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The Time Is Now: Diabetes Fellowships in the United States

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Abstract
Purpose of Review Diabetes is a complex and costly chronic disease that is growing at an alarming rate. In the USA, we have a shortage of physicians who are experts in the care of patients with diabetes, traditionally endocrinologists. Therefore, the majority of patients with diabetes are managed by primary care physicians. With the rapid evolution in new diabetes medications and technologies, primary care physicians would benefit from additional focused and intensive training to manage the many aspects of this disease. Diabetes fellowships designed specifically for primary care physicians is one solution to rapidly expand a well-trained workforce in the management of patients with diabetes.
Recent Findings There are currently two successful diabetes fellowship programs that meet this need for creating more expert diabetes clinicians and researchers outside of traditional endocrinology fellowships. We review the structure of these programs including funding and curriculum as well as the outcomes of the graduates.
Summary The growth of the diabetes epidemic has outpaced current resources for readily accessible expert diabetes clinical care. Diabetes fellowships aimed for primary care physicians are a successful strategy to train diabetes-focused physicians. Expansion of these programs should be encouraged and support to grow the cadre of clinicians with expertise in diabetes care and improve patient access and outcomes.

Keywords Diabetes · Primary care · Diabetologists · Fellowship · Training programs

Introduction

Type 2 diabetes mellitus is a chronic progressive disease on a course to destabilize the US health care system. At present, one in nine adults have diabetes and one in five US health care dollars is spent on persons with diabetes. The care and cost of

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care for this population are not sustainable with existing medical training and health care delivery models. To meet this challenge, we will need new and innovative approaches and collaboration from multiple sectors of the health care system. It is well known that the existing health care provider workforce is not sufficient to address the growing epidemic of diabetes. At present, there are not enough endocrinologists to meet the current clinical need, not to mention the projected growth of this patient population. Therefore, the great majority of people with diabetes are managed solely by their primary care providers. One obvious solution is to better train the primary care workforce to overcome the challenges of comprehensive diabetes care and prevention of its complications. While this concept has been more readily adopted in other countries, there is a dearth of such programs here in the USA. However, a few programs do exist in which physicians in primary care can intensify their knowledge and skills by completing a diabetes fellowship. This approach has the potential to develop a large cadre of well-trained "diabetologists" to serve on the frontline. This article will focus on the need for such programs, and provide a historical review, as well as the current experience of the two existing programs in the USA. Our aim is to justify the expansion of these programs so that we can improve patient access and provider readiness for a trajectory of the impact of diabetes on the future US population and health care system.

The Need for Diabetology Training Programs

There are many compelling reasons justifying the need to expand diabetes training programs among primary care physicians. Perhaps no single issue is more convincing than the profound growth in the prevalence of diabetes mellitus in our nation. As shown in Fig. 1 from the Centers for Disease Control and Prevention (CDC), the prevalence of diagnosed diabetes in adults has approximately doubled in the USA as a whole over the last 20 years [1•]. This equates to an estimated 30.3 million individuals living with diabetes in the USA. In addition, there are an estimated 84 million individuals living with pre-diabetes, suggesting that the prevalence of diabetes will remain high for at least the next decade. The CDC currently estimates that one in three Americans will have diabetes in their lifetime by 2050 [1•]. Further, Barker and colleagues have identified a "diabetes belt" in southeastern USA in which diabetes prevalence has exceeded 11% of the population [2]. Particularly concerning is the higher prevalence rates of diabetes in racial and ethnic minorities with African Americans, Hispanics and Latinos, American Indians, Pacific Islanders, and some Asian Americans having a higher risk than Caucasians. As the USA becomes a country with a minority majority, we anticipate that the rates of diabetes will continue to rise. Unfortunately, many of these geographically identified and/or racial and ethnic minority populations with higher prevalence rates may also have limited access to state-of-the-art diabetes care. Taken together, these data suggest that there is a tremendous disease burden and that some areas of our nation as well as some population subgroups are experiencing greater than average prevalence rates.

Another convincing reason to train more primary care physicians to be experts in diabetes is the simple fact that most individuals with type 2 diabetes mellitus (T2DM) (estimated 90–95% of people with diabetes) are managed in primary care settings and not by endocrinologists. This is largely due to the high prevalence of the disease and a shortage of endocrinologists. In a study conducted by the Lewin Group in 2014 on behalf of the Endocrine Society and the Association of Program Directors in Endocrinology Diabetes, and Metabolism, there was already an estimated shortage of 1484 full-time equivalent endocrinologists in the USA, and this shortage was expected to persist through 2025 [3••]. Furthermore, some endocrinologists may also limit their practice to thyroid disease and/or other specific endocrine disorders resulting in further reduced capacity to see the growing number of patients with diabetes. As a result, the 2008 Medical Expenditure Panel Survey (MEPS) by the Agency for Healthcare Quality and Research reported that 85% of patient visits for diabetes are with non-endocrinologists [4]. While most adult primary care training programs (i.e., family medicine, internal medicine, and internal medicine/pediatrics) include training in the management of diabetes, the training is limited and not proportionate to the number of people who seek care for diabetes. Further management is learned in the specialty or inpatient settings which have limited applicability to the typical general primary care practice. Moreover, specialized populations such as type 1 diabetes (T1DM), pediatric diabetes, and diabetes during pregnancy are subgroups that many primary care providers are not comfortable providing care for at the end of their training. Additionally, over the last 15 years, our nation has witnessed a fast and explosive growth in the number and types of anti-diabetic medications available. This has led to a significant knowledge deficit in how to optimally initiate, dose, and monitor the growing number and complexity of diabetes medications in the primary care setting. As the prevalence of diabetes has increased, managing patients with T2DM now consumes a significant proportion of the primary care provider's time and the complexity and time required to optimize treatment can create hardships in busy primary care settings. It has been estimated that a typical primary care physician needs 3.5 h per day to properly manage the patient's top 10 chronic conditions [5]. This results in a constant struggle in the priorities of a primary care visit and therefore inadequate diabetes management. Data as of 2010 demonstrates that only 52.5% of patients with diabetes have achieved the recommended A1c of < 7.0% and less than 20% of patients have achieved all three targets for A1c, blood

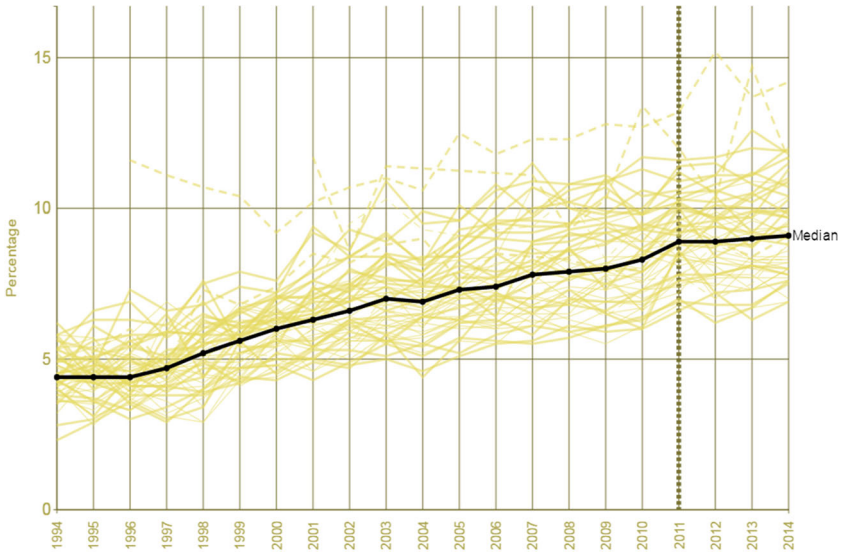

Fig. 1 Age-adjusted percentage of adults with diagnosed diabetes—total in USA (from https://www.cdc.gov/diabetes, accessed June 1, 2017) [1•]

pressure, and LDL that are recommended by clinical guidelines [6]. These factors suggest the need for expanded training in primary care to improve the comprehensiveness and quality of care for the growing number of patients with diabetes.

Finally, there is a clear deficit in access to care for some high-risk and/or vulnerable population groups not currently well served by the limited number of endocrinologists. The limited number of endocrinologists in the USA are focused around academic centers [7••]. In addition, the current graduating endocrinology fellows that will make up the future workforce are now 70% female. Female physicians are more likely to work less hours to maintain work-life balance, further limiting access to specialty care in this field [8••]. Many high-risk patient groups live in rural and/or underserved communities—areas where endocrinologists are not often available and which are primarily served by primary care providers. These primary care providers are on the front lines of managing complex diabetes cases, often in settings with limited resources [9].

Ideal Candidates for Clinical Diabetes Fellowship Programs

The diabetes fellowship programs are aimed at intensifying diabetes management in various clinical settings for primary care physicians. The most suitable candidate would have completed residency or be board certified already in a primary care-oriented field such as family medicine, internal medicine, pediatrics, and internal medicine/pediatrics. After residency in their primary specialty, these physicians spend an additional year for more intensive training in the prevention of diabetes, types of diabetes in variety of patient populations, and the management of diabetes in both inpatient and outpatient settings. The additional training allows time to focus on specialized and comprehensive care for their patient with diabetes regardless of the ultimate choice of practice setting.

Joslin Clinic: the First Diabetes Fellowship

Dr. Elliot Joslin was a pioneer in the treatment of diabetes. In 1897, while a student at Harvard Medical School, his aunt died of diabetes and shortly thereafter his mother was stricken with the same disorder. At that time, diabetes was a terminal disease. The following year, Dr. Joslin opened a practice in Boston dedicated to treating patients with diabetes, later known as the Joslin Clinic. Until 1922, the only therapy for diabetes was a semi-starvation diet that would prevent ketoacidosis for at most a few years. There were very few physicians able to care for these patients at that time. However, with the discovery of insulin in 1922, many more physicians became interested in the disorder and came from all over the world to Boston to study with Dr. Joslin and his colleagues. Postgraduate training programs in the USA in these early days were very informal. Specialization in medicine had begun in the early twentieth century, but formal certification in most specialties did not begin until well after World War II.

Physicians who came to study at the Joslin Clinic would typically spend 1 year in clinical training and then return to their home states or countries to be clinical diabetologists. Those who were more academically oriented would follow that year with two or more years doing research in the Joslin Research Center. These physicians would typically become leaders in diabetes research, treatment, and education at universities all over the world. Some fellows joined the Joslin faculty of the clinic (and the Harvard Medical School) and became teachers of the next generation of diabetes fellows. In fact, many key opinion leaders in the field of diabetes

trained at the Joslin. One of these physicians was Dr. Fred Whitehouse who completed his medicine residency in Detroit.

In 1954, after his residency and a stint as a Navy flight surgeon in the Korean War, Dr. Whitehouse became a Joslin "fellow" at Joslin Clinic and the New England Deaconess Hospital in Boston. Dr. Whitehouse studied with Dr. Joslin as well as the other great diabetologists in the clinic: Drs. Howard Root, Priscilla White, and Alexander Marble, often referred to as the "Big Four." Whitehouse stated that "the strength of Joslin was the distinguished group he accrued who were high-quality, experienced, and specialized people in diabetes, not just some physicians who saw it on the side." Whitehouse noted that the "team approach, the idea of focusing on high control of treatment, was what Joslin became known for. There were no clinical trials then and the thought was that complications may be hereditary, but that it could be controlled by intense care. But that wasn't proven by data for almost 40 years." [10].

In 1955, after serving 15 months as a fellow, Dr. Whitehouse returned to his native Detroit to practices diabetes. He asked Dr. Joslin for a certificate of his training which he used to qualify for board certification in endocrinology. This was the first time that any of the Joslin fellows received a certificate [11]. For over the next 30 years, the fellowship remained as a standalone 1-year program. This meant that the fellows were required to train elsewhere for another year to be board eligible in endocrinology. In the late 1980s, the program was merged into a 2-year endocrinology fellowship.

Review of Existing Diabetes Fellowship Programs in the USA

There are currently two well-established diabetes fellowship programs in the USA, East Carolina University Brody School of Medicine in North Carolina (ECU) and Ohio University Heritage College of Osteopathic Medicine (OUHCOM), both having been started in 2004. The following is a synopsis of the experience of each of these two programs. The benefits gained by completing one of these programs are summarized in Table 1.

East Carolina University

Eastern North Carolina (ENC) is one of the areas in the "Diabetes Belt" which is defined by the CDC as counties with diabetes prevalence of greater than 11% [2]. Three counties in ENC fit this criteria with two counties having a prevalence of greater than 13% and another with greater than 14%. The high incidence in ENC may relate to a higher percentage of minority individuals and increased prevalence of obesity, poor health literacy, and limited access to health care. To better prepare physicians to care for this growing complex population with diabetes, Robert Tanenberg, M.D., obtained grant support from a local foundation and began a 1-year clinical diabetes fellowship in 2004. Using his extensive experience and training from the well-known Joslin Diabetes Center and grant support from a local philanthropic foundation, he created a diabetes fellowship for primary care physicians. The fellowship is a program within the Division of Endocrinology and the Department of Internal Medicine at the Brody School of Medicine (BSOM) of East Carolina University (ECU) in conjunction with Vidant Medical Center (VMC) and the ECU Diabetes and Obesity Institute (ECDOI). The VMC office of Graduate Medical Education (GME) sponsors the program and provides the funds for salary and benefits for the fellows. The details of this fellowship are published earlier [12••].

Table 1 Important elements of Diabetes Fellowship Program

In-depth training on comprehensive diabetes management including pharmacological and non-pharmacological therapies
Creating a multidisciplinary practice for delivery of effective diabetes care
Experience with specialized diabetes populations in various clinical contexts such as pregnancy, inpatient, and outpatient
Organized curriculum with didactic and clinical activities
Clinical research or quality improvement projects focused in diabetes
Experienced faculty with careers focused in diabetes
Accreditation/certification by well-recognized national organizations
Funding for trainee compensation and administrative costs

The program is a 1-year fellowship during which there is intensive focus on the comprehensive management of diabetes in adult, pediatric, obstetric, and geriatric patients with different types and stages of diabetes. The BSOM adult and pediatric endocrinologists and the maternal fetal medicine Ob-Gyn physicians precept in the BSOM Clinics as well as the inpatient setting at VMC, a 950-bed tertiary care teaching hospital in ENC. Over the academic year, diabetes fellows are required to spend a minimum of 10 weeks on a busy inpatient consultation service. They work alongside the endocrinology fellows and residents under the supervision of an endocrinology faculty member. The fellowship also includes training in nutrition, lipid management, obesity/pre-diabetes treatment, and complications of diabetes such as diabetic foot and wound care. Exposure to diabetes in specialized settings such as pregnancy and pre and post bariatric surgery is also integrated into their clinical experience.

The curriculum includes a didactic series of weekly diabetes lecture, endocrinology grand rounds, journal clubs, and many other specialty conferences. There is also a week-long diabetes boot camp which provides intensive training on diabetes technology including continuous subcutaneous insulin infusion and continuous glucose monitoring therapy. Fellows are expected to make two formal presentations for

endocrinology grand rounds and present articles at journal clubs on recent diabetes publications. Fellows are also encouraged to submit interesting cases, as well as quality improvement and research projects to the BSOM and Vidant GME research day programs, and national conferences including the annual American Diabetes Association (ADA) Annual Scientific Sessions. Fellows have produced publications in scientific journals of various types including abstracts, case reports, reviews, and original articles during and after completing the fellowship. Four of the ECU alumni have gone into academic medicine and have published 26 peer-reviewed articles on diabetes in respected peer-reviewed journals, e.g., Diabetes Care, Endocrine Practice, and the Journal of the Cleveland Clinic.

As of 2017, this innovative and successful program has trained 26 diabetes-focused primary care physicians. By specialty, there have been 16 internal medicine physicians, 7 family medicine physicians, 1 pediatrician, and 2 internal medicine/pediatrics physicians who completed the program (Table 2). Graduates of this program have established clinical practices throughout the USA with most graduates located in North Carolina, South Carolina, Florida, and California. However, one graduate has an international practice in Poland. Most of the graduates are in primary care settings with a diabetes focus including community health centers in underserved areas, academic institutions, and primary care or endocrinology solo and group practices.

In 2011, the eighth year of the diabetes fellowship, the Division of Endocrinology began a traditional 2-year, ACGME-certified endocrinology fellowship under the direction of another faculty member. Since 2013, there have been six fellows in training at all times. The two programs have been synergistic for both the learners and faculty. There are now many more participants at the diabetes conferences, core lectures, and endocrinology grand rounds. When there are both a diabetes fellow and an endocrine fellow on the inpatient service, patient care, learning, and time management are enhanced for the fellows as well as the faculty. Additionally, having the two types of fellowships has increased the attractiveness of potential applicants for both programs.

Table 2 Graduates of the ECU and OU-HCOM Diabetes Fellowship Programs

Demographics	East Carolina	OU-HCOM
Gender		
Female	15	8
Male	11	8
Degree		
MD	26	9
DO	0	7
Residency		
Family medicine	7	9
Internal medicine	16	6
Pediatrics	1	1
Med/pediatrics	2	0

Ohio University Heritage College of Osteopathic Medicine

Appalachian Ohio has historically been a medically underserved area as well as an area with a high prevalence of diabetes. In 2013, the CDC estimated that Athens County had a diabetes prevalence of 11.1% with other counties in the region up to 17% prevalence of diabetes [13•]. Frank Schwartz, MD, an endocrinologist from Parkersburg, West Virginia, joined the faculty at Ohio University Heritage College of Osteopathic Medicine (OUHCOM) and quickly recognized the need for diabetes care in the area. In 2004, he and Jay Shubrook DO, a family practice physician, began a diabetes fellowship with the support of OUHCOM. This fellowship was also designed to train primary care physicians in comprehensive diabetes management and its complications. The program is 1 year long and produces primary care physicians whose expertise and focus is diabetes. The program has been funded by different entities over the course of its existence including philanthropic organizations, major local academic centers, and educational grants from pharmaceutical companies. The program had one fellowship position per year until 2012, at which time it grew to two positions in two locations, Ohio and West Virginia. Currently, the program obtains funding from two local participating hospital systems. As of 2017, the program will have trained a total of 16 primary care physicians with expertise and focus in diabetes over its existence.

During the year of diabetes training, the fellows gain clinical experience in both inpatient and outpatient settings. The outpatient experience includes a routine consultation and longitudinal clinic within the diabetes center but also includes a volunteer position at the college's monthly free diabetes clinic. On the inpatient diabetes rotation, fellows take diabetes call 2–3 days during the week and then two weekends per month and are responsible for the inpatient diabetes consultations under the supervision of the attending diabetologist or endocrinologist. Diabetes fellows also complete a week of diabetes camp, the ADA Postgraduate course, a rotation at Joslin Diabetes Center in pediatrics, and the ADA Scientific Sessions. Like the ECU program, the curriculum includes weekly didactic sessions on diabetes-related topics and journal clubs at which the fellows present on at least a monthly basis. During the fellowship year, each fellow is encouraged to engage in a research study related to diabetes. They are expected to design a project, obtain Institutional Review Board (IRB) approval, and execute their study with the support of the Clinical Translational Research Unit and mentoring of a program faculty member. Fellows are expected to submit a manuscript to a

peer-reviewed journal. Some of the areas of previous research projects have included management insulin protocols in the hospital, use of specific pharmacotherapies, hypoglycemia, the role of nutrient supplements in glucose control, insulin-resistant states, and diabetes management in special situations such as schools, ICU, and nursing homes. Their work has culminated in publications such as review articles on complementary and alternative medication in diabetes, prevention of cardiovascular complications, and the role of artificial sweeteners. Additional academic achievements include case reports and abstracts with poster presentations at various conferences during the time that OUHCOM has had its diabetes fellowship program.

By specialty, six internal medicine physicians, nine family medicine physicians, and one pediatrician have completed the program (Table 2). After completion of the program, the 16 OUHCOM graduates have been practicing in various clinical settings across the country: outpatient, inpatient academic, primary care including family medicine, internal medicine, and pediatrics, hospital based, as well as multispecialty practices. One graduate pursued an endocrine fellowship while the others have been able to practice as diabetologists in either primary care or endocrine practices. While the majority of graduates of the OUHCOM program are practicing in Ohio and California, others are practicing in other states including Washington, Oregon, and Pennsylvania. Some graduates have become affiliated with highly regarded academic institutions across the country and has resulted in more than 50 peer reviewed publications.

Accreditation and Recognition

For these training programs to be grown, they must also be acknowledged with certification. The graduates of these programs have spent an additional year of training with only institutional recognition of their expertise. This continues to be a barrier for the graduates and a concern for applicants to the programs. Formal accreditation bodies have not been involved in certification to date. Often, this leads insurance companies to classify these physicians as traditional primary care physicians rather than a consultant. Despite additional training in diabetology, these physicians accept less compensation than even a traditional primary care physician because the recognition is not secured.

One option would be to pursue accreditation through the Accreditation Council for Graduate Medical Education under a subspecialty. Another option for certification is to develop programs by professional societies in diabetes, with the curriculum and certification maintained and endorsed by the society, similar to those in hypertension and lipidology. Most importantly, this accreditation/certification should be recognized by employers and payers for appropriate compensation beyond primary care medicine. An additional financial benefit will attract more primary care providers to seek training and distinguish them beyond the usual peers. Payment models would need to account for the time and complexity involved in the treatment of these complex and multifaceted disease processes. Currently, hospital systems are paying the expenses of these programs but to grow their will need to be additional revenue streams. Recognition and compensation will promote the growth of diabetes training programs and readily increase the workforce of physicians who are skilled in combating the growing diabetes epidemic.

At this time, advanced practice providers (APPs) such as nurse practitioners and physician assistants are not eligible to train in the existing training programs. Future efforts could consider adding these clinicians to the training programs so that all primary care providers have the opportunity to gain training in comprehensive diabetes management. There have been APPs that have practiced in these settings and gained diabetes expertise on the job while collaborating with the endocrinologists and diabetologists and are now practicing with a more diabetes-centered focus in primary care settings; however, the training has not been as formal as that of the physicians who have trained in these programs.

Conclusion

The US health care and medical education system is facing potential disaster in the current diabetes epidemic because of insufficient access to expert clinicians who are highly skilled in the complexities of diabetes management. The authors posit that focused training in carefully designed diabetes fellowships has the potential to ameliorate this crisis by greatly expanding the workforce of primary care physicians and other providers with competence in the expanded skill set required for state-of-the-art management of diabetes and its complications. To succeed in this effort, we call for the collaboration of medical education institutions, certification organizations, both primary care and endocrinology professional societies, funding organizations, and policymakers. The time has certainly come to create a multifaceted approach to address the shortage of care for the burgeoning diabetes population.

Dedication

This manuscript is dedicated to the memories of Christopher A. Newton, MD (Endocrinology), and Michael J. Lewis, MD (Family Medicine), both beloved faculty members instrumental in starting the ECU Diabetes Fellowship, who left this world much too soon.

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Compliance with Ethical Standards

Conflict of Interest Robert J. Tanenberg, Shivajirao Patil, Doyle M. Cummings, and Archana R. Sadhu declare that they have no conflict of interest.

Amber M. Healy reports that Ohio University Heritage College of Osteopathic Medicine pays part of her salary.

Jay H. Shubrook reports that he has received fees from the American Diabetes Association for being a speaker (Diabetes is Primary), from Novo Nordisk and Lilly for being a consultant, and from Medicine Matters Diabetes of Springer Nature for being on the International AD Board.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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