POINTS OF VIEW

A hemodialysis curriculum for nephrology fellows using a blended learning approach: best of both worlds?

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Abstract

A comprehensive, hands-on hemodialysis curriculum during nephrology training is necessary for effective learning and optimal patient care. Traditional instructive approaches are unable to fully meet the needs of the digitally inclined learner and are limited by time constraints and increasing clinical workload. Internet based learning (E-learning) is becoming increasingly popular in medical education and nephrology and gaining even greater relevance in the COVID era. However, it presents technical challenges and may create an environment of social isolation. A 'blended learning approach' combines E-learning with traditional methods of teaching and offers advantages over either approach alone. We have designed and implemented a formalized hemodialysis curriculum at our institution that is based on blended learning, utilizing faculty-created E-learning tools combined with traditional pedagogical methods (bed-side and classroom). The web-based tools discuss hemodialysis adequacy, principles of urea transport, hemodialysis access examination and access complications. These tools are open access and structured around the science of cognitive learning using animation, interactivity, self-assessment and immediate feedback features. They have been viewed by a wide audience of nephrologists, dialysis nurses as well as medicine house-staff and have received strong validation in a post-test survey. The online tools have supported a 'flipped classroom' instructive model and our blended curriculum has been successfully used for nephrology fellow training at our institution. Incorporating faculty designed/approved E-learning tools to create a 'blended' nephrology curriculum for trainees at various levels of medical education, can help streamline active and time-efficient learning, with the goal of improving learner engagement, knowledge acquisition and academic curiosity in the field.

Keywords Education · Hemodialysis · Vascular access · E-curriculum · Blended learning · E-learning

Introduction

A comprehensive, structured and hands-on hemodialysis (HD) curriculum for nephrology fellows is necessary for effective learning and optimal patient care. A national survey that assessed perceived educational needs of United States based Nephrology fellows, found that HD was among the top ten areas where further instruction was desired [1]. Home based dialysis modalities i.e. home HD (HHD) and peritoneal dialysis (PD) were the top two on this list [1].

Conventional methods of teaching HD include bedside teaching and classroom lectures. The proven effectiveness of this traditional pedagogical approach centers on facilitating direct face-to-face communication between the learner, the teacher and often the patient within a common learning space thereby promoting 'community learning'.

Unfortunately, this approach is limited in current practice by time constraints, lack of flexibility and increasing clinical workload for both the learner and the teacher [2]. These factors have become even more relevant in the COVID era. In certain patient care scenarios especially related to procedural training, this approach might in fact jeopardize patient safety [3, 4]. Furthermore, traditional methods when used alone may not fulfill the needs of all "learner types" i.e. the visual learner (prefers visual presentation of information), auditory (learns using spoken and written information) and the kinesthetic leaner (learns by actively 'doing' the task and responds best to interactive methods of teaching) or one that learns best using a combination of the above [5, 6]. The overwhelming explosion of medical information brings

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newer challenges for both the educator and the learner in a traditional classroom. A related but more global issue is the declining interest in the field of nephrology as a future career amongst medical trainees partly due to the perceived difficulty of the subject [7]. In order to revive nephrology as a field, educators must find innovative and learner-centric approaches to teach the specialty at all levels of medical education [8–10].

E-learning and blended learning in nephrology

To overcome some of the above-mentioned limitations of traditional instructive methods, educators in nephrology are exploring newer, innovative and learner-centered pedagogical approaches [8–12]. Digital technology has greatly influenced the learning culture in medicine and nephrology in recent years [13]. Modern learners appropriately referred to as 'digital natives' respond favorably to this cultural change. The internet has allowed easy and wide dissemination of knowledge via various online platforms such as medical blogs, podcasts, social media, and online educational modules [12]. A re-designed medical student physiology curriculum showed that students that used multiple learning methods (online blackboard videos, live lectures, video recorded lectures) had favorable attitudes towards learning kidney physiology [10].

Internet-based learning is simplistically referred to as E-learning. However, pedagogically, its conceptual framework describes using web-based instructional tools that prioritize a learner-centered approach i.e. allow for interactivity, flexibility and wider dissemination; transcend space and time boundaries; allow reuse and repetitive review; and aspire to improve learner engagement, satisfaction, and knowledge acquisition [14, 15]. E-learning

is a popular learning platform among nephrology fellows and is being used to provide personalized learning in our field [12, 16]. Its relevance is even greater in the COVID pandemic era. However, the rising popularity of E-learning in medical education, brings with it concerns and challenges [17]. Firstly, disorganized use of technology can be a distraction rather than an aid to learning. Successful E-learning tools necessitate effective application of technology guided by the science of cognitive learning. A more descriptive term is 'Technology enhanced learning' (TEL) and requires clearly defined learning objectives and organized technical designing that prioritizes interactivity and learner participation [17]. E-teaching requires skilled e-teachers i.e. educators who are proficient at either creating e-learning tools or selecting and recommending pre-existing tools appropriate for their learners. It can be costly and time consuming and requires sophisticated resources. Lastly, e-learning alone can create a sense of isolation and a lack of collaborative learning environment for the student [18] (Table 1).

Since learning is a cognitive and social activity, combining traditional methods of medical education with E-learning, termed as 'blended learning', may perhaps be the ideal approach [19]. This approach promotes E-learning tools as an adjunct to traditional pedagogical methods and not as their replacement and overcomes some of the challenges of isolated E-learning. A blended learning approach can serve to enhance a medical curriculum, improve trainees understanding of fundamental concepts and facilitate its safe application to clinical practice [20]. A large meta-analysis showed that blended learning has a consistent positive effect on knowledge acquisition among health care professionals and may be more effective than non-blended learning alone i.e. traditional or e-learning [19]. At our institution, we have created a formalized curriculum in HD for our nephrology fellows that centers on 'blended learning' (Table 2).

Table 1 Advantages and disadvantages of E-learning

Advantages
1. Allows for independent learning in an unintimidating environment
2. Allows repetitive review and reuse
3. Flexibility of learning schedule
4. Wider dissemination
5. Interactive features to enhance learner engagement and knowledge testing
6. Can be utilized for teaching others
7. Especially relevant in the COVID era
Disadvantages
1. Disorganized use of technology can be a distraction
2. Requires skilled e-teachers
3. Expensive and time consuming to develop and requires exensive technological resources
4. Sense of isolation for the learner
5. Lack of collaborative learning

Table 2 Blended learning-based hemodialysis curriculum at a glance

1. Physiology and principles of HD, dialysis prescription, HD adequacy (E-learning module followed by a face to face discussion).

2. Basic working of a HD machine (Bed-side teaching).

3. Water treatment for dialysis (Bed-side teaching; Visit to the Water Treatment room)

4. Vascular access anatomy and functioning, along with complications (E-learning tool and Bed-side teaching

5. Catheter related infections (lecture)

6. Management of Anemia and metabolic bone disease in ESRD (work rounds and lab review)

Links to the E-learning tools:

https://hemodialysiskinetics.coursepress.yale.edu/

https://hemodialysisaccess.coursepress.yale.edu/

'Blended' hemodialysis curriculum

Our 'blended HD curriculum' covers six core topics in HD, selected based on ACGME competency requirements and utilizes an E-learning platform to complement traditional instructive methods (Table 2). We have created two online, interactive teaching tools for concept learning and self-assessment in HD. The first module discusses principles of HD, solute transport, HD kinetics and adequacy. The second module discusses HD access-anatomy, functioning and complications. The link to the modules is noted (Table 2). Nephrology fellows at our institution spend six weeks at the Veterans Affairs Medical center, West Haven, CT during their first year. At the start of their rotation, they are encouraged to do an independent review of the modules. This allows for a 'flipped classroom model" where the trainees can review the material prior to a didactic session promoting effective interaction and discussion between the fellow and faculty during the face to face session. Our trainees get a hands-on tour of the dialysis-unit water treatment room, where they learn about water purification and testing. Several other topics discussed via traditional didactic methods during this 6-week block are catheter related infections and their management, workings of a dialysis machine, and management of anemia and bone disease in ESKD (Table 2).

Description of our E learning tools

The content for the E-learning tools is presented in a methodical, step-by-step manner using multiple learning modalities and are developed using *Wordpress*. The first part of the modules focuses on concept learning, which is delivered via animated and narrated videos, designed in *Microsoft PowerPoint*. These videos facilitate enhanced visualization of concepts and appeal to both the visual and audio learners. We believe that animation is a powerful teaching tool for our modules. Animation allows information (a.k.a. cognitive load) to be processed easily by creating a mental model to build information on [17]. It allows one to package the cognitive load in a 'brain friendly manner' allowing effective transmission of large amounts of information while maintaining successful comprehension and assimilation [17]. Using animated videos; we discuss solute transport in HD, Kt/Vurea, access examination and stenosis, and other access complications, etc.

The second section focuses on self-assessment and utilizes activities such as digital games (*drag and drop, identify the hotspot, slider images, playground station, interactive patient videos, simulated patient cases and standard multiple-choice quizzes*) that facilitate proactive learning and appeal to the kinesthetic learner. The interactivity was added using HTML5 package (*H5P) software* for the HD access module. Immediate feedback is given throughout the module to help the learner with self-assessment.

These tools are freely available on the Internet and can be used for the purposes of learning and teaching by a wide audience (medical students, residents, vascular surgeons, radiologists, dialysis nurses and nephrologists in training and practice). As of September 2020, the videos in the HD kinetics and HD access module have a total of 25,329 and 15,628 views respectively. The top five most viewed subtopics across the two modules, in order were (1) Transmembrane pressure; (2) Convection; (3) HD filter and (4) Basics of HD and (5) Basics of AV access. A voluntary, online, pre and post-module completion survey shows that the modules are being utilized by a variety of disciplines (30% practicing nephrologists, 30% nephrology fellows, 15% dialysis nurses, 15% medicine residents and students). In the future, we will be formally evaluating this curriculum to study its effectiveness in a more controlled fashion.

Conclusion

We believe that we have created a successful HD curriculum at our institution based on a blended learning pedagogical approach that combines faculty designed E-learning tools and traditional instructive methods. These tools have been effective in creating a 'flipped classroom model' and have served as an adjunct to our traditional HD curriculum. This curriculum has the potential for wider applicability, as the

e-learning tools are freely available on the Internet. Faculty approved/created E-learning resources help trainees actively structure their own learning, making it efficient and effective rather than having them 'surf' the Internet in search of appropriate E-learning tools. Given the tremendous scope of digital technology use in medical education and needs of the modern learner, it's imperative that medical schools and training programs incorporate faculty supported E-learning tools routinely to create a structured curriculum for its students based on the concept of blended learning. This will help streamline active and time efficient learning, with the ultimate goal of improving learner engagement, knowledge acquisition and academic interest in nephrology.

Compliance with ethical standards

Conflict of interest I have no conflicts of interest to disclose.

Ethical approval Given the nature of this perspective paper, it does not require ethical approvals.

Informed consent Given the nature of this perspective paper, it does not require informed consent.

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