

Original Publication

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# A Primer on Diabetes Mellitus: Foundations for the Incoming First-Year Resident

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## Abstract

**Introduction:** Given the increasing prevalence of diabetes mellitus, trainees should have a strong foundation in the management of diabetes. Published literature on the knowledge base and comfort level of medical trainees in diabetes care describes varying levels of exposure to diabetes management in both inpatient and outpatient settings. **Methods:** This eight-module curriculum provides a foundation in the diagnosis, evaluation, and management of diabetes mellitus in the adult patient, as well as pharmacological treatment, patient education, and complications. Specifically, the modules consist of an introduction to diabetes, diagnosis and glycemic goals, patient education, basic nutrition, noninsulin therapies, insulin therapies, complications of diabetes, and financial considerations and cost. Each is a stand-alone presentation that may be viewed nonsequentially. We estimate each module taking 15 to 30 minutes to read. Students received a postsurvey. **Results:** We received responses from 23 (18%) of the total eligible residents over the course of 3 years. Approximately 50% of respondents completed an endocrinology elective as either a medical student or first-year resident. Overall, the majority of respondents felt that the modules had the correct amount of content, the online format was adequate, their understanding of diabetes was enhanced, and the curriculum led to altering their care. **Discussion:** This resource is unique to MedEdPORTAL as it includes basic information on diabetes education and medical-nutritional therapy. We have required completion of these modules by our internal medicine residents since the class that enrolled in 2013. The curriculum is directed towards incoming first-year internal medicine residents but may also be used by trainees in other primary care fields.

## Keywords

Diabetes Mellitus, Evidence-Based Medicine, Endocrinology, Chronic Disease Management

## Educational Objectives

By the end of this resource, the learner will be able to:

1. Review diabetes mellitus types, underlying pathophysiology, and diagnostic criteria.
2. Identify the need for diabetes and nutritional education at the time of diagnosis.
3. Review the classes of available pharmacologic treatment options, including oral antidiabetes agents, insulins, and noninsulin injectable agents.
4. Review the potential costs of diabetes care to patients living with diabetes in the United States.
5. Review the current evidence guiding glycemic management goals and individualizing care.

## Introduction

It is estimated that over 29 million people in the United States have diabetes mellitus, either type 1 or type 2. Diabetes and its complications affect every corner of medicine, and trainees see an increasing number of diabetes patients in inpatient and outpatient settings. Given this, it is important that trainees have a

## Appendices

- A. Basics of Diabetes Mellitus .pptx
- B. Complications and Screening.pptx
- C. Diabetes Self-Management Education.ppt
- D. Diagnosis and Glycemic Goals.pptx
- E. Financial Considerations .pptx
- F. Insulins.ppt
- G. Noninsulin Agents.pptx
- H. Nutrition.pptx
- I. Survey.docx

*All appendices are peer reviewed as integral parts of the Original Publication.*

strong foundation in the management of diabetes whether they pursue general medicine or subspecialty training.

The education of medical students and trainees in diabetes care is not uniform. Published literature on medical learners in diabetes care describes variable levels of skill in both inpatient and outpatient management.<sup>1-6</sup> Despite the development of guidelines and evidence-based practice recommendations,<sup>7</sup> residents often rely on modalities such as sliding scales and believe this is adequate diabetes management.<sup>8-10</sup> Computer-based learning activities can enhance diabetes knowledge, which is the first step in improving practice.<sup>11-12</sup> Advantages to computer-based learning modalities include less reliance on lecture attendance for formal teaching and availability of durable materials for later review. Here, we present our online curriculum for diabetes directed towards incoming first-year residents. Our goal was to establish a foundation of knowledge for our internal medicine residents. The Drexel University College of Medicine Institutional Review Board approved the assessment of the curriculum. At this time, 3 years of categorical internal medicine residents at our home institution have completed this activity.

Several modules in MedEdPORTAL also address aspects of diabetes care. In these learning activities, diabetes care may be presented as a part of larger chronic care modules, as diabetes emergencies, or in bridging basic science concepts to bedside. Our curriculum has a wider scope, encompassing risk factors, diagnosis, management, and long-term complications of diabetes in one place.

## Methods

We created a set of online diabetes learning modules after surveying residents to assess their educational needs. The curriculum was designed following strategies previously published for computer-based learning.<sup>13-15</sup>

The curriculum consists of eight evidence-based slide-show modules in the Diabetes for Residents curriculum:

- Introduction to diabetes (Appendix A).
- Complications of diabetes (Appendix B).
- Patient education (Appendix C).
- Diagnosis and glycemic goals (Appendix D).
- Financial considerations (Appendix E).
- Insulin therapies (Appendix F).
- Noninsulin therapies (Appendix G).
- Basic nutrition (Appendix H).

Modules are freestanding and may be accessed multiple times. They should ideally be accessed in order, although they may be accessed nonsequentially. [Table 1](#) describes the modules and the corresponding Accreditation Council for Graduate Medical Education competencies and milestones. Our target audience is first-year internal medicine residents entering their postgraduate training. The modules are updated to reflect standards of management, new diabetes medications as they are approved, and updated epidemiology data. However, approximately 80% to 85% of the curriculum is unchanged from the project initiation. Updates are primarily in epidemiology and newly approved medications.

**Table 1.** Module Topics and ACGME Competencies Addressed in the Curriculum

Module	Topic	ACGME Competency	ACGME Milestone
Introduction	Incidence and prevalence of diabetes mellitus (type 1 and type 2)	Medical knowledge	MK1
Diagnosis and Glycemic Goals	Screening and diagnosis testing, treatment goals	Medical knowledge, patient care	MK1, MK2
Patient Education	Defining the seven tenets of diabetes self-management education	Medical knowledge, patient care, and systems-based practices	MK1, SBP1, PC2
Basic Nutrition <sup>a</sup>	Concepts of carbohydrate content, basic meal planning	Medical knowledge, patient care, and systems-based practices	MK1, SBP1, PC2
Noninsulin Therapies	Currently available oral and injectable noninsulin diabetes agents, including discussion of branded medications and generic medications	Medical knowledge, patient care	MK1, PC2
Insulin Therapies	Currently available insulin therapies (excluding continuous subcutaneous insulin infusion), timing and dosage of insulin	Medical knowledge, patient care	MK1, PC2
Complications of Diabetes	Common micro- and macrovascular complications, and screening tests and intervals for these	Medical knowledge, patient care	MK1, MK2, PC2
Financial Considerations	Introduction to considerations of cost for medications, testing supplies, and barriers to adherence	Systems-based practices	SBP3

<sup>a</sup>Author is a registered dietician and certified diabetes educator.

Users should finish each module in approximately 20 to 30 minutes and the full set in less than 3 hours. Multiple accesses are allowed and encouraged. Residents completed these modules between June 23 and October 31 of their first academic year. Content is applicable to both inpatient and outpatient settings. We included resources from the American Diabetes Association, the American Association of Diabetes Educators, and significant diabetes-related clinical trials, among other content. Citations are in each module. A follow-up survey (Appendix I) is also provided.

Users at our institution accessed the modules via our learning management system. After a pilot period, the full curriculum launched with the categorical residency class beginning in academic year 2013-2014 as a required learning activity with completion enforced by the program directors.

## Results

We required completion of the curriculum by an assigned date, but residents chose any day or time for access based on their schedule. Residents had access by the first day of their internship and completed the activity by October 31. Our learning management system hosted the content, which also allowed us to track the dates and times of use. Residents largely chose to access the modules between noon and midnight; however, 9% of the time, the modules were accessed during overnight hours (defined as between midnight and 5:00 a.m.). The modules were also accessed every day of the week, including weekends, although they were accessed the least on Friday and Saturday. Residents retain access throughout their training, and approximately a third of residents voluntarily accessed modules as either second- or third-year residents.

We approached assessment three ways: a survey of the class at the end of the first training year, tracking resident scores on the endocrinology section of the in-training exam (ITE), and reviewing the diabetes quality indicators in the resident primary care clinic. No identifiable patient protected health information was collected at any time. The ITE is administered in the fall of each training year and is standardized in content. We opted not to use a pre- and posttest as these would not be proctored. The survey was designed by us and distributed 6 months after the residency-wide completion date. For clinical data, the quality indicators for diabetes care were collected as part of the Physician Quality Reporting System and were tracked for this period.

Survey data were collected and managed using REDCap (Research Electronic Data Capture), a secure, web-based application designed to support data capture hosted at Drexel University.<sup>16</sup> The survey was voluntary and anonymous, with no means of identifying an individual respondent. There were two sections of the survey, one to assess the curriculum and one to assess the exposure to diabetes care and

confidence in management. Questions regarding confidence followed a modified Likert scale. The survey included a question about an endocrine elective experience, as this could be a confounder. Residents could respond to the survey once from April to June of the first year of training. We received responses from 23 (18%) of the total eligible residents over the course of 3 years. Approximately 50% of respondents completed an endocrinology elective as either a medical student or first-year resident. Overall, the majority of respondents felt that the modules had the correct amount of content, the online format was adequate, their understanding of diabetes was enhanced, and the curriculum led to altering their care (Table 2). The questions pertaining to confidence based on the modified Likert scale are helpful for identifying areas where the curriculum can be expanded. We can also target additional learning activities to various clinical situations surveyed. Residents felt more confident when diabetes was seen in the inpatient setting. Despite a small survey response, we felt that the voluntary and anonymous nature of the survey contributed to an honest assessment of the experience.

**Table 2.** Survey Response for Modules<sup>a</sup>

Survey Question	Affirmative Responses: N (%)
I found the curriculum to contain the right amount of information.	20 (87%)
I found the online format was adequate for my learning needs.	20 (87%)
The Diabetes for Residents curriculum enhanced my understanding of diabetes care.	20 (87%)
I found the overall Diabetes for Residents curriculum has altered my care.	18 (78%)

<sup>a</sup>A total of 23 respondents from three residency classes participated in the voluntary online survey.

Since the ITE was standardized and required of all categorical students, we used the change in the residents' ITE results for endocrinology-related questions from 2011 to 2015 as an outcome. We understood this to be a rough estimate of overall knowledge. On average, the ITE includes 20 endocrinology questions, with an average of 3.67 questions pertaining to diabetes mellitus each year (we did not track diabetes questions in other content areas). We compared the residents' rank in endocrinology content area from highest to lowest percentiles. This was taken as a total score of the residency, not subdivided by residency class. As there are 11 content areas on the ITE, we ranked them with ordinals from 1 to 11. Scores prior to the curriculum had endocrinology being the seventh (in 2011) and ninth (in 2012) content areas. From 2013, endocrinology is now one of the top three content areas on the ITE for our residency as a whole.

Our initial approach included a clinical outcome arm of diabetes care in the internal medicine primary care clinic. The data included the total number of patients in the resident clinic population with diabetes, the percentage of patients with A1C levels greater than 9% and LDL cholesterol levels of less than 100 mg/dL, and the percentage with documented diabetes eye exams. These measures remained unchanged when comparing our baseline year to the end of our 3-year evaluation period. Thus, the same number of patients with A1C levels greater than 9% had documented dilated eye exams, and lipid panels with cholesterol levels of less than 100 mg/dL were similar from calendar year 2012 to calendar year 2015.

## Discussion

Through utilizing a computer-based learning activity, we maximized participation in an educational activity for one of the most common diseases in adult medicine. The educational content covers several topics in diabetes care in one curriculum that delivers an estimated 3 hours of educational content without needing face-to-face lectures, which can only occur on weekdays. With the varied backgrounds of our residents, we hoped to establish a foundation for further learning in diabetes. As this was a required learning activity, the support of the residency program director was essential to the implementation of the curriculum. The residents had few technical issues accessing the material, and several residents voluntarily accessed modules again in the second and even third training years.

Our assessment included an end-of-academic-year voluntary survey tracking clinical outcomes in the resident primary care clinic and tracking the endocrinology sections in the ITE. Each has its limitations. While the ITE has a limited number of diabetes questions, it is a standardized exam with diabetes questions that draw from any aspect of diabetes. The residency-wide endocrinology scores improved over this time. We theorize that by delivering the fundamental diabetes content to all residents with this curriculum, more effective teaching of general endocrine material may have occurred. This would have the combined effect of increasing the overall ITE scores in endocrinology. Clinical outcomes in the resident primary care clinic were unchanged. Certainly, this is a challenging patient population, but the lack of outcome change also underscores how improving medical knowledge is only the first step in improving clinical care. Responses from our voluntary survey supported the use of the format and the amount of content provided. The survey also identified areas of need for additional instructional material. Respondents to the voluntary survey were more likely to have taken an endocrinology elective, which allows for implementing the material from the curriculum.

The modules also allows for programs to use them in different ways. Programs may use all modules or selected modules that fill a niche in their diabetes educational materials. Our program is large, but small programs could benefit from the modules as well. Residents may complete the modules individually or in groups as a team-based learning activity with a facilitator. Programs may apply a variety of assessment techniques to the modules, such as written exams or an objective structured clinical examination. We elected not to use pre- and posttesting of medical knowledge as an outcome due to our large program size. Also, ours would not be a proctored activity, and all answers would be open book. However, the modules allow for flexibility of assessment based on a program's particular needs.

In summary, this curriculum allows for additional educational content to be delivered to first-year internal medicine residents without the barriers of traditional lectures. We envisioned the modules to be used by an individual trainee, but they can be done as a group activity. Content not only is applicable to internal medicine residents but also may be used by family practice residents and learners in other professional programs who care for patients with diabetes mellitus.

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#### Ethical Approval

This publication contains data obtained from human subjects and received ethical approval.

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