CLINICAL KIDNEY JOURNAL

CKJ REVIEW

Applying effective teaching and learning techniques to nephrology education

Helbert Rondon-Berrios and James R. Johnston

Renal-Electrolyte Division, University of Pittsburgh School of Medicine, Pittsburgh, PA 15261, USA

Correspondence and offprint requests to: Helbert Rondon-Berrios; E-mail: rondonberriosh@upmc.edu

Abstract

The interest in nephrology as a career has declined over the last several years. Some of the reasons cited for this decline include the complexity of the specialty, poor mentoring and inadequate teaching of nephrology from medical school through residency. The purpose of this article is to introduce the reader to advances in the science of adult learning, illustrate best teaching practices in medical education that can be extrapolated to nephrology and introduce the basic teaching methods that can be used on the wards, in clinics and in the classroom.

Key words: learning, medical education, nephrology, teaching

Anybody who believes that all you have to do to be a good teacher is to love to teach also has to believe that all you have to do to be a good surgeon is to love to cut.

  —Adam Urbanski, President of the Teachers Association of Rochester, Rochester, New York

Introduction

Kidney disease is a major health care problem in the USA. The prevalence of chronic kidney disease is growing, especially in the older population. However, changes in the health care system make it difficult to predict whether this need will cause an increased demand for nephrologists [1]. Despite an apparent demand, interest in nephrology as a career choice has decreased. For appointment year 2016, 58.9% of nephrology fellowship training programs did not fill in the nephrology match and there were only 0.6 applicants per nephrology fellowship position [2]. Several reasons have been cited for this decline, including perceptions that nephrology is too complex, poor mentoring and inadequate teaching of the subject [3]. What is more, innovation and research in nephrology education are lacking [4]. Teaching nephrology is a demanding, complex and often frustrating task, a task many nephrologists assume without proper preparation. To face this problem, nephrologists who assume a teaching role should not only be familiar with best existing teaching practices but should also consider novel strategies to adapt to the changing need of today's learner [5–7]. However, the literature of best teaching practices pertinent to nephrology education is very scarce. The purpose of this article is to review the existing literature regarding best teaching practices in medical education and consider options applicable to nephrology education.

What makes good teachers and do they make a difference?

The question, 'what makes a good clinical teacher in medicine?' has been the subject of considerable controversy. To identify some of the qualities that make a good teacher, Elnicki and Cooper [8] surveyed 72 third-year medical students who were rotating in the general internal medicine inpatient service on numerous teaching behaviors of attending physicians and house staff and evaluated their overall teaching effectiveness.

Teaching effectiveness of attending physicians correlated most strongly with the teacher's behaviors: showing enthusiasm and interest in teaching ($R^2 = 63.6\%$, $P < 0.01$), inspiring confidence in their knowledge and skills ($R^2 = 9.9\%$, $P < 0.01$) and providing useful feedback ($R^2 = 5.0\%$, $P < 0.01$) and less strongly with encouraging students to accept increasing responsibility ($R^2 = 1.2\%$, $P = 0.03$). Sutkin *et al.* [9] performed a systematic review of the literature to answer the same question. The authors found 68 articles, mostly surveys and essays, identifying 480 descriptions of characteristics of a good clinical teacher that they clustered in five common themes:

1. Medical knowledge
2. Clinical competence
3. Positive relationship with students
4. Communication skills
5. Enthusiasm for teaching

There is also evidence that good teachers influence students' performance and specialty choice. Stern *et al.* [10] analyzed a database of 362 third-year medical students who rotated in inpatient general medicine and cardiology services and their 138 supervising faculty physicians. The investigators organized the data in pairs of student–faculty physician and correlated faculty physician ratings by the student in the pair with the student's individual score in the National Board of Medical Examiners (NBME) subject examination in internal medicine, a validated instrument of postclerkship knowledge. After multivariate analysis, ratings of faculty physicians were small but significant predictors of student's performance on the NBME subject examination (β coefficient $= 0.15$, $P = 0.0047$). Griffith *et al.* [11] went to explore the question of whether excellent clinical teachers can influence the specialty choice of top students who usually have other choices available (other than internal medicine). The investigators analyzed a prospective cohort of 52 students who rotated in their third-year medicine clerkship and scored in the top 30% of the US Medical Licensing Examination step 1 within the prior 2 years. These students rated 62 faculty physicians with whom they worked during their clerkship rotation. Using multiple regression analysis, the investigators found that exposure to highly rated faculty physicians (rated top 20%) was an independent predictor of internal medicine residency choice for excellent medical students ($P = 0.02$).

Principles of adult learning

There are many different models to explain how adults learn [12]; however, the best known of these efforts is 'andragogy', described by Knowles in 1973 [13]. For Knowles, andragogy was based on six crucial assumptions (Table 1) about the characteristics of adult learners, different from the assumptions about child learners on which traditional 'pedagogy' is founded:

1. *Learners' experience*: Adults like to be given the opportunity to use their existing knowledge foundation and apply their life experiences to their own professional development (e.g. a nephrology attending asks a medical student if he or she has ever taken care of a patient with hyponatremia). This also has some potentially negative effects. As adults accumulate experience, they may develop mental habits, biases and preconceptions that tend to close their minds to new ideas and alternative ways of thinking (e.g. the student above responds affirmatively but also remembers that the patient with hyponatremia was given NaCl tablets to 'correct the sodium deficit').

Table 1. Principles of adult learning and their application to nephrology education [14]

Principle	Application
1. Learner's experience	Teacher should connect student's life experiences and prior learning to new information. Teacher should also find ways to help students examine their own habits and biases and open their minds to new approaches.
2. Self-directedness	Teacher should give up control of the course and allow trainees to be empowered. Teacher should allow learners to establish their own learning goals and activities. Teacher should encourage independent study and allow learners to proceed at their own pace.
3. Readiness to learn	Teachers should look for a 'teachable moment', an unplanned opportunity that lends itself to discussion of a particular topic.
4. Orientation to learning	Teachers should teach not only content that is useful for the learner's tasks at hand but in a way that explicitly states its practical application.
5. The need to know	Teacher should explicitly state the educational objective at the beginning of the activity. Teachers must help trainees become aware of their 'need to know' and make a case for the value of learning something by making it applicable to their practice.
6. Motivation	Teacher should create a non-threatening welcoming classroom environment.

2. *Self-directedness*: Adults feel responsible for their own lives. This sense of self-responsibility results in a psychological need to be seen and treated by others as being capable of self-direction. Therefore, they resent and resist learning when they feel others are imposing information on them. (This can be avoided by the nephrology attending meeting with the renal fellow on the first day of the rotation and soliciting the fellow's learning goals for the month.)

3. *Readiness to learn*: Adults become ready to learn when they have to cope effectively with problems that arise in the present. The key concept here is timing the learning experience to coincide with a task, i.e. finding a teachable moment (e.g. right after a medical student has completed a presentation on a patient with hypokalemia, the nephrology attending succinctly reviews the diagnostic approach to hypokalemia).

4. *Orientation to learning*: Adults are motivated to learn things when they perceive that learning will help them deal with problems they confront in real life. They learn new knowledge most effectively when it is presented in the context of application to real-life situations (e.g. a nephrology attending notes the large number of patients with chronic kidney disease the fellows see in the clinic and then reviews the fellows' charts and instructs them on current standards of care for patients with chronic kidney disease).

5. *Need to know*: Adults do not pursue learning for the sake of learning. They want to know why they need to learn something before undertaking learning (e.g. a nephrology attending lists three clinically relevant learning objectives at the beginning of his lecture on recognizing and treating kidney allograft rejection).

6. *Motivation*: Adults respond to some external motivators (e.g. high salaries, academic promotion, meeting performance standards), but the most potent motivators are internal pressures (e.g. job satisfaction, self-esteem). Adults are motivated to learn when they are recognized and appreciated for their individual contributions to the class (e.g. nephrology attending asks questions to a group of medicine residents in a non-threatening way, calls each by his/her first name, reinforces positive behavior and uses constructive criticism).

In 1984, Kolb developed a way of looking at the adult learning process, which he called the Experiential Learning Cycle (Figure 1) [15]. Learning is the acquisition of new knowledge, skills and attitudes. Kolb sees learning as happening in a cycle made up of four stages:

1. *Concrete experience*: The learner must have an experience; he or she must experience something directly.
2. *Reflective observation*: The learner reflects on the experience, comparing it with his/her prior knowledge.
3. *Abstract conceptualization*: The learner learns from the experience, he/she thinks about his/her observations and concludes something from them.
4. *Active experimentation*: The learner tries out what he/she has learned. This active experimentation stage becomes the basis of future learning.

It is important to note that a trainee can enter the learning cycle at any point. Completion of each stage is essential before progressing to the next, allowing for complete learning to occur.

McCarthy incorporated Kolb's ideas and developed a tool called 4MAT that can be used to train people in a way that suits all learning styles [16]. An effective teaching session should be planned to facilitate each of these stages. Table 2 describes a lecture-based didactic session for a group of first-year nephrology fellows that exemplifies the use of 4MAT.

The core principles of andragogy in association with Kolb's learning cycle provide a sound foundation for planning teaching encounters.

The teaching encounter

There are three basic settings where teaching encounters can occur:

1. *Teaching in the clinical environment*: This includes teaching in various clinical rotations such as renal inpatient consult, inpatient end-stage renal disease service, outpatient nephrology clinic, outpatient dialysis clinic and transplant nephrology rotation.
2. *Teaching in the classroom (for large groups)*: Lectures are the oldest and most common method of instruction for large groups.
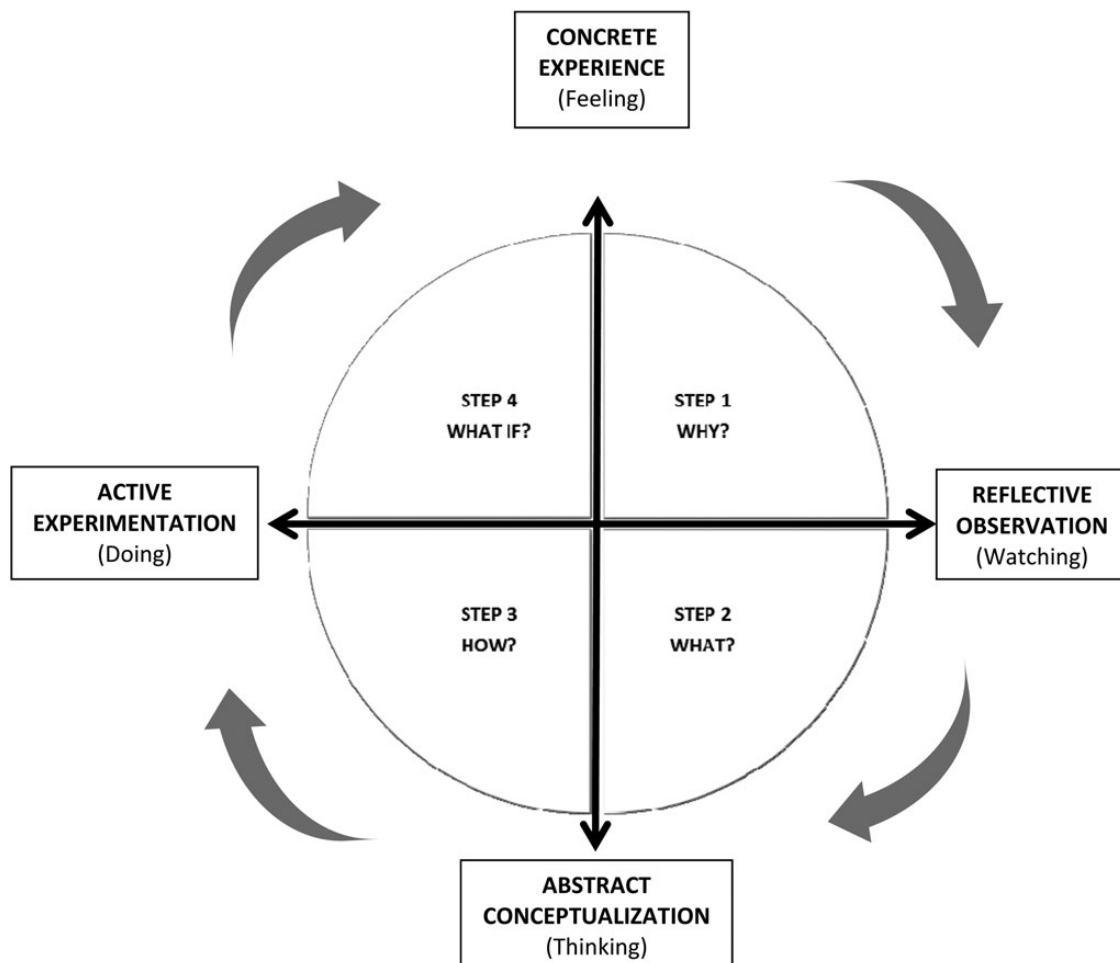

Fig. 1. Kolb's learning cycle and the 4MAT model [15].

Table 2. The 4MAT cycle and its application to a lecture on the management of lupus nephritis

Step	Learner's key question	Learner's main interest	Learning–teaching task
1	Why?	Learner seeks a personal connection, meaning	Faculty asks the learner if he/she has ever taken care of a patient with lupus nephritis and what was it like
2	What?	Learner seeks facts and to gather information	Faculty proceeds to deliver the core content of the lecture on the management of lupus nephritis
3	How?	Learner seeks to apply ideas	Faculty asks questions related to lupus nephritis management
4	What If?	Learner seeks to refine what they have learned and integrate it into their lives	Learner applies his or her knowledge of lupus nephritis management in a patient

3. *Teaching in small groups*: Examples of this include workshops, seminars and tutorials.

Irby and Bowen [17] developed a three-step approach for time-efficient teaching in the clinical environment. Each teaching encounter has three stages:

1. *Planning*: preparing for teaching by planning when and how to teach
2. *Teaching*: using a variety of teaching methods to actively involve the learners
3. *Reflecting*: evaluating learner's performance, giving feedback and encouraging self-reflection

This review will focus on the planning and teaching stages of the teaching encounter.

Planning

The advantages of advance planning include sharpening expectations, clarifying roles and responsibilities, allocating time for instruction and feedback and focusing learners on important priorities and tasks. The planning stage includes the following important elements:

- *Establishing expectations*: At the beginning of the first teaching encounter, expectations should be clearly communicated. Expectations are the ground rules or the code of conduct for the teaching encounters. Communicating expectations early reduces ambiguity, avoids future conflicts and provides the basis for feedback and evaluation.
- *Establishing goals and objectives*: A goal or objective is defined as an end toward which an effort is directed. A goal is a broad statement of what the students will be able to do when they have completed the teaching session. In contrast to goals, objectives are specific actions that support the attainment of an associated goal. A key to formulating useful educational objectives is to make them specific and measurable. Five basic elements should be included in such objectives [18]:

  <u>Who</u> <u>will do</u> <u>how much (how well)</u> <u>of what</u> <u>by when?</u>
    1   2   3   4   5

  Example:

  Goal 1:
      Internal medicine residents should be able to manage hyponatremia appropriately.
  Objective #1:

  <u>Second-year internal medicine residents</u>   <u>will estimate</u>
              1   2
  <u>at least once satisfactorily</u>
        3

<u>the response to fluid restriction based on the urine: plasma electrolyte ratio</u>
     4
<u>by the end of the nephrology elective.</u>
     5

    An objective is specific, measurable, attainable, relevant and time framed. Goals should be clearly stated, appropriate, realistic, doable, comprehensive and worthwhile.

    In 1956, Bloom published a framework for categorizing educational objectives, also known as Bloom's taxonomy [19]. Bloom's taxonomy divides the way people learn into three domains: cognitive, skills and attitudes. The cognitive domain refers to the intellectual capabilities or mental skills. Bloom identified six levels within the cognitive domain: from the lowest level, simple recall of facts, i.e. knowledge, through increasingly more complex levels such as analysis, synthesis and evaluation (Figure 2). When formulating an objective, the verb used in 'will do' (number 2) and the teaching strategy used to accomplish such objectives should match the Bloom's taxonomy level being assessed (Table 3).

- *Soliciting learners' goals*: Students should have their own learning goals that will be particular for their own needs and experience. Teachers should solicit learners' goals. Mutual understanding of learners' goals facilitates feedback regarding progress toward and attainment of them.
- *Create a positive learning climate*: Learners are more likely to participate and contribute to the group's learning if a safe and respectful learning environment is created. Some strategies to achieve this are calling learners by their first name, soliciting learners' goals, encouraging interactions and discussion,

Fig. 2. Bloom's taxonomy pyramid of learning domains [19].

Table 3. Educational objectives and teaching strategies based on Bloom's taxonomy

Cognitive domain level	Verb used when formulating educational objective	Teaching strategy used to achieve educational objective
Knowledge	Define, list	Lecture, video
Comprehension	Describe, explain, identify	Questions, test, presentations
Application	Apply, demonstrate, perform	Practice exercises, simulations, role play
Analysis	Analyze, calculate, compare, contrast, differentiate, distinguish	Case studies, discussions
Synthesis	Arrange, compose, create, design, formulate, organize, prepare	Project, plan
Evaluation	Assess, evaluate, estimate, judge	Critiques

using positive reinforcement, promoting enthusiasm and humor and being respectful of others (and their time).

Teaching in the clinical environment

The patient care setting is likely the most difficult and complex educational arena that the clinician educator will encounter. The learners vary from third-year medical students to senior residents and fellows. Teaching to the different levels of learners is quite challenging and the educator constantly runs the risk of boring some while confusing others. The patients are complex, the demands for rapid patient care are intense and faculty face constant time pressure to provide quality care, educate and bill. The number of learners in the outpatient setting is usually much smaller (almost always one to one), but the constraints of time and efficiency still apply. In the clinical setting, learners and teachers prioritize educational opportunities as illustrated in a survey conducted at the University of Pittsburgh in 2003. Residents, program directors and medical students considered procedures, case management, 5-min talks and bedside teaching as the highest-value learning experiences [R. Patel (personal communication. September 18, 2013)].

In the patient care setting, faculty teach most effectively when they set the stage for teaching. This planning stage was discussed previously in this article. Please note, in the clinical environment, not every patient is a teaching case. The educator must be selective in picking 'teachable moments' [20, 21].

A number of techniques have been used successfully for teaching in the clinical environment [22–24].

Role modeling

This method works best with inexperienced learners or when the learner encounters an unfamiliar problem. The educator sets the stage, e.g. 'Watch how I discuss the need for dialysis with this patient.' After the session, the teacher will 'debrief' the learner and activate the opportunity for teaching. The learner is asked to describe what was modeled, followed by questioning (gently) on why dialysis was needed, the side effects of the procedure and so on. The clinician educator can also use this technique to think out loud in front of the patient and the learner, modeling the decision-making process.

Pattern recognition or 'Aunt Minnie'

If your Aunt Minnie is walking down the street in her favorite hat, shoes and dress, you will easily recognize her without seeing her face. This is a variation on the theme of 'if it walks like a duck and quacks like a duck, it is probably a duck.' Experienced clinicians use this technique of pattern recognition frequently to rapidly reach a diagnosis. When using this method in the patient care setting, the learner takes the history and examines a patient and then presents the case to the teacher as a 'one-liner' with a presumptive diagnosis. For example, 'Mr. McHepsee is a 40-year-

old gentleman who has a history of hepatitis C, frothy urine, and palpable purpura on his hands, feet and ears. I think he has hepatitis C–associated cryoglobulinemia'. While the learner is writing the note, the teacher sees the patient and constructs a diagnosis and management plan. This is followed by a case discussion with the learner, review of the note and sign-off. Both the teacher and the learner must understand the process. The teacher needs to see the patient or know the diagnosis. If the teacher is unsure of the diagnosis, then this must also be communicated to the learner. It teaches the valuable lesson of being able to say, 'I don't know,' a widely recognized sign of clinical maturity [25].

One-minute observation

One-minute observation benefits the educator and learner in several ways. It is a quick way to observe the learner performing a specific skill such as discussing dialysis modalities, obtaining consent for a renal biopsy and so on. It is also a required part of medical training, the mini-clinical evaluation exercise (mini-CEX) [26]. The key to this method is immediate feedback to the learner. Documentation of the mini-CEX in the learner's portfolio allows tracking of improvement during residency or fellowship and is useful in the current evaluation using milestones.

The Five Microskills or 'the one-minute preceptor'

The Five Microskills are valuable in a number of ways. This method takes advantage of the teachable moment. It allows teaching on the fly, i.e. there is no preparation required for the learner or the teacher. It is best applied when the learner needs guidance in progressing to the next step. Examples include the learner who reports but stops before interpreting or the trainee who presents a general management plan but no specifics [27, 28]. The Five Microskills are as follows:

1. Get a commitment—'What do you think is going on?'
2. Ask about supporting evidence
3. Teach a general principle
4. Reinforce what they did correctly
5. Identify areas that need improvement

An example of this method in action is presented in Table 4.

Teaching in the classroom

The lecture is the most commonly used teaching method to present information to large groups of learners. When done well, it can introduce new material and can be recorded for online review. Since it is a controlled setting, the material can be presented in an organized fashion supported by evidence from other sources. Lectures have come under increasing criticism for being teacher centered, i.e. lacking the capacity to adjust to the learning styles of members of the audience. Lecture participation is passive, decreasing the retention of salient points from the presentation.

Table 4. Use of the Five Microskills teaching technique in nephrology education: a renal fellow presenting a case of multifactorial acute kidney injury in a patient with oliguria

Step		Example
1. Get a commitment	*Preceptor:*	'What do you think is going on?'
	Learner:	'I think he has ATN.'
2. Ask for supporting evidence	*Preceptor:*	'What supports your diagnosis?'
	Learner:	'The patient has exposure to IV contrast, aminoglycosides and his systolic BP has been less than 90 mmHg for several hours.'
	Preceptor:	'What did the urine sediment show?'
	Learner:	'I didn't do that. It is obvious from the history that he has ATN.'
3. Teach a general principle	*Preceptor:*	'The situation you describe is certainly consistent with ischemic or toxic ATN. A urine sediment exam showing dirty brown granular casts would help confirm your diagnosis and eliminate other possibilities.'
4. Reinforcement	*Preceptor:*	'You did a nice job identifying the possible causes of the patient's acute kidney injury.'
5. Identify areas that need improvement	*Preceptor:*	'Always make sure you check the urine sediment by microscopy. Come on, let's get some urine and I'll show you how to do a poor man's renal biopsy.'

This scenario was a case with a novice first-year renal fellow. Subsequent evaluation showed a bland urine sediment and hydronephrosis on ultrasound due to an occluded Foley catheter. The fellow noted that it was a valuable lesson.

Other criticisms include an unenthusiastic speaker who reads his/her slides and turns his/her back on the audience as well as sensory overload (death by PowerPoint) caused by too much information per slide, too many slides, small font size and unnecessary animations. However, lectures remain one of the primary methods of teaching. There are many guides on proper and improper presentations [29–33]. The following hints are taken from these sources as well as the authors' own experience in critiquing and giving lectures.

1. *Preparation*: The speaker must understand what the audience wants and the level of the learner in the audience. The needs of a medical school class are far different than those of colleagues at a specialty society meeting. A lecture should stick to a single topic, delineate a few specific learning objectives and deliver the material as a flowing coherent process. Before the PowerPoint program is opened, an outline of the presentation is very helpful in organizing the material needed.

2. *Keep it simple*: Speakers are invited because they are experts on a topic. As experts, we are passionate about our areas of interest. Presenters frequently make the error of flooding the audience with too many details. There is no quicker way of losing your listeners than by referring to obscure factoids that have little to do with your major themes. Pick three or four main points that you want the audience to take home, emphasize them in the beginning, discuss them in the body of the talk and state them clearly when finishing.

   Slide mechanics: Please remember, you are the focus of the presentation, not the slides. The PowerPoint presentation is a tool to help you develop the three or four objectives of your talk. Therefore, slides should be easy to read. Your text should be clearly visible on the background: white or pale text on a dark background or black or dark blue on lighter backgrounds. Next, use a font that is readable from the back of the room. The larger the venue, the larger the font should be. Anything less than a 28-point font will frustrate the audience due to the difficulty in reading it. Fonts that are sans serif such as Calibri or Arial work better in presentations than fonts such as Times New Roman that function better on the printed page. These guidelines also apply to tables and figures. A table with 30 rows showing a study's population demographics is distracting and irritating. Pick those rows that deserve to be highlighted and present that material on a slide or highlight and expand the rows of interest. The speaker should not be saying, 'I apologize for this busy slide.'

   Limit the material on the slide. A useful rule is six lines per slide and six words per line. When possible, the presentation should use pictures with color [33, 34]. These have the highest retention rate after the lecture. A slide should have one message and be parsimonious in the number of pictures, figures and graphs. A slide that contains a western blot, two complicated bar graphs and the proposed structure of an epithelial transporter is confusing and dilutes your message.

   Finally, as demonstrated in the McMillan [32] and Phillip [33] web links, be cautious with animation. The use of this tool can be helpful in providing emphasis. When overused, animation distracts from the presenter and from the presentation.

3. *The presenter*: Giving a lecture is, in many ways, a performance. Interacting with the audience through body language, enthusiastic delivery and smiling enables the speaker to more readily engage those in attendance. Position the computer monitor on the podium so that you can maintain eye contact with the audience. Do not turn your back on the audience to highlight areas with a laser pointer. Slide emphasis can be much more effectively done by using simple animation to have a line of text or figure appear in the slide or by using the computer's pointer function. Above all, *do not read the slides*. The audience knows how to read and nothing is more boring than a speaker reading his presentation in a monotone.

   Illustrate concepts with stories from your experience. Patient cases are particularly useful when giving clinically based talks, but stories can also be used in basic science lectures to note how a particular collaboration came to be or the background behind an experiment that led to a new discovery.

   Lastly, speakers should actively try to 'reboot' the audience every 10–15 min. Bligh [35] has shown that the audience's attention will start to diminish ~10 min into a talk. Knowing this, the presenter should use these intervals to regain the audience by asking questions, telling a story or presenting a case.

4. *Rehearse*: Practicing the lecture can reveal much that is right or wrong with a lecture. The presentation should be given out loud to a colleague. This allows the presenter to assess the amount of time needed to give the lecture, to evaluate

transitions and to obtain feedback on the effectiveness of a lecture. The use of a coach is invaluable in improving presentation skills.

Teaching in small groups

Small group interactions are frequent in the clinical and preclinical years of medical education. Before entering the wards, medical students traditionally participate in workshops and problem-based learning sessions. Increasingly, 'flipped classrooms' and team-based learning sessions are being introduced. In the clinical setting, work rounds, morning report and teaching rounds have been a mainstay of instruction [21, 36]. Small groups encourage active learning, provide greater interactions among students and with the teacher and enhance communication skills and team work.

As with any educational exercise, the teacher must be prepared. Knowing how many learners will be in the group and the level of training is vital. The teacher must include all participants in the discussions, establish goals for the sessions (patient care, interpretation of labs, images, etc) and encourage interaction within the group as well as peer teaching. Resources such as electronic medical records and computerized knowledge bases or reference texts should be available for further discussion, answering questions and clarifying decision making.

As discussed previously, the facilitator should have group members introduce themselves and determine what the individual goals are for each learner at the beginning of the session. The teacher must also clearly state the goals expected for the small group sessions. After the session starts, the facilitator guides the small group conference. Telling the group that participation is expected may require gentle questioning of less involved learners and steering discussion away from more vocal learners, giving all an opportunity to participate. Define tasks, e.g. 'I would like you to present this patient' or 'Can you find out what information is available on treatment of this illness?' Resist the urge to lecture and talk too much. The facilitator's job is to lead and encourage discussion and not be the focus of the activity. The microskills approach discussed previously is a good approach.

Conclusions

During training, doctors receive little or no preparation in how adults learn or on how to teach the skills of clinical practice, patient care and research. As interest in nephrology fades and the need for nephrology care and insights into the functioning of the kidney grows, we as a community must reignite the spark in our learners that captured our own excitement. We must also prepare our fellows to practice high-quality clinical care and undertake research to understand renal physiology and pathophysiology. Effective and enthusiastic teaching in medical school and residency is a first step in this direction. Teaching skills are not some mysterious or arcane talent limited to a few. Excellence in education can be taught and matured with faculty development and teaching coaches. Building time for education into our schedules in the lab, on the wards, in the clinic and in the classroom will pay benefits later by increasing interest in our field and producing inquisitive and competent nephrologists. Rewarding good teaching through academic advancement of clinician educators will also forward this goal. Our hope is that reviews such as this will increase efforts in the field to mentor and develop the nephrologists of the future.

Conflict of interest statement

H.R.-B. is a member of the advisory board of Astute Medical Inc.

References

1. Salsberg E, Quigley L, Masselink L et al. The US Nephrology Workforce: Developments and Trends. https://www.asn-online.org/education/training/workforce/Nephrology_Workforce_Study_Report_2015.pdf (April 24, 2016, date last accessed).
2. Pivert K. NRMP SMS Nephrology Match for Appointment Year 2016–2017: ASN Brief Analysis. https://www.asn-online.org/education/training/workforce/ASN_NRMP_SMS_2016_Analysis.pdf (April 24, 2016, date last accessed).
3. Jhaveri KD, Sparks MA, Shah HH et al. Why not nephrology? A survey of US internal medicine subspecialty fellows. Am J Kidney Dis 2013; 61: 540–546
4. Jhaveri KD, Perazella MA. Nephrologists as educators: clarifying roles, seizing opportunities. Clin J Am Soc Nephrol 2016; 11: 176–189
5. Hoenig MP. Share your passion for nephrology: ten tips to invigorate attending rounds and precepting sessions. Am J Kidney Dis 2015; 66: 28–32
6. Jhaveri KD, Shah HH, Mattana J. Enhancing interest in nephrology careers during medical residency. Am J Kidney Dis 2012; 60: 350–353
7. Jhaveri KD, Sparks MA, Shah HH. Novel educational approaches to enhance learning and interest in nephrology. Adv Chronic Kidney Dis 2013; 20: 336–346
8. Elnicki DM, Cooper A. Medical students' perceptions of the elements of effective inpatient teaching by attending physicians and housestaff. J Gen Intern Med 2005; 20: 635–639
9. Sutkin G, Wagner E, Harris I et al. What makes a good clinical teacher in medicine? A review of the literature. Acad Med 2008; 83: 452–466
10. Stern DT, Williams BC, Gill A et al. Is there a relationship between attending physicians' and residents' teaching skills and students' examination scores? Acad Med 2000; 75: 1144–1146
11. Griffith CH III, Georgesen JC, Wilson JF. Specialty choices of students who actually have choices: the influence of excellent clinical teachers. Acad Med 2000; 75: 278–282
12. Merriam S, Caffarella R, Baumgartner L. Learning in Adulthood: A Comprehensive Guide. San Francisco, CA: Jossey-Bass, 2007
13. Knowles MS. The Adult Learner: A Neglected Species. 4th edn. Gulf, 1990
14. Kaufman DM. Applying educational theory in practice. BMJ 2003; 326: 213–216
15. Kolb DA. Experiential Learning: Experience as the Source of Learning and Development. Englewood Hills, NJ: Prentice-Hall, 1984
16. McCarthy B, McCarthy D. Teaching Around the 4MAT Cycle. Thousand Oaks, CA: Corwin Press, 2006
17. Irby D, Bowen J. Time-efficient strategies for learning and performance. Clin Teach 2004; 1: 23–28
18. Kern D, Thomas P, Hugues M. Curriculum Development for Medical Education. A Six-Step Approach. 2nd edn. Baltimore, MD: Johns Hopkins University Press, 2009
19. Bloom BS, Engelhart MD, Furst EJ et al. Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I, Cognitive Domain. New York, NY: Longmans Green, 1956
20. Alguire P, DeWitt D, Pinsky L et al. Teaching in Your Office. Philadelphia, PA: ACP Press, 2008
21. Wiese J. Teaching in the Hospital. Philadelphia, PA: ACP Press, 2010
22. Irby DM, Wilkerson L. Teaching when time is limited. BMJ 2008; 336: 384–387
23. Jaques D. Teaching small groups. BMJ 2003; 326: 492–494

24. Ramani S, Leinster S. AMEE Guide No. 34: teaching in the clinical environment. *Med Teach* 2008; 30: 347–364

25. Cunningham AS, Blatt SD, Fuller PG *et al.* The art of precepting: Socrates or Aunt Minnie? *Arch Pediatr Adolesc Med* 1999; 153: 114–116

26. Norcini JJ, Blank LL, Arnold GK *et al.* The mini-CEX (clinical evaluation exercise): a preliminary investigation. *Ann Intern Med* 1995; 123: 795–799

27. Neher JO, Gordon KC, Meyer B *et al.* A five-step "microskills" model of clinical teaching. *J Am Board Fam Pract* 1992; 5: 419–424

28. Parrot S, Dobbie A, Chumley H *et al.* Evidence-based office teaching—the five-step microskills model of clinical teaching. *Fam Med* 2006; 38: 164–167

29. Brown G, Manogue M. AMEE Medical Education Guide No. 22: refreshing lecturing: a guide for lecturers. *Med Teach* 2001; 23: 231–244

30. Harden RM. Death by PowerPoint—the need for a 'fidget index'. *Med Teach* 2008; 30: 833–835

31. Holzl J. Twelve tips for effective PowerPoint presentations for the technologically challenged. *Med Teach* 1997; 19: 175–179

32. McMillan D. *Life After Death by Powerpoint.* 2010. https://www.youtube.com/watch?v=2gt0XlY_Dd4 (May 1, 2016, date last accessed).

33. Phillip D. *A Seminar on How to Avoid Death by PowerPoint, Full with Practical Usable Tips.* https://www.youtube.com/watch?v=bOrHxRB3JrQ (May 1, 2016, date last accessed).

34. Cantillon P. Teaching large groups. *BMJ* 2003; 326: 437

35. Bligh D. *What's the Use of Lectures?* San Francisco, CA: Jossey-Bass, 2000

36. Skeff K, Stratos G. *Methods for Teaching Medicine.* Philadelphia, PA: ACP Press, 2010