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HOSPITAL MANAGEMENT OF DIABETES (A WALLIA AND JJ SELEY, SECTION EDITORS)

Innovations in Professional Inpatient Diabetes Education

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Abstract

Purpose of review In the rapidly evolving and complex field of inpatient diabetes, complex care teams of physicians, nurse practitioners, physician assistants, nurses, and pharmacists are challenged to remain well informed of the latest clinical treatments and health care trends. Traditional continuing medical education (CME) and continuing education unit (CEU) strategies that require travel and/or time away from work pose a major barrier. With advancements in technology, there are media and other electronic strategies for delivering CME/ CEU that may overcome these current challenges.

Recent Findings Electronic and internet-based formats are growing due to their convenience, ease of use, lower cost, and ready access to large audiences. Some formats are already being used such as computer-based programs, simulations, and mobile CMEs and CEUs. Other strategies could be further explored including hospital credentialing, stewardship programs, and interdisciplinary health care professional education. However, there is little data on the utilization and efficacy of these newer formats.

Summary While traditional CME/CEU meetings prevail, there is a need and an emerging trend using electronic and internet based strategies that are particularly suited for inpatient diabetes education. These methods show great potential and deserve further exploration and development.

Keywords Inpatient diabetes · Professional education · Continuing medical education · Innovative education

Introduction

In an environment of evidence-based practice, health care is rapidly evolving with advancements in all specialties. Clinicians such as physicians, nurses, and pharmacists are challenged to research and review the most current literature to keep up to date on new developments in patient care. However, the sheer volume of information that a health care provider needs to review as well as increasing time constraints in current practice can be overwhelming. One traditional method to help physicians and other clinical providers accomplish their goals of education is through continuing medical education (CME) or continuing education units (CEU) courses, usually arranged at a location where learners gather to hear expert speakers. These courses were designed to condense the utmost important information in a didactic format that clinicians have traditionally used to learn. Health care professionals such as nurses and pharmacists may also acquire CEU via journals, or online companies that provide courses on a fee-schedule versus the traditional method of professional meetings.

In endocrinology, inpatient diabetes management is considered challenging since every patient's management of blood glucose can differ. Very often, the patient's home regimen may require significant modifications such as transition from oral agents to basal-bolus insulin regimens due to acute medical conditions and other therapies that result in alterations in the blood glucose patterns and an increase in the potential for adverse effects (e.g., high-dose steroid therapy, enteral feedings, contrast studies, surgery, and sepsis). To prepare health care professionals with the necessary tools, education focused on inpatient diabetes management is necessary, especially

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when inpatient diabetes consultation services are not available or are limited.

CME/CEUs are ubiquitous and provide information for all providers in their respective fields. In this age of technological advancement, providers have even more opportunity to improve their skills in health care delivery. In inpatient diabetes management, multiple approaches can be utilized to assist providers in the management of patients. The advancements in pharmacotherapy and diabetes technology that occur each quarter are so fast-paced that a provider's knowledge in diabetes management can easily fall behind. In this review, we will describe current CME/CEU methods and their shortcomings and propose newer alterative options for the future with respect to inpatient diabetes education.

Overview of Current CME/CEU Methods

It is indisputable that health care professionals need CME/CEUs to continue to maintain a high-quality and effective clinical practice. Currently, 62 board certification programs in the US require CME credits for physician licensing. For nurse practitioners, the American Nurses Credentialing Center (ANCC) and the American Academy of Nurse Practitioners (AANP) both require either a minimum of 100 h of continuing education every 5 years (25 CEs must be advanced practice pharmacology) or by retaking the certification exam (if available) while holding licensure during the period of certification. Physician assistants have a National Commission on Certification of Physicians Assistants (NCCPA) certification requirement of 100 h of continuing education every 2 years to maintain certification [1–3]. Most health care professionals can achieve the requirements by attending live meetings that are held on specified dates and locations. This usually requires that the providers travel to the meeting and spend anywhere from 1 to 5 days away from their clinical practice so that they can immerse themselves in all the latest information presented by expert speakers in the field. In recent years, another common option is with electronic course recordings that can be viewed at the provider's convenience. In regards to physicians, many professional organizations such as the American College of Physicians, The Endocrine Society, and American Association of Clinical Endocrinologist (AACE) have designed hundreds of online CMEs available to cover a wide range of interests and learning styles. Recently, new mediums are being used which vary widely from WebMD iPhone app to cruises accredited by the Accreditation Council for Continuing Medical Education (AACME). The traditional and non-traditional methods for CMEs for physicians are outlined in Tables 1 and 2, respectively.

Similar to physician CMEs, nurses and pharmacists have to complete certain requirements to renew their license annually. Nurses and pharmacists both use Continuing Education Units (CEU) to keep current in the latest health care practices and techniques while the latter also needs to have certain amount of contact hours (depending on state) of continuing education activity as well. Several options are available for nurses to obtain the required CEU that include hospitals offering CEU courses in house, pharmaceutical/equipment company-sponsored events, or by their nursing societies in the form of symposiums or lectures. However, online sites where CEUs are earned as quickly as possible continue to be very popular among nurses (Nurse.com, Nurseceu.com, RN.com, CEUsforfree.com, etc.). The American Association of Colleges of Nursing and the Commissions on Nurse Certification also lists nationally accredited CE providers on their websites. The American Pharmacy Association (APhaA) is recognized among pharmacists as a reliable provider of continuing pharmacy education (CPE). Members receive free access or discounts to a variety of CPE formats-in-person, live-webinar, and self-paced learning delivered by specialists in their field [4].

Current Challenges of CME

A universal challenge for most health care professionals is allocating time to obtain CME/CEU credits. Prescribers (physicians, nurse practitioners, and physician assistants) with high volume patient panels and even those with shift-dependent specialties find that taking time off for several days to attend a professional conference is a major barrier. This has even led some CME/CEU providers to use an external incentive to increase participation.

As the internet becomes more integral in our daily life, it seems to be an ideal medium for knowledge transfer, but it is also not without challenges. Curran and Fleet describe that the three main challenges to online CME include: 1) ensuring

Table 1 Available traditional CME methods

Methods	Description	Available resources offering CME credits	Average time requirement
Grand rounds	A weekly conference that features national and international speakers	• Offered in academic centers	1–2 h per session
Professional society meetings	Annual conferences held by various professional societies that feature the latest advancements in endocrinology.	• ADA • AACE • Endocrine Society	An average of 2–5 days per year per society

Table 2 Available non-traditional CME methods

Methods	Description	Available resources offering CME credits	Average time requirement
Podcasts	Medical audio broadcasts that can be played using several platforms; web pages, iTunes, handheld devices, etc.	• Medscape • UpToDate • AACE Clinical Conversation Series • Clinical Endocrinology News • Diabetes Discourse (ReachMD) • American College of Physicians • Peervoice • Mayoclinic	Majority are 15–19 min
Mobile	Presenting CME to physicians through a digital medium, most commonly via mobile app	• Medscape • E-Medicine • Merck Medicus • Epocrates Mobile • Qstream • Quantia MD • WebMD	Average length is 30 min
Simulations	Simulation based medical education	• UCLA Simulation Center • Baylor Simulation Center • Penn State Simulation Center • Center for advanced medical learning and simulation (CAMLS) • Texas Tech University – El Paso; Center for advanced teaching • Florida Hospital – Nicholson Center	Varies depending on specialty. Some courses are six-hours long.

learners have the computer skills, 2) attracting learners, and 3) developing a valid curriculum [5]. At this time, it remains unknown whether health care providers avoid online CME due to lack of computer or online skills and up-to-date computer equipment, but this is expected to diminish over time. Additionally, many online CME courses often resemble their traditional paper-based book counterparts and are just mere substitutions for older formats [6]. Online CME carry the potential to enhance prescriber learning and implement a change in clinical behavior but only if executed well. Whether the venue of CME courses is a physical gathering or online, the impact of traditional methods on optimal clinical practice remains uncertain, leaving opportunity for innovation and implementation of more effective methods. Crenshaw et al. explored the link between physician web-based CME participation and their patients' A1C level. One hundred thirty-three participating physicians (intervention = 64; control = 69) provided information for 1637 patients with diabetes. They assessed the total number of pages viewed of a web-based CME course to improve diabetes care and its correlation with A1C. As the total number of pages viewed decreased, so did A1C control (137, 73, 68, 57; $P = .007$); while for a given 10% increase in the proportion of patients with controlled A1C, physicians viewed 1.13 times more pages (95% CI: 1.02–1.26, $P = 0.02$) [7]. This study shows that web-based CME provides physicians with a powerful resource to optimize care to patients with diabetes, but unfortunately is not widely used. Identification of learners' needs is essential to building an effective CME curriculum. Additionally, health care providers are faced with the challenge of keeping up with the ever-growing body of knowledge in their own field, and this may limit their ability to expand their knowledge in other highly focused areas, like inpatient diabetes.

Future Directions of Inpatient CME/CEU Using Nontraditional Formats

Computer-Based Programs or Virtual Simulations

Due to the tremendous advancements in computer technology, the age of software simulations has progressed to where individuals, professional organizations, and even hospitals can incorporate this technique into their CME/CEU courses. In fact, this strategy has been so highly regarded, that it is now used in today's United States Medical License Exams (USMLE) as part of the computer-based exam.

The concept of computer-based simulations is not foreign as demonstrated by the international popularity of modern video games that revolve around virtual simulations. Through these video games, people can enter a mimic environment with unimaginable limits and perform a variety of tasks, each with potentially different outcomes. Using the same premise, physicians, residents, and medical students can now learn in a simulated environment without the real-life consequences of failure. This allows reinforcement of concepts they need to master and practice safely and effectively with their own patients.

Tatti and Lehmann showed one example of this advancement using the AIDA Diabetes Simulator. The main aim of this study was to provide the AIDA diabetes simulation tool "as a teaching tool for general practitioners (GPs)." The study

recruited 60 primary care physicians with the primary objectives of providing an overview of metabolic management in diabetes. They offered different methods for diabetes therapies with detailed explanations of those methods, and highlighting the complexities of diabetes management when accounting for insulin, meal planning, and daily activities. To accomplish this, these physicians attended a day-long workshop with two different sessions. Session 1 consisted of three different physicians giving an overview of diabetes and theory behind the use of simulations in medicine. Session 2 consisted of the physicians being split into small groups to perform preset simulation scenarios. After the conclusion of the sessions, physicians filled out surveys to give qualitative feedback to the investigators to see if their objectives were met. The feedback gathered from the GPs showed a positive response to this method of education; however, the authors did not include the detailed analysis of the responses for the survey [8].

Diehl et al. used an electronic game as an option to further educated physicians through a new approach. In their study, the objective was to assess the effectiveness of their game, InsuOnline, through applicability, user acceptance, and education effectiveness. They recruited primary care physicians from South Brazil either by phone or email to enter this unblinded, randomized controlled trial and were assigned to either the intervention group (electronic game) or control group (onsite lectures and case discussion). Both groups had same content and duration of 4 h with focus being on factual knowledge, problem-solving skills and attitudes that was assessed by a questionnaire administered before, immediately after, and 3 months following the intervention. Results from this study showed no difference in applicability (78% vs. 89%; intervention vs. control). The study also showed improvement in the competence scores, with initial scores (at baseline) 52% for both groups with the interventional group reaching 92% and the control group reaching 85% ($P < .001$.) post-intervention. The authors also examined the competence score 3 months after the intervention in which a similar pattern was noted (80% intervention vs. 76% control; $P < .001$). The absolute increase in competence scores was 40% in intervention group vs. 34% in the control group ($P = 0.1$). Participants found the intervention "fun, pleasant, useful, and practice-changing." It was also noted that 98% of participants in the intervention group would recommend this game to their friends [9•].

Sullivan et al. utilized an online educational module to reduce insulin administration errors by nursing staff in hospitalized pediatric patients. The study design used a mandatory online educational module instructing nurses on insulin pharmacokinetics, the insulin order form and use of diluted insulin with 15 interactive cases. The impact of this online module was a reduction in insulin error rates from a baseline of 14.8 to 1.7% ($P < 0.0001$) after the educational intervention [10]. This is another example of the effectiveness of computer-based modeling in training health care professionals and improving patient outcomes.

Computer-based programs have also been reported in house staff training programs by Vaidya et al. in their study on diabetes management in hospitalized patients. Like the previous model, this group designed a computer-based diabetes training with the goal of improving house staff knowledge and comfort in the management of inpatient diabetes. It required the house staff to answer a series of questions pre- and post-intervention to determine if their comfort and knowledge improved. The authors reported that the knowledge level of all providers did improve ($P < 0.02$) with the smallest increase in senior house staff. In addition, the authors noted an increased use in the preferred basal-bolus insulin therapy as compared to the sliding scale insulin method. However, the investigators did not achieve statistical significance likely due to small sample size and short duration of study [11].

Tamler et al. used web-based educational interventions successfully in various specialties to polish and enhance clinical practice. In this study, 129 medicine residents (117 completed the initial training) at a large academic medical center underwent a case-based online curriculum in the fall. All residents underwent specific training courses based on their current level of training with the addition of an optional 20-min refresher course in the spring. At the end of the course, 11,089 blood glucose values and 4799 event blood glucoses values were analyzed from a pool of 299 hospital admissions. These hospital admissions with target glycemia increased from 19.4 to 33.0% ($P = 0.055$) without increased hypoglycemic events [12].

Wakefield et al. studied nursing staff knowledge using an e-learning method for teaching standards of diabetes care. The study was a prospective, randomized controlled study in a south Texas health system in which no formal diabetes education was in place. Initially, 202 nurse participants were assigned equally to either the intervention or control groups. The intervention consisted of a 4.2-h interactive, self-paced, audio PowerPoint with 14 individual chapters and chapter-specific quizzes. Three different overall tests (pre-test, post-test, and 3 months follow-up test) were used to measure knowledge. Their findings were pertinent for the following: 1) significant gain in raw mean scores of 35% for the combined test (factual and applied knowledge) with an effect size of 0.97, 2) retention of knowledge when participant scores of the post-intervention and 3 month follow-up tests were compared, and 3) need to focus on applied knowledge within nursing education [13].

Taylor et al. designed an educational program that guides physicians through the different steps of a patient's hospital course (admission through discharge) while teaching avoidance of common errors and providing opportunities for providers to familiarize themselves with local charts and protocols. The target group consisted of physicians from 4 different

hospitals that had graduated within 4 years of completion of their medical training. The endpoints were measurements of the quality of care provided and the confidence of the junior physician before and after the intervention. Out of 242 participants, only 85% completed the study, of which 94% stated that the program was either very or extremely easy to understand. In the other endpoint, the mean confidence score increased from 17.6 to 24.9 ($P < 0.001$) with reduction of 49% (15.4% before and 7.8% after, $P < 0.05$) in insulin prescription errors. These results showed that an inpatient diabetes education program deliverable in 1 h can increase physician confidence and quality of inpatient diabetes care [14].

All of these studies show support for an emerging trend in the use of computer-based education in inpatient diabetes management. Further evidence is needed to determine the full effect and utilization as CME/CEU evolve in this area.

Podcast

Podcast is a media format that uses audio to convey the author's message on a specific topic to their audience. The podcast is not a new concept and has been in existence since the mid-2000's [15]. However, it is still underutilized in today's academic teaching methods. The advantages of the podcast are convenience, easy formatting, and the ability to convey information to an unlimited population without hosting a large meeting. Moreover, it is at a lower cost when compared to traditional CME meetings and can focus on a vast number of topics with ease.

A few organizations and independent companies are using this format to provide updates to health care providers (Physician, PA, and NPs), pharmacists and nurses. These groups include Medscape (Medscape Diabetes & Endocrinology Podcast), PeerVoice (Endocrinology & Metabolic Disorders), Clinical Endocrinology News, Diabetes Discourse (ReachMD), and AACE Clinical Conversation Series for physicians and other clinical providers. Groups that cater to nurses specifically include Medscape Nurses Podcasts, Traveling Nurse Insider Podcast, The Nursing Show, and Dartmouth Hitchcock Medical Center Lectures. Additional podcasts like Best Science Medicine Podcast or Medscape Pharmacists Podcast can cater to all clinical professionals with a special interest for pharmacists. There is not yet any robust data on the efficacy of the podcast as an educational tool in medicine, but based on the popularity of its use in other areas, it has potential to be successful in this area.

For inpatient diabetes education specifically, hospitals and professional societies should further explore the use of podcasts to focus on techniques to improve blood glucose management, educate physicians, NPs & PAs on new therapeutic agents, and approaches to handling different inpatient clinical scenarios. The relatively simple and convenient format of the podcast is ideal for physicians, NPs & PAs in a busy clinical practice to focus on a specific topic such as inpatient diabetes management.

Mobile CME

Like the podcast, electronic CME (e-CME) is another media that involves digital audio, but also uses text and video format to communicate information to providers while avoiding large conferences or meetings. It does require internet access, but this is not a significant barrier in current times.

The most current and reputable CME sites for this format are created by state-associated medical associations, professional groups, private medical teaching institutions, or even well-recognized commercial entities in medicine such as Medscape and Epocrates Mobile that are certified by Accreditation Council for Continuing Medical Education (ACCME) or by American Medical Association (AMA). The advantages to this media, like podcast, are its convenience, easy format, and low cost. Additionally, it has another distinct advantage which is the flexibility of different formats ranging from audio, text, question-based learning, and an array of other multimodal approaches [16].

In utilization of this media format, hospitals and professional organizations can create in-house apps that providers can view panel lead lectures ,or use mobile applications to practice sample cases with evidence-based recommendations. These apps can also contain reference guides and links to educational articles for new therapies or medical technologies. However, when choosing a method of learning, this decision for many organizations will be based on cost and institutional preference since no single type of education format has been shown to be superior. On the contrary, in one independent study by Sanaiey, blended models (traditional and electronic format) have been shown to be more effective in CME [17].

In a review by Al-Azri et al., the authors investigate the effects of problem-based learning (PBL) vs. the traditional format of lectures in continuing medical education. The authors conducted extensive literature searches from 2001 to 2011 in which only randomized controlled trials were selected that examined "knowledge enhancement, performance improvement, participants satisfaction, or patients' health outcomes" [18]. When reviewing the data, the authors noted that the PBL format as compared to didactic learning had no advantage in knowledge acquisition in postgraduate trainees or practicing physicians. In regards to physicians' performance and health outcomes, the authors noted that PBL programs did increase physician behavior with improvements in screening rates and number of patients treated with insulin. However, there was no change in clinical practice behavior overall. The limitation for this study was the

small-effect size and inconsistent reporting or analysis of comparable education interventions for the control groups. In all, online PBL can be an effective method for CME but there is limited evidence to fully examine its impact and role in the future.

Social Media

Social media has become an essential component in modern day life. The creation and sharing of information, opinions, and ideas is routine through this media format. Currently, there are a number of social media sites including LinkedIn, MySpace, Facebook, Yahoo! 360, Twitter, Tumblr, Google+, Snapchat, Instagram, and Pinterest. The most recent site with the focus of connecting US health care professionals specifically is Doximity, which is growing in its network and popularity. Other social networking sites for nurses are American Nurses Association's ANA Nurse Space, NursingLink, and Social RN while pharmacists have ASHP Connect or The Pharmacist Society. These resources clearly lack a commanding presence of CME/CEU as compared to other provider focus sites, despite their potential to reach a large audience to share new information and provide peer to peer discussion on topics of interest. In this forum, professionals can discuss complex cases, alternative therapies, and new information with a large group unlike ever before.

In reviewing benefits of this media format, Cheston et al. performed a systematic review of 14 studies using social media in medical education. They concluded that social media had better learner engagement (81% of studies), feedback (57%), and professional/collaboration development (36%). The authors noted challenges in technical issues, different variable learner participation and concerns over privacy and security [19].

One key issue to address in social media would be ensuring access to only credentialed medical professionals by verifying their board status through national or state-governing bodies for certification boards. This would ensure that designated sites would be used appropriately by providers that can share new ideas and advancements while preventing nonprofessionals (e.g., patients or family members) from using this resource. Unforeseen dangers included patients being discouraged to seek medical advice from their own providers or misinterpreting the information that can lead to additional harm and legal ramifications. Currently, some sites like Sermo, Doximity, and Among Doctors exist with a site gatekeeper to verify physicians' credentials prior to membership acceptance.

In his review, Ventola states social media can be utilized to promote sharing of ideas, debate health care policy, and explore or promote health care behavior and for patient education [20]. The dangers though are poor quality of information (as verification of information is not routinely done), breaches of patient privacy, violation of the patient-health care provider boundary, and legal risks. Such examples range from health care professionals being disciplined for unprofessional posts, legal advice posted on these sites being "discoverable" and utilized by opposition in court, and opening oneself to lawsuits by answering medical questions that constitutes as medical advice. In the last decade, this issue has been debated by many professional organizations including American Medical Association (AMA), Federation of State Medical Boards (FASB), and National Council of State Boards of Nursing (NCSBN) that have even issued a policy on professional use of social media [21–23]. It remains an active topic of interest.

As social media continues to grow, these issues will need to be addressed and resolved before expanding its role in health care education. In the near future, social media is likely to be a big contender as a source of CME/CEU as it is already being utilized informally by many clinicians.

Potential New Strategies for Professional Inpatient Diabetes Education

Hospital Credentialing

It is estimated that approximately a third of hospitalized patients have diabetes or hyperglycemia during the hospital stay [24]. The most ubiquitous hypoglycemic drug used in inpatient diabetes management is insulin, which is also a high-alert medication due to its risk for patient harm [25]. Unfortunately, this high-alert drug is also very challenging to use safely and effectively in the hospital. The need for frequent assessment of patient's clinical conditions and coordination of activities in the hospital such as timing of glucose measurements and intake of calories, all affect the outcome of insulin therapy. Moreover, the number of different insulins and other diabetes medications has grown rapidly in recent years. The complex environment of a hospital setting along with increasing unfamiliarity with new therapies creates potential for harm if clinicians are not adequately skilled in inpatient diabetes management strategies.

An ideal opportunity to educate clinicians on managing diabetes in the hospital is during the hospital credentialing process. It is widely accepted that for hospital privileges of surgical or bedside procedures, applicants must have additional certification to demonstrate their skill. Recently, the Society for Vascular Surgery published specific guidelines for hospital privileges in vascular surgery and endovascular interventions so that only physicians with recognized training, certification, and demonstration of clinical experience would be granted hospital privileges to perform these procedures [26••].

Insulin, however, can be prescribed by any clinician with prescriptive authority in any clinical setting. The clinical competence of the prescriber is assumed simply by their licensure. While it is impractical to have stringent credentialing criteria for the privilege of prescribing insulin in the hospital,

demonstration of adequate clinical knowledge and experience should be assessed. Currently, there are five categories of insulin types (long acting, intermediate acting, rapid acting, short acting, and inhaled) and 15 different insulins at the time of this publication, with more in the process of FDA approval. Each of these has different pharmacokinetics and even different concentrations within one insulin type (U100, U200, U300, U500). While endocrinologists and other diabetes specialists maintain continuing education in this rapidly evolving market, the non-endocrine practitioner will be much less likely to have the knowledge base or clinical experience to utilize all of these insulin types safely and effectively. Additionally, diabetes technology with continuous subcutaneous insulin infusions (insulin pump) and continuous glucose monitoring systems are also increasing in prevalence in the outpatient management of diabetes and therefore crossing over to the inpatient setting as well. This technology requires special training that is well outside the usual practice of non-endocrinologists but is frequently managed by non-endocrine clinicians when the patient is hospitalized. The most common prescriber of insulin in the hospital is not the trained endocrinologist, but rather an internist, hospitalist or even subspecialist who is assumed to be skilled in this rapidly evolving and complex therapy with a high potential for harm. Furthermore, national quality organizations such as the National Quality Forum (NQF), Agency for Healthcare Research and Quality (AHRQ), and the Centers for Medicare and Medicaid Services (CMS) have recognized the consequences of in hospital hypoglycemia including increased mortality, longer hospital stays and higher costs [27]. In 2018, as part of their efforts to reduce adverse drug events, CMS has proposed a new hospital measure to track hypoglycemic events within 24 h of administration of a hypoglycemia agent [28]. With this impending measure, hospitals and clinicians should be even more incentivized to be well educated and skilled in diabetes management.

It seems logical then that the physician, nurse practitioner, or physician assistant who will manage insulin therapy should be required to undergo additional education, demonstrate clinical competency, and be given feedback for safety events such as hypoglycemia or iatrogenic DKA. Hospital credentialing is an ideal opportunity for prescribers to educate themselves on this therapy to improve performance and patient outcomes. This can be readily accomplished during the credentialing process using any of the CME formats we have outlined that are convenient and easy for the clinician to complete.

Inpatient Diabetes Stewardship

In current hospital practice, providers are familiar with the concept of antimicrobial stewardship. This specific stewardship is a "coordinated program that promotes the appropriate use of antimicrobials with the goal of "improving patient outcomes, reducing microbial resistance, and decreasing the spread of infections caused by multidrug-resistant organisms" [29, 30]. For inpatient diabetes management, a tailored stewardship program could be established to assist with the primary goal of reducing hyperglycemia and hypoglycemia and improving hospital outcomes with evidence-based practice in real time.

Rushakoff et al. designed a novel educational and interventional tool that demonstrates this concept. In their program, a new diabetes education tool was established at the University of California San Francisco (UCSF) in which a virtual glucose management service (VGMS) was implemented to improve glycemic control. The VGMS begins with using the electronic health record to identify patients with multiple point-of-care glucose measurements greater than 225 mg/dL. An endocrinology provider would then review the electronic records of the patients on this list and write a VGMS chart note with insulin dosing recommendations for the primary physicians. One year after implementation of the VGMS program, they noted a 39% decrease in the proportion of hyperglycemia patients per calendar day. In addition, physicians also had strongly agreed that this method was a valuable educational tool for their ongoing learning and management of hyperglycemia [31•]. The advantage of this intervention is that it provides educational opportunities for house staff using their own patient cases in real time.

Interdisciplinary In-House Service Training

While in-house service training is a very familiar format for nursing education in the hospital, physicians are not well-versed in this form of continuing education. This differs from the usual education model of individualized information that physicians receive such as when pharmaceutical representatives discuss new medications or devices. The advantage of in-service training is that many providers of various disciplines such as physicians, physician assistants, nurse practitioners, pharmacists, dietitians, and nurses can all benefit from education that is directed to their own specific practice in the hospital. In addition, it promotes a general understanding of the goals between the different medical professionals while allowing for an interdisciplinary discussion.

At Johns Hopkins University School of Medicine, Golden et al. are currently conducting a study using a super user inpatient diabetes education program. The investigators have developed an educational program with models for inpatient diabetes management for physicians and nursing staff with the focus on safe, evidence-based diabetes care in the hospital setting. The physician module will have 10 case-based modules for teaching internal medicine residents and hospitalists at two academic hospitals while the nursing education will consist of 12 case-based modules at two academic and one community-based hospitals. Primary outcomes will be hypoglycemia and hyperglycemia events. The study is entering the

completion phase and the results are expected to give clarity on the effectiveness of this approach as a model for future educational strategies [32].

Learner-Center Curriculum

Another interesting version of continuing education was theorized by DeSalvo et al. in which they developed a multifaceted, learner-centered diabetes curriculum. The objective was to address the numerous concerns and challenges with managing inpatient diabetes that included "errors to insulin, communication, intravenous fluids, nutrition, and discharge delays" [33]. In this study, an 8-week educational intervention was implemented in a tertiary children's hospital that consisted of the following: 1) an online tutorial addressing resident current baseline diabetes management knowledge, 2) an interactive discussion on diabetes management pathway, 3) question and answer sessions initiated by the learners, and 4) case presentations featuring pathway errors for residents to recognize, resolve, and prevent.

The results of this study showed a decrease in resident errors within the inpatient diabetes population. Prior to the study, resident errors occurred in 28 patients (19.4% of 144 admissions of patients with diabetes) over 9 months. After the intervention, the number of errors decreased to 11 patients (6.6% of 166 diabetes admission) over 10 months ($P = 0.0007$) [33]. This study showed the value of pro-active learning and the effect it can have in patient care with the added benefit of being applied to many other specialists as well. The only limitation is the time required to complete an 8-week curriculum in the busy schedule of health care professionals.

Conclusion

The demands of the current health care system on providers to deliver high-quality, high-volume, and low-cost care require readily accessible, reliable, and effective ongoing diabetes education. At present, the mainstay option remains the traditional CME/CEU format where speakers and attendees gather in person at a pre-specified date and location. However, such a format limits access due to its inflexibility and costs, especially for the busy health care professional. We have outlined current and future alternative strategies for delivering medical education that have many advantages and are gaining rapid popularity due to their convenience, ease of use, time-efficiency, potential for large audiences and lower costs. Unfortunately, at present, there is a paucity of data and underutilization of these new formats. It is now time for the medical community to invest resources in exploring, developing, and validating these new educational strategies that will meet the needs of the current health care practices.

Compliance with Ethical Standards

Conflict of Interest Ashkan Zand, Karim Ibrahim, and Archana R. Sadhu declare that they have no conflict of interest.

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.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. [Internet]. Nursingworld.org. 2018 [cited 23 July 2018]. Available from: https://www.nursingworld.org/~4abfd7/globalassets/certification/renewals/RenewalRequirements
2. Continuing Education - AANPCP [Internet]. Aanpcert.org. 2018 [cited 23 July 2018]. Available from: http://www.aanpcert.org/recert/ce
3. Continuing Medical Education (CME) for Physician Assistants - NCCPA [Internet]. Nccpa.net. 2018 [cited 23 July 2018]. Available from: http://www.nccpa.net/ContinuingMedicalEducation
4. Continuing Education [Internet]. Pharmacist.com. 2018 [cited 23 July 2018]. Available from: https://www.pharmacist.com/education
5. Curran V, Fleet L. A review of evaluation outcomes of web-based continuing medical education. Med Educ. 2005;39:561–7.
6. Zimitat C. Designing effective on-line continuing medical education. Medical Teacher. 2001;23:117–22.
7. Crenshaw K, Curry W, Salanitro A, Safford M, Houston T, Allison J, et al. Is physician engagement with web-based CME associated with patients baseline hemoglobin A1c levels? The rural diabetes online care study. Acad Med. 2010;85:1511–7.
8. Tatti P, Lehmann E. Utility of the AIDA diabetes simulator as an interactive educational teaching tool for general practitioners (primary care physicians). Diabetes Technol Ther. 2001;3:133–40.
9. • Diehl LA, Souza RM, Gordan PA, Esteves RZ, Coelho ICM. InsuOnline, an electronic game for medical education on insulin therapy: a randomized controlled trial with primary care physicians. Journal of Medical Internet Research. 2017;19. **This study provides recent data of the utilization of virtual stimulation as method for continue education among providers as compare to lecture format.**
10. Sullivan M, O'Brien C, Gitelman S, Shapiro S, Rushakoff R. Impact of an interactive online nursing educational module on insulin errors in hospitalized pediatric patients. Diabetes Care. 2010;33:1744–6.
11. Vaidya A, Hurwitz S, Yialamas M, Min L, Garg R. Improving the management of diabetes in hospitalized patients: the results of a computer-based house staff training program. Diabetes Technol Ther. 2012;14:610–8.
12. Tamler R, Green DE, Skamagas M, Breen TL, Lu K, Looker HC, et al. Durability of the effect of online diabetes training for medical residents on knowledge, confidence, and inpatient glycemia. Journal of Diabetes. 2012;4:281–90.
13. Wakefield PL, Wilson MA. Enhancing nurses' knowledge regarding the complex care of hospitalized patients on insulin. J Nurses Prof Dev. 2014;30:174–80.

14. Taylor CG, Morris C, Rayman G. An interactive 1-h educational programme for junior doctors, increases their confidence and improves inpatient diabetes care. Diabet Med. 2012;29:1574–8.
15. Podcasting Historical Timeline|International Podcast Day [Internet]. International Podcast Day. 2018 [cited 23 July 2018]. Available from: https://internationalpodcastday.com/podcasting-history/
16. Ruiz J, Mintzer M, Leipzig R. The impact of E-learning in medical education. Acad Med. 2006;81:207–112.
17. Sanaiey N. The comparative study of the effectiveness of using E-learning, blended learning and presence learning in continuous medical education. World Journal of Medical Sciences. 2014;10:488–93.
18. Al-Azri H, Ratnapalan S. Problem-based learning in continuing medical education: review of randomized controlled trials. Can Fam Physician. 2014;60:157–65.
19. Cheston C, Flickinger T, Chisolm M. Social media use in medical education. Acad Med. 2013;88:893–901.
20. Ventola CL. Social media and health care professionals: benefits, risks, and best practices. Pharmacy and Therapeutics. 2014;39:491–520.
21. Professionalism in the Use of Social Media | American Medical Association [Internet]. Ama-assn.org. 2018 [cited 23 July 2018]. Available from: https://www.ama-assn.org/delivering-care/professionalism-use-social-media
22. [Internet]. Fsmb.org. 2018 [cited 23 July 2018]. Available from: https://www.fsmb.org/globalassets/advocacy/policies/model-guidelines-for-the-appropriate-use-of-social-media-and-social-networking.pdf
23. [Internet]. Ncsbn.org. 2018 [cited 10 October 2018]. Available from: https://www.ncsbn.org/NCSBN_SocialMedia.pdf
24. Umpierrez GE. Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. Journal of Clinical Endocrinology & Metabolism. 2002;87:978–82.
25. High-Alert Medications in Acute Care Settings [Internet]. Institute for Safe Medication Practices. [cited 2018Sep3]. Available from: https://www.ismp.org/recommendations/high-alert-medications-acute-list
26.•• Calligaro KD, Amankwah KS, D' Ayala M, et al. Guidelines for hospital privileges in vascular surgery and endovascular interventions: recommendations for the Society for Vascular Surgery. J Vasc Surg. 2018;67(5):1337–44. **The Vascular Surgery Society has put forward a recommendation in their guidelines that ensure that hospital privileges are granted to physicians with recognized training, certification, and demonstration of clinical experience for any vascular surgery and endovascular interventions.**
27. NQF: Prioritization of High-Impact Conditions [Internet]. Qualityforum.org. 2018 [cited 21 July 2018]. Available from: http://www.qualityforum.org/projects/prioritization.aspx?section=MeasurePrioritizatinAdvisoryCommitteeReport2010-05-24.
28. [Internet]. Cms.gov. 2018 [cited 21 July 2018]. Available from: https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/MMS/Downloads/FMQAI-Glycemic-Control-Measures-Public-Comment.pdf
29. APIC | Antimicrobial stewardship [Internet]. Apic.org. 2018 [cited 20 July 2018]. Available from: https://apic.org/Professional-Practice/Practice-Resources/Antimicrobial-Stewardship
30. Doron S, Davidson L. Antimicrobial stewardship. Mayo Clin Proc. 2011;86:1113–23.
31.• Rushakoff J, Kornberg Z, Shah A, Rushakoff R. Virtual glucose management service: a novel resident educational tool. Medical Education. 2017;51:1174–5. **This study shows the creation of a virtual glucose management service in which an endocrinology provider reviews charts while providing recommendation through the institution electronic medical record. This service is similar to the antibiotic stewardships that are currently being implemented in other institutions.**
32. Implementation and Evaluation of an Inpatient Diabetes Superuser Education Program - Full Text View - ClinicalTrials.gov [Internet]. Clinicaltrials.gov. 2018 [cited 23 July 2018]. Available from: https://clinicaltrials.gov/ct2/show/NCT02847390?term=NCT02847390&rank=1
33. Desalvo DJ, Greenberg LW, Henderson CL, Cogen FR. A learner-centered diabetes management curriculum: reducing resident errors on an inpatient diabetes pathway. Diabetes Care. 2012;35:2188–93.