blood glucose levels. The patient should also be given an appointment for one week after discharge to be examined at the district-level NCD clinic. The importance of follow-up should be emphasized to the patient.

7.4.2 Insulin Regimen Selection

Insulin should be made available at the health-center level, along with appropriate training in its use. For a program that is relatively new in a district, it may be preferable to manage insulin-dependent patients with diabetes at the district level, where nurse clinicians have more extensive training and physicians are available to supervise. However, in most cases, patients live further from the district clinics than from health-center clinics. In such situations, a community health worker is vital to ensuring that patients do not run out of insulin. The community health worker or the patient may refill insulin prescriptions at the health center in the periods between district clinic visits. Eventually, programs may find it possible to decentralize insulin management to the health-center clinic, once a patient has established a stable regimen.

In Rwanda, there are three types of insulin available through public pharmacies (see TABLE 7.9): NPH (insulatard or lente), regular (insuline
rapide), and combination (mixte or mixtard). NPH is generally considered to be a basal insulin; it provides a long-acting baseline insulin level. On the other hand, regular insulin is shorter-acting, and is thus usually used to treat mealtime glucose surges. Combination insulin is a third option, which consists of a premade mixture of regular and NPH insulin. The most common ratio for pre-mixed insulin is 70/30 (70% NPH, 30% regular).

<table>
<thead>
<tr>
<th>TABLE 7.9 Properties of Insulin Available in Rwanda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regular (rapide)</strong></td>
</tr>
<tr>
<td>Time to onset</td>
</tr>
<tr>
<td>Peak effect</td>
</tr>
<tr>
<td>Duration</td>
</tr>
<tr>
<td>Dosing</td>
</tr>
<tr>
<td>Vial appearance (manufacturer-specific)</td>
</tr>
</tbody>
</table>

The available types of insulin can be used in isolation or in various combinations to achieve the desired effect. Simpler regimens result in looser glucose control than the complex regimens. Of course, more complex regimens are more difficult for patients to follow. For this reason, all patients using insulin should have access to regular assistance from a trained community health worker.

The initial regimen will be determined in the inpatient setting, but it may need to be adjusted after the patient is discharged. The simplest insulin regimen is a single nighttime injection of NPH. This approach targets the fasting blood sugar and can serve as a building block for future adjustments, if needed.

This strategy has been shown to control glucose in roughly half of adult patients with diabetes in a U.S. population. However, in our experience, most patients in rural Rwanda cannot be controlled on a once-a-day regimen. This may be because their insulin secretion is more impaired than in the average patient with type 2 diabetes in an industrialized setting. Most of our patients require twice-daily NPH with regular insulin or twice daily pre-mixed insulin. These regimens avoid severe hyperglycemia due to carbohydrate-rich meals. TABLE 7.10 outlines the available insulin regimens in order, from simplest to most complex. The most commonly used regimens in Rwanda are highlighted in red. The starting doses of insulin provided here are purposefully on the low side and most patients will require much higher dosing than this over time.
<table>
<thead>
<tr>
<th>Regimen</th>
<th>Injections</th>
<th>Coverage of basal glycemia</th>
<th>Coverage at meals</th>
<th>Notes</th>
<th>Starting dose type 1</th>
<th>Starting dose type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH (insulatard or lente) 1x/day</td>
<td>1</td>
<td>Some</td>
<td>None</td>
<td>Most simple, but not good coverage if high-carbohydrate diet</td>
<td>Not appropriate</td>
<td>0.2 units/kg/day or 10 units/day (whichever is less) given at bedtime</td>
</tr>
<tr>
<td>NPH (insulatard or lente) 2x/day</td>
<td>2</td>
<td>Good</td>
<td>None</td>
<td>Good for some patients with type 2 diabetes, but again problem with coverage if high-carbohydrate diet</td>
<td>Not appropriate</td>
<td>0.3–0.6 units/kg/day; 60% pre-breakfast, 40% pre-dinner (20–30 minutes before meal)</td>
</tr>
<tr>
<td>70/30 (mixte) 2x/day</td>
<td>2</td>
<td>Good</td>
<td>Breakfast and dinner (no lunch coverage)</td>
<td>Post-prandial hyperglycemia. For high-carbohydrate diets, may need closer to a 50/50 mix</td>
<td>Not appropriate</td>
<td>0.3–0.6 units/kg/day; 50% pre-breakfast, 50% pre-dinner (20–30 minutes before meal)</td>
</tr>
<tr>
<td>NPH (insulatard or lente) and regular (rapide) Insulin 2x/day</td>
<td>2</td>
<td>Good</td>
<td>Breakfast and dinner</td>
<td>Allows patients to control mix Patients combine insulin from two vials (NPH and regular) and give the injection 2x/day</td>
<td>0.2–0.3 units/kg</td>
<td>0.5–0.7 units/kg</td>
</tr>
<tr>
<td>Basal/Prandial</td>
<td>3</td>
<td>Good</td>
<td>All meals</td>
<td>Best for large midday meals Dinner-time NPH and regular combination. Regular alone with breakfast and lunch</td>
<td>0.2–0.3 units/kg</td>
<td>0.5–0.7 units/kg</td>
</tr>
</tbody>
</table>

*Table 7.10: Insulin Regimens*
7.5 Insulin Use in the Community

Insulin injection. Typically, insulin injections should be given in the subcutaneous fat of the abdomen. Alternative sites include the subcutaneous fat of the thighs and arms. The abdominal fat is generally thought to be the best site for absorption because it contains a greater fat-to-muscle ratio. However, with repeated injections, many patients develop pain, calluses, or bruising, and sometimes they prefer alternating sites. For this reason, it may be reasonable to recommend that morning injections be given at abdominal sites, and evening injections in the thigh. The emphasis should focus on the consistent use of the site or sites, in order to ensure reliable absorption.

Insulin storage. If insulin is stored improperly, it may not have the desired effect. For patients who have hyperglycemia despite escalating doses of insulin, proper insulin storage should be reviewed with the patient. In an ideal setting, insulin should be refrigerated. However, this is impractical and probably unnecessary in rural Rwanda and in most other limited-resource settings. Alternatively, patients can place the vial in a small container of water, which should be kept in a cool place out of the sun, such as an inside corner of the house on the floor. Clay pots filled with sand and water, allowing for evaporation, are also frequently used. Fortunately, Rwanda has a temperate climate. In other, hotter countries, refrigeration may be available through local soft drink distributors. There is little evidence that problems with insulin storage are currently a major barrier to good outcomes for patients with diabetes in such areas.49
### TABLE 7.11  Example of Glucose Monitoring Chart

<table>
<thead>
<tr>
<th>Date</th>
<th>Blood sugar</th>
<th>Insulin</th>
<th>Symptoms of hyperglycemia/hypoglycemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>183 mg/dL</td>
<td>2U Regular</td>
<td>None</td>
</tr>
<tr>
<td>Day 2</td>
<td>240 mg/dL</td>
<td>2U Regular</td>
<td>None</td>
</tr>
<tr>
<td>Day 3</td>
<td>170 mg/dL</td>
<td>2U Regular</td>
<td>None</td>
</tr>
<tr>
<td>Day 4</td>
<td>204 mg/dL</td>
<td>2U Regular</td>
<td>None</td>
</tr>
</tbody>
</table>

**Blood sugar levels:**
- Before breakfast: 183 mg/dL
- Before lunch: 240 mg/dL
- Before dinner: 170 mg/dL
- Before bedtime: 204 mg/dL

**Insulin doses:**
- Day 1: 2U Regular
- Day 2: 2U Regular
- Day 3: 2U Regular
- Day 4: 2U Regular

**Symptoms of hyperglycemia/hypoglycemia:**
- None
Insulin syringe disposal. After use, insulin syringes should always be placed in an appropriate sharps container. These safety containers should be distributed to patients. Patients should be instructed to bring their filled boxes to the local health center for disposal.

Blood glucose monitoring for patients on insulin. After starting insulin therapy, the blood glucose should be monitored closely. In the hospital, a patient’s eating and other activities are very different than at home. Hypoglycemia or hyperglycemia can result after discharge. Ideally, patients should be monitored with finger-sticks as often as four times per day (before each meal and before bedtime). However, given the high cost of test strips, we have pursued a strategy to minimize unnecessary use of these consumables.

In our clinics, each community health worker is given a glucometer and test strips to check a patient’s blood sugar twice daily for the first 2–3 weeks following discharge. Having data points at different times of the day (see Table 7.11) can help the practitioner decide which insulin dose needs adjustment. On one day, the patient checks glucose pre-breakfast and pre-dinner; on the next, the patient should check glucose pre-lunch and pre-bedtime. During this period of adjustment, patients should be seen at the district NCD clinic weekly. Once a patient is on a stable regimen, community health workers may teach patients to use twice-daily urine glucose testing to monitor for hyperglycemia. If the patient has two or more positive urine dipsticks per week, home blood glucose monitoring is started again.

7.5.1 Principles of Insulin Adjustment

Insulin can be a life-saving medication. However, if it is administered or dosed incorrectly, serious complications can ensue. Making insulin adjustments can be complicated. Until a stable regimen is achieved, patients should be followed at district level. When there is doubt regarding a change of insulin dose, the decision should be made with the help of a doctor. It is important that specialists from referral centers make regular visits to district hospitals to consult and supervise care. Large changes in regimens (such as switching to a new type of insulin) should happen only in the hospital setting.

Small dose changes. In general, the size of the dose increase should be small (around 1–2 units). Decreases in dosage can be larger (2–4 units). These general guidelines will limit unexpected hypoglycemia in response to an increase in the dose, or severe hyperglycemia in response to a dose reduction. Patients with uncontrolled diabetes have likely been poorly controlled for a long time, so one extra month of hyperglycemia is unlikely to have much of a detrimental impact. If a practitioner is concerned about
a particular patient, more frequent follow-up will be needed. However, insulin should continue to be adjusted by small amounts each time.

**Start with a simple regimen.** For patients beginning insulin, compliance will be more likely if the regimen is simple. As a patient learns how to administer insulin and monitor for side effects, transitioning to a more complex regimen will become easier for the patient. The regimen should be selected and started by the district inpatient physician. The simplest regimen would be a single dose of NPH at bedtime. However, most patients in Rwanda will have high blood sugar spikes at mealtimes because of their carbohydrate-rich diets. For this reason, most patients are started on a more physiologic regimen with a shot of NPH and regular insulin (either as two separate shots or combined) twice daily (see **TABLE 7.10**).

**Watch for patterns and tailor the regimen accordingly.** After the first week of insulin use in the community, the district-level NCD provider has data on the patient’s glucose trends (see **TABLE 7.11**). The thresholds for adjusting the insulin dose are listed in **TABLE 7.5**. Initial control should aim for glucose levels between 150 and 180 mg/dL (8.3–10 mmol/L) prior to meals and at bedtime. The goal HbA1c should be between 7.5% and 8%. There should be roughly 3 or 4 pre-meal and 3 or 4 bedtime measurements available for a given week. The first step is to identify measurements that are outside of the goal range. If there are correctable causes not related to the prescribed medication dose, these should be addressed first (**PROTOCOL 7.3**). If there is no other correctable cause, and at least 2 of the measurements are below the target level (e.g., 150 mg/dL) or there is symptomatic hypoglycemia, the insulin regimen should be adjusted downward. Similarly, if two or more measurements are above the target level (e.g., 180 mg/dL), the insulin regimen should be adjusted upward.

The insulin adjustment strategy depends on the kind of insulin regimen used at baseline. The peak effect of NPH (**lente**) and 70/30 (**mixte**) insulins is experienced 3–12 hours after administration (see **TABLE 7.9**). **TABLE 7.12** shows the recommended adjustment strategy for regimens using only these insulins.
For patients on a regimen involving both NPH and regular insulin, adjusting insulin is slightly more complicated. The pharmacokinetics of regular insulin and NPH must be kept in mind when reviewing the timing of hyperglycemia and hypoglycemia. If hyperglycemia or hypoglycemia occur 3–4 hours after an injection, the effect is likely due to regular insulin. If the symptoms occur 6–12 hours after an injection, the effect is likely due to NPH (see TABLE 7.13).

### TABLE 7.12 Principles for Adjusting Insulin 70/30 (Mixte) or 2x/day NPH Regimens

<table>
<thead>
<tr>
<th>Timing of hyperglycemia/hypoglycemia</th>
<th>Hyperglycemia (documented)</th>
<th>Hypoglycemia (documented OR symptoms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning/overnight</td>
<td>Increase dinner-time or evening insulin by 2 units</td>
<td>Decrease dinner-time or evening basal insulin by 4 units or 10%, whichever is greater</td>
</tr>
<tr>
<td>Mid-day/evening</td>
<td>Increase morning insulin by 2 units</td>
<td>Decrease morning insulin by 4 units or 10%, whichever is greater</td>
</tr>
</tbody>
</table>

Patients who need to be transitioned to a different regimen altogether should be hospitalized to have this change made. Although physicians in the hospital will make these adjustments, we outline the basic principles below.

**All transitions.** In transitions from one insulin regimen to another, there are two methods for choosing the starting dose for the new insulin: (1) dosing based on the current dose of insulin, or (2) weight-based dosing. When possible, it is preferable to use an existing insulin dose as a starting point for a new insulin regimen. In general, the dose of insulin should be rounded downward to avoid hypoglycemia.

**Dosing based on current dose of insulin.** In most patients who are already on insulin, the current total daily dose can be used as a starting point for the new regimen. For instance, if a patient is already taking 20 units of NPH as a single evening dose, this can be transitioned to 20 total
units of a combination of NPH and regular insulin given twice daily. Of the 20 units, 50% (or 10 units) can be given as NPH and 50% (10 units) can be given as regular insulin. Of the NPH, 60% (6 units) can be given before breakfast and 40% (4 units) can be given before dinner. The regular insulin can be divided between meals (rounded down to 3 units with each meal for 9 total units of regular insulin per day).

**Weight-based dosing.** If a patient is not already taking insulin, the initial dosing can be based on weight by using the formulas provided in **TABLE 7.10**. To divide the total daily insulin among multiple administration times, the value can be rounded down to the nearest whole unit so as to avoid hypoglycemia.

**Transition to 70/30 insulin.** While 70/30 insulin preparations are widely available in many regions, adequate glycemic control is often difficult to achieve in patients with high dietary carbohydrate intake. These preparations can be used if necessary (i.e., when stock-outs leave no other available insulin) and dosing can be based either on a prior insulin regimen or based on weight. If a patient’s fasting glucose is controlled with NPH insulin, but the daytime, post-meal glucose measurements are still very high, the patient may benefit from a mealtime dose of regular insulin in addition to NPH. Using insulin 70/30 can help with this. In general, one can use the same dose as insulin NPH 2x/day as the starting dose for insulin 70/30 2x/day. For example, if a patient takes insulin NPH 12 units in the morning and 8 units before dinner, the starting dose of insulin 70/30 can also be 12 units in the morning and 8 units at dinner.

**Transition from a 70/30 combination to NPH/regular.** Since the ratio of NPH insulin to regular is fixed in insulin 70/30, patients may have persistent midday hyperglycemia (due to an insufficiency of short-acting insulin prior to meals) despite having controlled fasting glucose (due to a correct amount of NPH). Indeed, as the dose of insulin 70/30 is increased, patients may well develop fasting hypoglycemia and midday hyperglycemia. These patients will need to have NPH insulin and regular insulin in a different ratio than that available in fixed-dose preparations. Patients should first be transitioned to NPH and regular insulin at the same dose and in the same ratio as insulin 70/30 (**TABLE 7.14**). Adjustments should then be made as outlined in **TABLE 7.13**. Some patients may also require an extra dose of regular insulin prior to lunch if midday hyperglycemia continues to be a problem (see **TABLE 7.10**).
7.6 Adjuvant Therapies and Routine Monitoring for Complications in Patients with Diabetes

Patients with diabetes in rural areas living on less than $1 per day are typically younger (below 40) and have a low prevalence of vascular comorbidities such as obesity, tobacco use, hyperlipidemia, and lack of physical activity. Complications from diabetes in these populations are typically microvascular in origin (retinopathy, diabetic foot, renal failure), rather than macrovascular (strokes and heart attacks).\textsuperscript{50,51} The risk of complications is highest in patients who have had their disease untreated for 10 to 20 years. TABLE 7.15 outlines the most common complications of diabetes and their prevalence in some African cohorts from Ethiopia, Malawi, and Tanzania.

At the time of initial diagnosis, all patients with diabetes should have a blood pressure measurement, a foot exam with a monofilament, a fundoscopic examination by an ophthalmic officer, a creatinine test, and a urine dipstick.

Blood pressure goals for patients with diabetes should be set at less than 130/80 mmHg. For children less than 18 years old, blood pressure goal should be set to less than the 95% percentile for age, sex, and height. We do not check lipid levels routinely, but if patients have diabetes and have BMI greater than 25 kg/m\textsuperscript{2}, they should also take aspirin daily at a low dose such as 100 mg. Given the low incidence of coronary events in this population, we have not pursued statin therapy.

### TABLE 7.14 Example of Transitioning from 70/30 (Insuline Mixtard) to NPH/Regular (Insuline Lente + Rapide)

<table>
<thead>
<tr>
<th>Initial dose:</th>
<th>Pre-breakfast</th>
<th>Pre-dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td>70/30 (Insuline mixtard)</td>
<td>20 units</td>
<td>10 units</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Final dose:</th>
<th>Pre-breakfast</th>
<th>Pre-dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH (Insuline lente)</td>
<td>14 units (70% of 20 units)</td>
<td>7 units (70% of 10 units)</td>
</tr>
<tr>
<td>Regular (Insulin rapide)</td>
<td>6 units (30% of 20 units)</td>
<td>3 units (30% of 10 units)</td>
</tr>
</tbody>
</table>
TABLE 7.15  Common Complications of Diabetes and Their Prevalence in Some African Cohorts

<table>
<thead>
<tr>
<th>Complication</th>
<th>Prevalence</th>
<th>Mode of evaluation</th>
<th>Frequency of evaluation</th>
<th>Action if abnormal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral neuropathy</td>
<td>35%–70%</td>
<td>Monofilament sensory testing of the feet. If a microfilament is not available, proprioception can be tested. Patients may also complain of neuropathic pain (burning, electrical sensations) in the feet</td>
<td>Once yearly</td>
<td>Intensify treatment regimen if possible. Consider treating neuropathic pain with amitriptyline 25 to 100 mg per day orally (in adults). Shoes if needed. Counsel on foot protection</td>
</tr>
<tr>
<td>Foot ulcer</td>
<td>1.7%–10%</td>
<td>Visual inspection, probe evaluation to rule out osteomyelitis</td>
<td>Every visit</td>
<td>Referral to district hospital for possible debridement and broad-spectrum antibiotics</td>
</tr>
<tr>
<td>Retinopathy or sight-threatening eye disease</td>
<td>5%–35%</td>
<td>Fundoscopic evaluation or retinal photography</td>
<td>Once every 3 years, performed at a district hospital with an ophthalmic clinical officer. More frequent follow-up if established retinopathy.</td>
<td>Intensify treatment regimen if possible. Referral for evaluation at an ophthalmic center if needed for intervention</td>
</tr>
<tr>
<td>Cataracts</td>
<td>8.7%–25%</td>
<td>Fundoscopic evaluation</td>
<td>Once every 3 years performed at a district hospital with an ophthalmic clinical officer</td>
<td>Referral for evaluation at an ophthalmic center for intervention</td>
</tr>
<tr>
<td>Albuminuria</td>
<td>18%</td>
<td>Urine dipstick</td>
<td>Every six months</td>
<td>Intensify treatment regimen if possible. Add an ACE inhibitor</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>19%–34%</td>
<td>Serum creatinine testing</td>
<td>Yearly</td>
<td>Intensify treatment regimen if possible. Add an ACE inhibitor if no counterindication</td>
</tr>
</tbody>
</table>

**Retinopathy and cataracts.** Intervention for established diabetic eye disease can reduce the risk of blindness by as much as 50%.\(^{55}\) Focal photocoagulation is indicated for clinically significant macular edema due to nonproliferative diabetic retinopathy, and panretinal photocoagulation is indicated for severe proliferative diabetic retinopathy.\(^{56}\) Typically, the yield of patients who will benefit from treatment is around 1% to 4%.\(^{57}\) Rwanda has trained ophthalmic clinical officers for work at district hospitals and photocoagulation is available at referral–center level.\(^{58}\) However, the quality of screening for such rare findings may be difficult to control. One solution that has been implemented at many other sites around the world, including South Africa, is use of retinal photography, followed by interpretation at a referral center.\(^{59,60}\)
Peripheral neuropathy, foot ulcers, and limb sepsis. Peripheral neuropathy is a common complication of diabetes that poses a great risk to patients living in rural areas. Loss of sensation and lack of proper footwear can lead to small cuts and infections, which can result in sepsis or death.\textsuperscript{61} One study in Tanzania found that almost 10% of patients with diabetes with foot injuries evaluated at a referral center had evidence of being bitten on the foot by rodents.\textsuperscript{62} Prevention of diabetic foot ulcers requires good glucose control and focused education regarding foot care. Care of foot ulcers requires evaluation by providers at district levels with skills in debridement, and also in some cases the use of broad-spectrum antibiotics. Specific training initiatives for diabetic foot care have been established in Africa and India.\textsuperscript{63} It is a goal of the Rwandan NCD program to integrate these skills into the competencies of district NCD providers. Patients with diabetes must learn to take seriously even small injuries to the hands or feet, as these may progress quickly to sepsis if not dressed properly.\textsuperscript{64}

Proteinuria and nephropathy. Although we do not check routinely for urine microalbumin, urine dipstick is used to screen for more significant proteinuria (see \textsc{CHAPTER 8, TABLE 8.2}). A dipstick should be checked twice a year, and a serum creatinine should be checked once per year. The finding of 2+ proteinuria or greater on a dipstick should lead to initiation of therapy with an ACE inhibitor after exclusion of other causes of proteinuria. One contraindication to use of ACE inhibitors is severe renal dysfunction (estimated glomerular filtration rate less than 29 ml/min). A reasonable starting dose of an ACE inhibitor for an adult is 5 mg per day orally. This can be increased at subsequent visits up to a goal dose of 10 mg, and then to 20 mg unless the blood pressure falls too far (less than 100 mmHg systolic) or potassium rises too high (more than 5 mEq/L). For children weighing ≤ 20 kg, a reasonable starting dose of lisinopril is 0.07 mg/kg once per day (maximum dose 5 mg). A reasonable starting dose of captopril in these children is 0.6 mg/kg three times per day (maximum dose 2 mg/kg three times per day).

7.7 Diabetes and Pregnancy

The danger of diabetes in pregnancy is that the fetus may develop birth defects or become unusually large and thus be at increased risk of trauma at birth. Hormonal changes during pregnancy lead to a degree of insulin resistance. So-called gestational diabetes as a result of these changes can arise, but it is rare in women who are younger than 30 who have low to normal body weight. Therefore, we focus on issues specific to pregnant women who had diabetes prior to pregnancy.
Women between the ages of 15 and 45 who have diabetes should be counseled regarding the risks of pregnancy, and should be offered the usual family planning options. Pregnancy may expose women with diabetes to increased risk, particularly those who already have complications due to their diabetes. All contraception options are reasonable, although progestin-only injectables should probably be avoided because of the increased risk of hyperlipidemia.

Women with diabetes who become pregnant should be changed from oral agents to insulin, because the safety of metformin and glibenclamide for the fetus are not well established. Because of the increased risk to fetus of both hypoglycemia and hyperglycemia, treatment should aim for a narrower than usual therapeutic goal. We suggest a goal HbA1c of 7% to 7.5% (see TABLE 7.5). Finger-stick glucose monitoring should be performed twice per day with community health worker support during pregnancy. At the time of delivery, glucose levels should be kept below 126 mg/dL (7 mmol/L) to avoid hypoglycemia in the neonate.

7.8 Social Assistance and Community Health Workers

Insulin-dependent patients with diabetes are some of the most vulnerable patients in any health system. Inability to access food or interruption of medication supply can rapidly become life threatening. For this reason, we ensure that our patients on insulin receive a full social work assessment and, if necessary, assistance with food and transport to clinic appointments. In addition, all patients on insulin in our Rwanda clinics are assigned a community health worker.

7.8.1 Community Health Workers and Accompaniment

Taking the right type of insulin in the right dose at the right time can be very difficult for a patient who has no medical training. Community health workers provide assistance. They help ensure that patients are taking their insulin correctly and monitor for symptoms of hyperglycemia and hypoglycemia. They also make sure patients do not miss appointments or run out of medications. Community health workers also serve as the keepers of relatively scarce glucometers; they can intensely monitor a patient’s blood glucose while patients are first adjusting to an insulin regimen. They can assist patients in checking blood glucose readings, improve compliance and adherence to treatment regimens, and help identify and relay problems patients may be having with their therapies.

7.8.2 Food Assistance

The timing of meals in relationship to the dose of insulin is very important. If a patient takes insulin without eating, hypoglycemia will result. Ensuring that patients on insulin have stable supplies of food is essential.
This may be accomplished by providing food packages to the patient’s family or by supporting the family’s ability to grow food, either on their own land or on a community plot, through patient associations. A full social work evaluation of the family should be done, as the family of a patient without enough food will often have other malnourished members.
Chapter 7 References


Ejigu A. Patterns of chronic complications of diabetic patients in Menelik II Hospital, Ethiopia. Ethiop J Health Dev 2000;14:113-16.


