The Impact of the Electronic Health Record (EHR) on Dental Education
“It is likely that the EHR of the future, embedded with advanced clinical decision support and artificial intelligence, will be able to do some of the tasks of the dental provider.”
A Note from the 2016 Chair of the Academy of Distinguished Educators

This year marks five years since the inception of the Academy of Distinguished Educators at the NYU College of Dentistry (NYUCD). There are several reasons for considering this a “special” issue of the Journal of the Academy of Distinguished Educators (JADE). First is the content of this edition. Dental education, with new technologies emerging, will have a profound impact on all us. This issue looks at how the blending of these two worlds may have an impact both on learning for our students and teaching for our faculty. Included in the Journal are the viewpoints of experts on the challenges ahead.

The second reason the Academy considers this a special issue is because of the transition that is taking place with this edition and that I feel is most important to mention. JADE would not have been published if it were not for the expertise and knowledge of Dr. Mary Northridge, the inaugural chair of the JADE Editorial Board. Mary, along with Elyse Bloom, the Executive Editor, has been responsible for all the innovative editions that have preceded this issue. It is with this issue that Mary took the time to train and support Dr. Silvia Spivakovsky, the incoming Editorial Board chair, in preparation for her new role.

I will take this opportunity, in the name of the Academy, to congratulate Silvia on her new position and to extend our gratitude to Mary. The Academy is very grateful for all she has accomplished in bringing the Academy to its current level.

Thank you and enjoy the new edition.

By Analia Veitz-Keenan, DDS
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A Note from the Incoming JADE Editorial Board Chair

It is with pleasure and pride that I introduce the latest issue of the Journal of the Academy of Distinguished Educators (JADE).

As the newest member of the JADE team, I had the opportunity to experience, first hand, the exciting creative process from its inception while at the same time learning from the best.

This issue of JADE incorporates each and every aspect of what the Academy stands for. We explored an issue that is timely and relevant to clinical education, with collaboration among Academy members and outside experts. We were guided, supported, and mentored every step of the way.

Since the implementation of the EHR at the NYU College of Dentistry, we were both curious and cautious about its possible effects on the development of students’ critical thinking abilities. Together with my colleague and co-guest editor of this issue, Dr. Debra Ferraiolo, we began to ask questions like: What will be the effect of menus and guiding options on the students’ ability to think independently? Will students stop and pay attention to an important issue in the absence of pop-up windows? How will students be able to demonstrate critical thinking in the clinic setting?

Because of our interest in this issue, we chose to address the topic of the effect of the EHR on dental education and enlisted foremost experts to share their personal perspectives on the topic. Debra and I developed our piece...
from the perspective of our experience with the EHR and how it has impacted the courses we teach.

A centerpiece article by one of the most knowledgeable and experienced authors on the topic, Dr. Muhammad Walji, from the University of Texas Health Science Center at Houston School of Dentistry, walks us through positives, potentials, and shortcomings of a variety of issues related to the EHR.

Commenting on the centerpiece article are two equally experienced and renowned authors in their fields: Dr. Heiko Spallek of the University of Sydney, and Dr. Rachel Ramoni of NYU and Harvard.

“Since the implementation of the EHR at the NYU College of Dentistry, we were both curious and cautious about its possible effects on the development of students’ critical thinking abilities.”

Dr. Spallek concentrates on technological aspects and introduces us to very provocative issues like computable industries, artificial intelligence, and the way they may help shape the future healthcare provider. Dr. Ramoni focuses on the value of records and the advantages and importance of developing data sharing platforms using a common language.

I hope you enjoy reading this issue as much as I did in helping to create it.

To continue the conversation or to start a new one you can contact us at jade@nyu.edu

A special thanks to Mary Northridge for taking me under her wing and making me part of her legacy at the Academy.
A Note from the Executive Editor

Welcome to the spring 2016 issue of the Journal of the Academy of Distinguished Educators (JADE). From its inception in 2013 to the present, JADE has had as its goal to reflect and advance the think-tank mission of the Academy of Distinguished Educators at the NYU College of Dentistry (NYUCD). Specifically, the Academy seeks to advance the art and science of teaching and learning at the College; stimulate interest in teaching practice, change, innovation, and scholarship; and network and collaborate with educators within and beyond the College to share best practices.

In support of this mission, JADE strives to promote the free exchange of ideas by creating a forum in which educators are encouraged to propose bold theories and are not afraid of encountering opposition. To that end, JADE invites experts in higher education to face off on the thorny issues confronting higher education, even as it endeavors to foster interdisciplinary and interprofessional collaborations. JADE acknowledges that not every pedagogical idea is going to motivate students to learn, but that in order to discover the ones that will, it is necessary to explore.

The theme of this edition of JADE, “The Impact of the EHR on Dental Education” has special resonance for NYUCD as we transition to a comprehensive electronic health record. That transition is led by Dr. Mark Wolff, professor and chair of the Department of Cariology and Comprehensive Care and associate dean for predoctoral clinical education and for development. The system integrates business, clinical, and radiographic systems into one HIPPA compliant paperless record.

We at JADE hope that in reading this issue you will feel that you are listening to an intertextual conversation that is both insightful and provocative, and that you will be moved to join the conversation. Please let us know what you think about the theme we explore in this issue by contacting us at jade@nyu.edu, and also let us know what themes you would like us to focus on in future issues.

By Elyse Bloom, MA
Assistant Dean
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Since their inception, electronic health records (EHRs) have had a major impact on the health care and policy environments. Although patient privacy and implementation challenges have received broad attention, the effects of EHRs on teaching and learning are less well known.

The changes are far-reaching and involve more than simply a technological alternative to paper charts. With their ability to access data historically and via other health systems, EHRs can more closely integrate medical and dental services to provide patient-centered care. With their potential to reduce provider input errors and flag concerning values and contraindications, EHRs can improve patient safety and quality of care. And through the use of an intelligent decision support system (IDSS) to prompt and guide providers through the information-gathering process, EHRs can aid in patient diagnosis and treatment planning.

Despite these heartening possibilities, there is uncertainty regarding the impact of EHRs on students’ abilities to develop critical-thinking skills and instructors’ capacities to assess student competencies. The American Dental Education Association (ADEA) defines critical thinking as “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual,
As NYUCD clinical faculty, developing and assessing students’ critical thinking in practice environments is at the heart of what we do every day. Before the introduction of our EHR system, we observed the process of information gathering by students from patients, and evaluated the type and quality of the questions asked and students’ subsequent analyses. We believed that students’ abilities to generate appropriate questions followed by their interpretations of the findings were valid means for assessing their critical-thinking skills related to the dental management of a range of medical conditions.

Our third- and fourth-year dental students are tasked with applying the didactic training gained during their first two years of dental school to caring for their patients in clinical settings. As their supervisors and mentors, we have gained familiarity with those sections of the EHR related to patient diagnosis and medical management. As our first year of implementation draws to a close, vital questions have surfaced. Most central of these is, “What will be the effect of EHRs on students’ abilities to develop critical-thinking skills?” Further, “How does using an IDSS affect the development of student judgment in diagnosis and treatment?” And finally, “Will the set structure and guided approach affect students’ abilities to practice dentistry independently, for instance, in practices with alternative EHRs in operation or in settings such as schools without EHR systems in place?”

Previously, we depended upon the unscripted nature of the patient interview process to assess student competency. Because these encounters no longer exist, we are searching for replacement options. The real-world attributes of service learning create challenges, including the tension between assessing student progress and competency while assuring patient safety and quality of care. Ultimately, it is our responsibility as clinical faculty to create environments that foster critical thinking and place students on the path to lifelong learning. Our overarching pedagogical goal is
to foster the development of oral health professionals who use the best available evidence along with their clinical judgment and patient preferences to inform their decision making in caring for their patients.

In our view, continued evolution of EHR systems would do well to include both guidance from clinical faculty who use the EHR as a teaching tool and feedback from their students. Successful EHRs ought to enhance students’ abilities to gather key patient data—both self-reported dental and medical history information and clinical examination results. Students need to ask the relevant questions that lead to appropriate indicators for

“In our view, continued evolution of EHR systems would do well to include both guidance from clinical faculty who use the EHR as a teaching tool and feedback from their students.”
Do EHRs Affect Students’ Abilities to Develop Critical-Thinking Skills?

developing and analyzing medical management plans. The challenge for developers of EHRs is to proceed iteratively, ensuring that all essential aspects of their implementation are considered in order to maximize student learning and patient care.

To achieve their highest standards, EHRs should also allow for the assessment of competency in all aspects of dental care in order for students to become oral health professionals who deliver quality care to their patients. At present, it is unclear whether EHRs will abet the development of dental students into healthcare providers who can confidently practice as independent, self-assessing practitioners. Instead, students often report being overwhelmed with the mechanics of completing the EHR forms and obtaining the requisite approvals, rather than focusing on the relevance of the patient information received and interpreting it properly to arrive at proper diagnoses and management plans.

As with any innovation of this magnitude and complexity, EHRs stand to benefit from the experiences and expertise of many stakeholders, including clinical faculty. In particular, we recommend assessing critical thinking and competency via a Competency Chart, where development and progression of each case depends on the questions students pose and the decisions they make. Appropriate answers then lead to the correct diagnosis and

ADEA considers critical thinking to be the process of assimilating and analyzing information. This encompasses:

• an interest in finding new solutions,
• a curiosity with an ability to admit to a lack of understanding,
• a willingness to examine beliefs and assumptions and to search for evidence to support these beliefs and assumptions, and
• the ability to distinguish between fact and opinion.

Resources available at:
http://www.adea.org/about_adea/governance/Pages/Competencies-for-the-New-General-Dentist.aspx
Do EHRs Affect Students’ Abilities to Develop Critical-Thinking Skills?

“It is our intent in this guest editorial to open the debate to make certain that all relevant perspectives are heard, including those of the authors featured in this issue of JADE.”

In August 2010, the American Dental Association (ADA) adopted a resolution stating that dental school graduates must be competent in the use of critical thinking. In the accreditation standards, critical thinking is one of the principles and also part of Standard 2, Educational Program. The intent is for educational programs to use teaching and learning methods that support the development of critical-thinking and problem-solving skills.

Resources available at: http://www.ada.org/~/media/CODA/Files/predoc.aspx

It is our intent in this guest editorial to open the debate to make certain that all relevant perspectives are heard, including those of the authors featured in this issue of JADE. In this way, we can best ensure that the promise of EHRs to enhance student learning and patient care is achieved, without the peril of diminished critical thinking of future generations of oral health professionals.

Reference

Paper health records, until recently, have shown a remarkable resilience against the technological tidal wave that has swept through other industries. However, electronic health records (EHRs) are now being rapidly adopted. Most dental schools have one, or will implement one soon. The government isthrowing money at healthcare providers to buy and use them. Some dental schools have reaped significant funds to offset the costs of EHR implementation through the “meaningful use” incentive program.(1) According to the Office of National Coordinator, the purpose of “meaningful use” is to use an EHR to:

- “Improve quality, safety, efficiency, and reduce health disparities
- “Engage patients and family
- “Improve care coordination and population and public health
- “Maintain privacy and security of patient health information”(2)

In dental schools, the EHR serves as a critical tool to manage patient care and to assess and document students’ clinical experiences. The EHR is often the fourth member of a dental encounter along with the patient, student dentist, and supervising faculty. In some cases, the dental provider and EHR spend more time interacting with each other than with the patient.
In addition, the patient can now interact directly with the EHR, bypassing the person at check-in by using a kiosk, or by logging into the web portal to confirm an appointment or complete a medical history.

While good progress has been made in the development, adoption, and use of EHRs in dental schools, there is still much work to be done before we can fully realize the benefits of improved patient care while at the same time fostering an excellent learning environment for our students.

EHRs Can Help Make Care Safer, of Higher Quality, and More Cost Effective

One of the biggest potential advantages of adopting and using EHRs is the promise of improving the safety and quality of care. Information in EHRs is more legible and readable than in paper charts. The potential for misinterpreting poor handwriting is minimized. Unlike paper charts, the information is available on demand to those who need it. Increased access to information is thought to lead to reduced costs, as healthcare providers have access to all prior exams and imaging studies, thereby lessening the need to redo these costly procedures.

However, there is limited compelling evidence to date that demonstrates that quality or safety of care has dramatically improved following the implementation of EHRs. In some hospital settings, the mortality and morbidity rate of patients actually worsened. (3) Much of this is blamed on misconfigured and poorly designed EHRs and workflows. As we have learned in dental schools, a collaborative effort is required by clinicians, IT teams, and software vendors to deploy systems that are both useful and usable. (4)

Accordingly, the EHR in dental schools is being used to explore the safety and quality of care provided. We are asking such questions
as: “Do we know how many times the wrong tooth is extracted?” The EHR contains valuable data which we can use to answer such questions. A team of researchers from the dental schools at UTHealth at Houston, Harvard, UCSF, and OHSU are working on mining such EHR data to quantify and identify the types of adverse events experienced by patients while undergoing dental care.

Another approach to improving the safety and quality of care through the EHR is the use of clinical decision support (CDS) which “provides clinicians, staff, patients, or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care.”(5) Alerts and reminders that pop up on the screen notifying the provider that the patient is allergic to a medication or that a consent form needs to be signed are examples of CDS. As our colleagues in medicine have learned, these approaches are helpful but can also backfire. Due to the sheer numbers of false alerts in medical EHRs, the vast majority of computerized drug interaction alerts are ignored.(6) So even relevant alerts will be mistakenly dismissed, leading to potentially fatal consequences. Our challenge in dentistry is to be parsimonious when implementing CDS into our systems.

**EHRs as Student-Learning Platforms**

EHRs are designed primarily to document clinical care, billing, and scheduling. In dental schools our systems also need to have built-in safeguards to prevent students from treating patients without faculty approval. Moreover, we need functionality to grade and evaluate student clinical work and to keep track of competencies attempted and mastered. Data collected in our EHRs are also used for accreditation and other reporting requirements, as well as for ongoing quality improvement processes.

Although less recognized, the EHR also influences the way our students learn. I have seen how students now pause and think more carefully about their patients’ diagnoses before selecting a treatment because the EHR now requires an explicit diagnostic term to be
Recent evidence suggests that the introduction of diagnostic terminology may have a positive impact on students' critical-thinking skills. Similarly, structured templates in the EHR serve as a reminder to help guide the comprehensiveness of the notes that are produced. In addition, e-prescribing applications, if well designed, help to identify potential drug interactions and provide an opportunity for discussing alternatives with the supervising faculty as well as with the patient.

It is likely that the EHR of the future, embedded with advanced clinical decision support and artificial intelligence, will be able to do some of the tasks of the dental provider. For example, our EHRs can already calculate a patient’s caries risk status based on a simple algorithm after a user inputs some data. In the future, our EHRs may be able to identify an appropriate dental diagnosis automatically by “reading” a radiograph or detect a rare lesion by interpreting a high-resolution, intraoral image.

There is, of course, debate whether such “intelligent” EHRs will make our students “less smart.” After all, making effective clinical decisions is one of the skills dental students
need to master through practice and experience. One challenge we currently have is that the teams responsible for the EHR are often separate from the learning and education specialists at our schools. It is perhaps time to see the EHR as a learning and support platform, and to involve our faculty experts and instructional technologists in helping to determine how we can best structure the EHR of the future to support student learning as well as to ensure high-quality patient care.

“One challenge we currently have is that the teams responsible for the EHR are often separate from the learning and education specialists at our schools.”

EHR Has Fostered a Sharing and Learning Community

Dental schools love to share. We have organizations such as the American Dental Education Association (ADEA) that bring the academic dental community together to help discuss curricular issues. The purpose of a sharing community is to learn from each other while at the same time advancing the field. Not surprisingly then, the rapid adoption of EHRs among dental schools has spurred the growth of a sharing and learning community around this development. The Consortium of Oral Health Research and Informatics (COHRI) was formed in 2007 by a group of dental faculty and staff from dental schools that use the axiUm EHR.(9) This group has rapidly grown to include 38 member institutions committed to collaboration. The mission of COHRI includes working together to develop research projects to promote evidence-based dentistry and to define and facilitate the implementation of best practices and standards of care. The schools are motivated by the potential for pooling standardized data and have already developed standardized forms to collect medical and dental histories. Six of these schools now also contribute EHR data to the Big-Mouth Dental Data Repository, which contains data on over two million patients.(10) It contains demographics, diagnoses, procedures, periodontal measurements, odontogram/tooth measurements, medical and dental histories, and information about the provider type (hygienist, dentist, dental student, resident). BigMouth was recently used to determine significant gaps in how institutions followed
Perhaps the most exciting component of COHRI is the potential for dental schools to learn from each other. In medicine, there has been increased interest in a “learning health system,” or LHS. The goal of a learning health system is to “improve the health of individuals and populations. The LHS will accomplish this by generating information and knowledge from data captured and updated over time—as an ongoing and natural by-product of contributions by individuals, care delivery systems, public health programs, and clinical research—and sharing and disseminating what is learned in timely and actionable forms that directly enable individuals, clinicians, and public health entities to separately and collaboratively make informed health decisions.”

The EHR is a critical component of a learning health system as we need data to learn. However, one of the biggest challenges is interoperability of data stored in our disparate systems. Currently, many of our institutions are part of large academic medical centers. Dentists, nurses, physicians, and other providers all strive to provide safe and effective health care to patients at our clinics. As we move toward team-based and interprofessional care, there is an even greater need for a common understanding among health professionals regarding a patient’s health status and care needs that include medical, nursing, and oral health care. We share patients between our dental and medical clinics, but few of us use the same EHR. In addition, the terminology and vocabulary used within these records are often not consistent. Any vocabulary must be relevant, understandable, and useful to multiple health professionals for efficient, effective, and safe delivery of health care. While many have opined for decades about the lack of diagnostic coding in dentistry, not until recently has there been a movement to adopt diagnostic terminology.

“While it is unlikely that we will all use the same EHR, we do need to ensure that patient data can be passed seamlessly among our systems.”
The EHR of the Future: Supportive, Collaborative, and Barely Noticeable

ones where they do not exist. COHRI is an example of a collaborative platform for such work to occur in dentistry.

The EHR of the Future

Moving from paper to digital health records has been a paradigm shift. Paper is flexible, malleable, and portable. Moving to computers has required a generation of healthcare providers to change the way in which they work and document care. Currently, the majority of data in EHRs are painstakingly entered manually through the keyboard and mouse. We may take the blood pressure of a patient using the latest digital technology, but we still have to walk over to and enter findings into the EHR. The EHR of the future will automatically capture such data. Further, data we store in the EHR will likely include that which is generated outside the walls of our clinics. Patients are already self-monitoring the number of steps they climb and the food they eat. As sensors become more ubiquitous, it is not inconceivable that rather than asking a patient if they brush and floss, we will be able to see a graph of their oral hygiene behavior as reported by their toothbrushes. Our students and faculty will likely need some additional training in informatics to manage this onslaught of data. But it will be the role of the EHR, like any good technology, to provide the support necessary to extend the effectiveness and capabilities of humans so that the EHR of the future will be as integrated into dentistry as the dental handpiece is today.

“It is perhaps time to see the EHR as a learning and support platform, and to involve our faculty experts and instructional technologists in helping to determine how we can best structure the EHR of the future to support student learning as well as to ensure high-quality patient care.”
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Muhammad Walji describes the many opportunities that the EHR of the future will bring to dental education. He defines the EHR as a critical tool for managing the care of patients and the clinical education of students and judiciously assesses the potential benefits of the dental EHR for patient safety and clinical decision support. The use of standardized terminologies is the *sine qua non* for reaping the benefits of institutionally supported data repositories, such as the Consortium of Oral Health Research and Informatics’ BigMouth Dental Data Repository. Walji’s vision of connecting dental EHRs to the continuous learning health system’s infrastructure is another example of his forward-looking approach to the current state of dental EHRs that will benefit dental education in the years to come.

I argue, however, that despite our arrival in the age of computation, we are currently experiencing only a slow and gradual increase in our ability to improve the care of our patients and the education of our students. As I have
recently outlined with some of my colleagues in an article describing the cost of health information technology in dental education (1), these gradual improvements come at a high price. Many educators assert, quite understandably, that investing in hiring more clinical educators to improve the faculty-student ratio would be more advantageous to patients as well as to students. Despite spending precious clinical encounter time to enter data into “poorly designed records [that] act more as loosely woven historical archives than as a clinically useful database,” we still find that most EHRs are “described as WORN—write once read never.”(2) Dental educators are only beginning to use EHR data and virtual cases to transition students from the basic sciences to the clinical sciences. To be honest, it appears that at times we still argue about whether or not we should use laptops.(3) And while society is mostly enthralled by the implications of social media radically changing how we interact with our surroundings and each other, dental educators have just started the discussion of its effects on provider-patient interactions.(4,5,6)

**“Dental educators are only beginning to use EHR data and virtual cases to transition students from the basic sciences to the clinical sciences. To be honest, it appears that at times we still argue about whether or not we should use laptops.”**

During the American Dental Education Association (ADEA) fall 2015 meeting in Chicago, Tom Wujec introduced dental educators to the concept of “computable industries” in his keynote address. Wujec, who carries the title of Chief Disruptor at Autodesk, one of the world’s largest software companies and leaders in 3D design, shared his proven approaches to encourage exploration, engagement, prototyping, and innovation. He argued that industries that become computable quickly enter an exponential growth phase
inspired by human innovation and digitization of business processes.

Where are we heading in dental education and what will the “exponential growth phase of computable industries” that Wujec describes look like in dentistry? A few examples might give us a glimpse into the future.

The fast growth of the tech industry will inevitably affect dental EHRs. Companies like Amazon, Google, and Microsoft build huge server farms for the Cloud, removing considerable hardware equipment costs.(7) Would it not make sense for dental EHR users and vendors to explore reducing costs by exploiting the power of the Cloud, now that we can purchase computing power on an as-needed basis? One company, ICE Health Systems, is trying to do this in collaboration with the universities of Michigan, Pittsburgh, North Carolina Chapel Hill, and Buffalo.(8)

After the IBM supercomputer Deep Blue won a chess game in a 1996 match against Garry Kasparov and after IBM’s Watson won Jeopardy in 2011, we saw the first “Watson-enabled” hospitals.(9) Watson, originally designed as a question-answering computer system capable of answering questions posed in human-computer interaction, acts as Oncology Expert Advisor at MD Anderson’s leukemia treatment center in Houston.(10) The IBM program can synthesize patient data, offer a set of possible treatments, and rate the confidence of its recommendations. Watson’s performance is not magic, but rather it is the result of what is known as machine learning—a laborious process guided by computer scientists and clinicians facilitated by huge reference databases. When Watson makes mistakes, it self-adjusts and thus continuously improves the underlying algorithms to generate better output.(11)

Given these advances in the “intelligence” of computer systems, will we finally start to overcome the culture in medicine of heroic individualism (12,13), autocracy, and meritocracy (14), and embrace clinical decision support tools? Nobel-prize winner Daniel
Kahneman writes that “proponents of algorithms have argued strongly that it is unethical to rely on intuitive judgments for important decisions if an algorithm is available that will make fewer mistakes.” (15) As the Institute of Medicine (IOM) stated in 2013, “Today in health care, there is more to know, more to manage, and more to do than ever before. The rate at which new scientific knowledge is being produced outstrips the cognitive capacity of even the most adroit clinician to monitor and evaluate effectively.” (16) Clinicians need to understand that using computers to make better decisions for patients does not pit the computer against the clinician as demonstrated in chess or jeopardy, but enables the clinician to focus on higher-level questions. As Steve Lubow, cited by Wenz (17), says, “People who were using a lot of time reducing data can now spend more time thinking about it and trying different things.”

Medicine needs a transformation like the one astronomy experienced after the printing press. In The Printing Press as an Agent of Change, Elizabeth L. Eisenstein writes that “Copernicus...was freed from the task of copying tables and charts, and thus had time for reading and reflecting.” (18) When will we be freed from measuring undercuts on plaster models and have sufficient time to think about the individual risk factors regarding the oral health of our patients? A first step in dentistry is the trigger tool—which identifies EHRs with characteristics (“triggers”) that are associated with adverse events in dentistry—that Walji helped develop for improving patient safety. (19)

Should we as dental educators be empowered by these developments or see them as an existential threat? The entrepreneur Elon Musk tweeted: “Hope we’re not just the biological boot loader for digital super intelligence. Unfortunately, that is increasingly probable.” (20) I do not share this bleak vision as I am convinced and energized by the notion that we can improve oral health and dental education by creatively using information technology and combining it with human intuition and creativity. These technologies, as Tom Wujec shared with dental educators, are first impossible, then impractical, next possible, and, finally, they are expected.
Is Dentistry a Computable Industry?

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If every dental clinic and medical-care facility fully shared their data, then, as a totality, these data would be profoundly more valuable and useful than they are in isolation. Collectively, these data could do extremely useful things: reveal the comparative effectiveness of treatments, identify links between oral and general health, and identify regional trends in disease, to name just a few. These are all components of the learning health system highlighted by Dr. Walji. The learning health system has a distinct and important population-level perspective. Precision medicine, on the other hand, emphasizes the individual patient. As President Obama said when he announced the Precision Medicine Initiative in January 2015, “That’s the promise of precision medicine—delivering the right treatments, at the right time, every time to the right person.” (1) As dentists, the era of precision medicine will allow us to ask and answer questions like, “How can all the information we have amassed benefit Mrs. Patel, who is sitting in my chair right now?”

Both the learning health system and precision medicine rely upon breaking down the silos that contain and constrain our clinical knowledge base, the vast majority of which is captured by dental and medical professionals in electronic health records.
(EHRs) all around the country and the world. Alas, with the exception of research efforts like the BigMouth Dental Data Repository, which was highlighted by Dr. Walji, clinical data exchange across institutional boundaries in dentistry is often limited to demographics like name and address, rather than substantive clinical information. Needless to say, demographics alone cannot drive robust learning or precision medicine. So what’s stopping us from reaping the rewards of all the countless hours of data entry into our EHRs?

There exist three major barriers to the broad-based data sharing that is required to drive the learning health system and precision medicine: 1.) data standards, 2.) privacy concerns, and 3.) institutional factors.

As Dr. Walji noted, we need to ensure that our systems can communicate. Think about it like people having a conversation: meaningful communication relies upon a shared vocabulary. If one person speaks Urdu and the other speaks Mandarin, little communication is going to occur. The same holds true for our EHRs. Having been isolated for so long, the terminologies underpinning our systems have become idiosyncratic, much like dialects within a country. This is a serious impediment to communication between two systems, let alone among the thousands of systems in use across the United States.

Because procedure codes (Code on Dental Procedures and Nomenclature, CDT) underpin billing, these have long been standardized across dental practices, so communication across systems about procedures should be relatively straightforward from a terminology point of view.

“A promising recent development is the emergence of standardized diagnostic terminologies, such as the Dental Diagnostic System (DDS) (2) and the Systematized Nomenclature of Dentistry (SNODENT).(3) Of course, it would be ideal if there were a single diagnostic terminology used by all dental clinics, but mapping (“translating”) meanings across the different terminologies is at least a tractable
problem. The larger challenge to the use of standardized dental diagnostic terminologies is both technical and social: These terms must be available in the EHR, and dental team members must be motivated to enter them.

The second impediment to broad-based data sharing is a concern for the privacy of our patients. In the clinical setting, the Health Insurance Portability and Accountability Act (HIPAA) serves to protect the privacy of individually identifiable health information. A first step, then, is to share data that has been de-identified, such as is being done in the Big-Mouth Dental Data Repository. The so-called safe harbor method to de-identify data is to remove a range of identifiers, including names, all elements of dates that are directly related to an individual except year, full-face photographs, etc. One can make substantial progress with de-identified data sharing, particularly in the context of learning health system population-level considerations. With that said, in the precision medicine setting, such as in the case of rare conditions, the act of de-identification makes the data substantially less useful. Broad sharing of identifiable data across institutions...
as part of clinical care will require fundamental shifts in HIPAA. Thus, this type of data sharing currently occurs primarily in the research setting, in which participants give informed consent to share their identifiable data.

Finally, institutional factors can present barriers to the kind of data sharing that will fuel both a learning health system and precision medicine. Data are viewed as both a commodity and a risk to healthcare institutions. They are a risk because release of the data could reveal information about the institution, such as success and failure rates, e.g., proportion of dental implants placed that fail. Data are a commodity because they represent a perceived competitive advantage in terms of learning and improvement. In an ecosystem without data sharing, practices with large datasets enjoy an advantage over smaller practices with yet smaller datasets.

All these points about data sharing may seem extremely theoretical. In fact, I have seen that data sharing has tangible implications for our patients. In addition to being a dentist, I am part of the National Institutes of Health-funded Undiagnosed Diseases Network.(4) The network is comprised of 13 Institutes working together to help patients with mysterious medical conditions find a diagnosis. Ultimately, these people most often are diagnosed as having extremely rare diseases. The patient and family adviser to our project is Matt Might. His son, Bertrand, was born with a mysterious disease. The family was able to obtain a diagnosis thanks to genetic sequencing, yet struggled to locate others with a similar condition. It wasn’t until Matt blogged about it that he was able to locate other children with the same condition as Bertrand’s. Today, as a group, they are able to understand the condition better and to advocate for research that may improve their children’s lives: They would not be able to do this as individual patients. I am personally inspired by the ingenuity and tenacity of people like the Might family; at the same time, I am inspired to

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wonder why we have not been able to create a culture and practice of clinical data sharing that would do some of the legwork for them.

I am not the only one asking these questions, and the Precision Medicine Initiative has the potential to catalyze the incorporation of data sharing into clinical practice. As individual practitioners, as a profession, and as institutions, we will have a choice to make: to embrace the promise and change of precision medicine or to continue to keep our knowledge and data siloed.

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