PROCEEDINGS OF THE 10TH ARCORA DISTINGUISHED PROFESSOR IN DENTISTRY SYMPOSIUM: THE CHANGING FACE OF DENTISTRY

The Forefront of Dentistry—Promising Tech-Innovations and New Treatments

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Abstract: *Change in our world is happening quickly. For dentistry, this is no exception, and now is the time to foster new opportunities. Advances in the foundational science of dental, oral, and craniofacial health are expanding and enabling personalized care built on strong discoveries in the fields of microbiology, immunology, and neuroscience. Digital communication through electronic health records, patient portals, and teledentistry is emerging as vital new armamentarium for contemporary dental practice. Wearables linked with smartphone apps are trending to monitor pain levels, postoperative symptoms, wound healing, and home oral health habits. Oral fluid diagnostics are rapidly surfacing for use in diagnostics, drug testing, and hormone detection. Manipulation of the oral microbiome is under investigation for caries management and for potential impact on systemic conditions. Resolving mediators of inflammation are promising for addressing the chronic inflammation that plagues periodontal patients. New imaging modalities paired with digital approaches and 3-dimensional printing are formulating disruptions in the technical aspects of dentistry. Augmented reality and virtual reality are providing great potential as teaching tools for dental students and bear promise for lifelong learning for providers. Optimization of information technology and the incorporation of data science partnered with artificial intelligence and machine learning to improve patient care in a learning health care system approach will benefit large numbers of patients. These are exciting times for our profession, yet we need to navigate these paths carefully. Technology needs to significantly and positively change the experience of those involved (patients, dentists, staff, payors). New technologies need to be backed with solid research and implementation science. Automation should focus on improving care with attention to expanding care to the underserved and not lose the critical human connection that our patients need. There is great potential in the emerging innovations yet also great responsibility to ensure they are evidence based on rigorous science and deployable with equity and sensitivity.*

Knowledge Transfer Statement: *This article discusses innovations in technology and treatments that have enormous potential to revolutionize our dental care, including novel concepts in electronic health records, communication between dentists and patients, biologics around diagnosis and treatment, digital dentistry, and, finally, the real-time optimization of information technology. The early implementation and validation of these innovations can drive down their costs and provide better dental and medical services to all members of our society.*

Keywords: digital dentistry, learning health systems, teledentistry, wearable, oral microbiome, auto-therapy

Introduction

"Gentlemen! This Is No Humbug"—This phrase was directly attributed to Dr. John Collins Warren, working with a dentist called Dr. William Thomas Morton, who made the first public demonstration of ether anesthesia at the Massachusetts

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General Hospital on October 16, 1846. Dr. Morton administered sulfuric ether to a patient in the surgical amphitheater, while Dr. Warren successfully operated on a congenital vascular malformation in the neck of their painless patient (Haridas 2016; Mashour 2016). This event was a moment in history where a particular innovation profoundly affected medicine and dentistry, which certainly changed the risks and facilitated the decision-making of all surgical treatments. Dentistry was always at the forefront of health care regarding the development of new biomaterials and approaches that benefit patients on a large scale, such as implementing anesthesia methods for procedures (Choi and Kim 2021), as the example above; developing novel materials for dental implants (Ricci and Terracio 2011); and the public health benefit with fluoride and nonrestorative treatments to prevent or manage caries (Urquhart et al. 2019). Nowadays, its creative approach has not ceased to expand to other medical and technology fields, including biosensors, e-health, learning health systems, and data sciences (Al Turkestani et al. 2021; Weber et al. 2021; Benoit et al. 2022; Pundir et al. 2022).

Nonetheless, there is always tension about adopting things that are just emerging that need more evidence of safety and effectiveness. The "no-humbug" expression used by Dr. Warren was not a surprising choice. We must think about innovations consolidated by evidence-based care and rigorous scientific studies to avoid dire consequences that can put patients at risk (Slayton et al. 2018; Howick et al. 2022; Xu et al. 2022), such as the failing protoplast/Teflon implants in the 1980s and 1990s that highly affected thousands of lives of patients with temporomandibular disorders (Lee et al. 2018). There is great potential to be more integrated than ever with patients and their other care providers via devices and combining medical and dental electronic health records. In fact, novel healthy technologies are extending our clinical ecosystem beyond the office. They now allow us to empower patients on their own treatment and lifestyle, as well as monitor and deliver our care more objectively in real time and remotely via sensors and mobile applications. These advances also optimize the concept of personalized care, where each patient receives a more customized treatment based on their biological profile, from modulating their microbiome or developing new targets of the inflammatory process such as specialized proresolving inflammatory mediators (Panigrahy et al. 2021). Combining holistic approaches and precise data analysis with machine learning (ML) from multiple teams will lead to more accurate diagnoses, successful treatment outcomes, and fewer mistakes in dental practice (Le et al. 2021).

After validating their benefit over conventional methods, there is an economic challenge with new health innovations and technologies. Due to their initial high costs and expertise requirements, they have limited upfront adoption and application and are frequently first deployed for wealthy patients and prominent academic and clinical institutions. This conundrum is well exemplified in dentistry with 3-dimensional (3D) printing. The early implementation of new technologies is an opportunity for all stakeholders in public health to test and invest in their scalability, including expert training and entrepreneurship, which will drive down their costs in a shorter time and provide better dental and medical services to all members of our society. Herein, we will discuss in detail 4 frontiers in innovation and treatments that have enormous potential to revolutionize our dental care—first, the new era of electronic record and communication between dentists and patients; second, the whole area of biologics around diagnosis and treatment, followed by digital dentistry, including 3D printing; and, last, the real-time optimization of information technology.

Electronic Dentist–Patient Communication

Traditional dental practices offer an ideal setting for patient education and care about preventing and treating dental, oral, and craniofacial diseases. Between those walls, the motivational communication between dentists and patients is crucial for changing patient oral health–related behavior (Inglehart 2019). However, technology has expanded our care ecosystem beyond the walls and the limited time of the traditional in-person appointments, allowing for remote and constant health monitoring and treatment compliance. In turn, patients have gained more access and control of their treatments and health records, sometimes from the convenience of their home. This advantage amplifies the delivery of care, or at least its assessment, to patients physically impaired, living in remote areas, or without local health care infrastructure. This increased interchanging of health information and outreach has largely benefited our society but also posed rapid challenges to guarantee, for instance, the timely response to meaningful changes in the patients' clinical status, the proper integration of the health information and care of patients seen by multiple dental and medical specialists, and the establishment of a payer model that can make this more holistic treatment sustainable. When it comes to electronic dentist–patient communication, 3 areas have advanced its evolution and extensive adoption: the 2-way patient portals, teledentistry, and mobile technologies, like wearables.

Two-Way Patient Portals

Patients portals have been used in medicine fairly extensively, and they are much more common in medicine than in dentistry (Shimpi et al. 2018; Robinson et al. 2021). Recently, there has been an increased emergence of portals in dentistry and opportunities for integrating them with medical portals in some health care settings and systems. They emphasize a patient-centered model of care, where patients are active participants in their care and focus on their individualized needs and preferences. This approach provides an equilibrium in patient–doctor communication where advice from health care professionals is balanced with a more informed patient.

Patients usually have access to previous dental procedures, history, and routine appointment reminders in a dental portal. Patients describe them as vital to strengthening their communication with their dentists. Research in this area has shown that a large percentage of patients, including minorities, who access their health through a patient portal, has expressed satisfaction with accessing their health records (Ochoa et al. 2017). Patients who access portals are more compliant with their medication adherence, and they have also been shown to increase trust between practitioners and patients. Still, we need to keep in mind that not all of our potential patient populations have the access, wherewithal, or interest to work through portals. In addition, the usability and experience with the portal systems vary based on the level of transparency (Stogmann 1993).

Teledentistry

The coronavirus 2019 (COVID-19) pandemic has changed teledentistry dramatically. During this challenging period, one of the benefits of teledentistry for patients and dental services is the ability to screen cases who do not require immediate attention to be promptly assigned to a provider (Danciu et al. 2021). This practical remote approach eliminates the cost associated with an initial in-person appointment (teletriage) or treatment follow-up (telemonitoring), such as the use of personal protective equipment and transportation. Consequently, the dentist can focus on patients who genuinely need immediate and procedure-based assistance. At the initial phase of the pandemic with more strict quarantine mandates and risks, teledentistry provided remote access to care to our patient community, who had nonurgent concerns, which allowed us to prevent potential exposures between our workforce and our patients.

In addition to the video consultations, reproducible and straightforward protocols for patients to take intraoral photos with their smartphones with sufficient image quality have facilitated the monitoring of their oral health (Maret et al. 2021). Further improvements to the quality of patient-performed intraoral photography will likely ensue and benefit the diagnostic accuracy of oral lesions. Another area for development identified from a thematic analysis centers on the clinical limitations in not undertaking a thorough physical examination, including cancer and special needs patients (Spivack 2020; da Silva et al. 2021; Murthy et al. 2021). There are hybrid models of in-person and remote care, where health care teams are deployed to patients' homes in rural regions or their local basic health care settings, and later patients are followed up with remote telemedicine/dentistry sessions. Hence, these hybrid models still help to provide comprehensive care with adequate health data recording and referral at individual and populational levels through a portal to a practitioner or provider responsible for care in a distant or large region (Bohm da Costa et al. 2021).

The recent success and broad acceptance of teleservices are also expanding, especially in medicine, to more densely populated regions and create a niche of virtual specialized care and exams directly providing episodic treatment and monitoring to low-grading conditions and high-grade stable conditions at home (PontoCare, NY). The development of new portable imaging protocols and equipment similar to those employed in clinics ensures that the outreach, experience, and convenience deliver health care to previously neglected or resistant populations. Certainly, teleservices have increased the number of patients served, especially during the pandemic, and decreased costs. However, the adoption of telehealth services is significantly affected by the social determinant factors of health inequality, such as income and insurance coverage (Luo et al. 2021).

Personal Technologies for Patient Monitoring

There are 2 ways that personal technologies can help monitor and analyze patients' health, by direct input from the patient to mobile e-health applications or by sensors. Both have their advantages and disadvantages. The first way is more holistic and requires the patient's active engagement, and the second one provides more objective data but with the patient in a completely passive role.

Using traditional approaches, the actual complexity of a given dental, oral, or craniofacial disorder and their progression were never precisely documented, especially when associated with pain and multiple symptoms. Patients have frequently been asked to give a single number to represent their overall pain or symptoms from a numerical rating scale (NRS: from 0 [no pain] to 10 [worst pain]), if not marked on a 10-cm line (visual analog scale [VAS]), and to delineate and record it in 2-dimensional (2D) full-body or dental, oral, craniofacial drawing in paper templates, either as a cross or in a freehand style and checkmarks. Attempts to analyze such recorded data were too subjective and cumbersome and serve only the purpose of rough clinical and research observations or general assumptions. This is especially challenging in patients with overlapping conditions (Maixner et al. 2016). The advent of smartphones has facilitated the development of more user-friendly applications to monitor pain and other intra- and extraoral symptoms remotely. They allow patients, clinicians, and researchers to precisely track, display, and analyze the nuances of symptoms over time across multiple body regions, including head, feet, and, most crucial for dentistry, intraoral regions. The flexible data models and visualization are treated as common data elements for interoperability supporting diverse body types, age groups, and personal patient preferences. Such data aggregation, even in 3D, also enables effective exploratory analytics and model-free machine learning methods to interrogate the heterogeneous data, which is critical in complex dental, oral, and craniofacial medicine patients (Kaciroti et al. 2020). The resulting data from those novel mobile applications have the potential to predict the diagnosis, progression/regression, and model individual and diverse patient characteristics over time. Their integration to the clinic has initiated, with web-based dashboards or tablets for real-time remote monitoring of participants' symptoms, measures, with alerts to the providers when a patient is at risk, and compliance assessment of medication intake after dental or surgical treatment.

Recent technological advances have also supported the extensive implementation of wearable devices, for instance, smart wrist bands and watches, capable of monitoring multiple body measures from patients in a passive way. They are primarily more adopted to improve patients' lifestyles and activities. However, due to extensive use, they permit the collection and transmission of relevant health parameters, such as psychophysiological signals, sleep quality, and body movement, that can detect and manage stress in anticipation or after dental treatment (Labus et al. 2021). These digital biomarkers have mainly focused on accelerometer data and heart rate due to the well-established sensors from mass-market wearables. In fact, recent studies with wearables are demonstrating a correlation between heart rate variability and sleep disturbance that is linked to multiple health disorders (Allen et al. 2022; Chalmers et al. 2022). There are now emerging biosensors promising to detect biomarkers noninvasively in sweat, saliva, and exhaled breath, but more studies are needed (Brasier et al. 2021).

Biology-Based Diagnosis and Treatment

Invasive blood testing still represents the great majority of diagnostic approaches used to routinely monitor our health. However, its invasive nature has led to the search for other diagnostic approaches that are more convenient and painless. In addition, more sensitive technologies have improved our ability to identify new biomarkers that can more objectively pinpoint multiple disorders from cancer and caries to major medical disorders. Recently, 3 biological-based diagnoses and treatment innovations have created a significant shift in medical and dental fields due to their potential and clinical significance: salivary diagnostics, the management of the oral microbiome, and auto-therapies to resolve inflammation.

Salivary Diagnostics

Dentistry has been a leader in analyzing biofluids (gingival and peri-implant crevicular fluids) to detect oral disorders and monitor healing (Pellegrini et al. 2017; Khurshid et al. 2021). However, the groundbreaking results from salivary analysis have led to a significant paradigm shift in diagnostic analyses. It has expanded dramatically in the past years, facilitating mass screening programs in COVID-19 testing, even for children. New studies have shown that the oral cavity is an important site for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and implicate saliva as a route of SARS-CoV-2 infection, transmission, and detection (Huang et al. 2021), rapidly substituting the first deployed deep nasal swabs. Such ubiquitous use of saliva testing is also based on its versatility in covering genomics, proteomics, microbiomics, metabolomics, and transcriptomics, with over 2,000 proteins detected in saliva. Even though a large percentage of those biomarkers is also found in the blood, the procedures to collect saliva are much more straightforward than collecting blood. It has facilitated the rapid testing of hormone levels, drug testing, and medication compliance in our daily lives (Egorov et al. 2021). In dentistry, dozens of companies market various saliva-based diagnostic tests for a wide variety of diseases, including caries and periodontitis. Most of these tests are not approved by the US Food and Drug Administration (FDA) and take 1 of 2 forms: detection at the point of care or collection at the point of care and shipping the sample to a laboratory for analysis. The following web-based article provides a good review on this area: https://www.arkrayusa.com/oral-wellness/sites/arkrayusa.com.oral-wellness/files/files/DentalTown-Saliva-Testing-in-the-Dental-Practice.pdf.

Nonsurgical Management of the Oral Microbiome

The microbial-based therapies on the modulation of the gut microbiota have been extensively documented. In addition to the fecal microbiota transplant (FMT), which has been used successfully to treat *Clostridioides difficile* infection, many of the selected probiotic species, including *Lactobacillus* spp., *Bifidobacterium* spp., and other coliform bacteria, are able to change the population of microorganisms in the gut microbiota and modulate the functioning of gut microbiota. The following mechanisms have been proposed to explain the modes of action: 1) enhancement of mucosal barrier function, 2) modulation of the immune response, and 3) antagonism of pathogens either by the production of antimicrobial compounds or through competition for mucosal binding sites. Considerable evidence of clinical trials of probiotics in animal and human models has reported suitability for the treatment of a variety of gut diseases, including Crohn's disease, inflammatory bowel disease (IBD), and ulcerative colitis.

In dentistry, the oral microbiology community has also pioneered many vital concepts related to the human microbiome, how specific bacteria imbalance has been associated with disorders, and more specifically to periodontal disease using checkerboard hybridization methods (Jakubovics and Shi 2020). The human oral microbiome database now lists nearly 700 different types of bacteria in the oral cavity. There is a growing interest in reengineering the oral microbiome to prevent caries and periodontal disease. Arginine, an amino acid, has been shown to decrease the conversion of sucrose to lactate and hence has a potential role for caries management. The same applies to prebiotics and probiotics for caries management. Recent studies show the beneficial impact of probiotics, for instance, in the management of periodontal disease (Hathaway-Schrader and Novince 2021). The first probiotic strategy for targeting dental caries was developed by Hillman and coworkers at Forsyth Institute in 1974, where a noncariogenic mutant strain (JH1001) of *Streptococcus mutans* was used to replace cariogenic *S. mutans* strains (Hillman 1978). This represents an example of a probiotic approach involving production of a bacteriocin effective against a virulent bacterium. Since then, attempts have been made to use probiotic strains, such as noncariogenic strain *Streptococcus salivarius* TOVE-R and a *S. mutans* strain deficient in lactate dehydrogenase activity to achieve caries prevention by antagonizing cariogenic bacteria (Tanzer et al. 1985). Another potential probiotic approach for reducing dental caries involves the utilization of oral streptococci, which are able to metabolize arginine or urea to ammonia, thus maintaining pH homeostasis within dental plaque. These include more recently discovered species, such as *Streptococcus dentisani*, which is able to inhibit the cariogenic bacteria via the production of bacteriocins (Lopez-Lopez et al. 2017), as well as improve plaque pH homeostasis through an arginolytic pathway, and *Streptococcus* A12, a highly arginolytic *Streptococcus* species that also potently antagonizes *S. mutans* (Huang et al. 2016). Thus, the deliberate implantation of specific oral streptococci or the encouragement of their growth in dental plaque can be considered a probiotic approach for encouraging the shift from a pathogenic to a nonpathogenic biofilm. Since some of these organisms naturally occur in dental plaque and therefore qualify as GRAS (generally regarded as safe) organisms, it may be possible to use these organisms in a probiotic approach for controlling dental caries.

Auto-therapies to Resolve Inflammation

Inflammation is central to periodontal disease. Specialized proresolving mediators of inflammation drive macrophage efferocytosis and resolution. They are lipid mediators such as lipoxin and resolvin, which are naturally produced and facilitate the termination of inflammation, but they are not considered anti-inflammatory agents as inflammation is still allowed to occur. However, proresolving mediators facilitate the end of the resolution of inflammation and restoration of homeostasis. There is an unmet need to develop a novel treatment for periodontal diseases with these specific mediators as well as the trigger of their release (McCauley et al. 2014; Panigrahy et al. 2021).

Digital Dentistry for Diagnosis and Treatment

According to *Oral Health in America: Advances and Challenges: Executive Summary* (National Institute of Dental and Craniofacial Research 2021) the dentistry field is at a pivotal point with regard to the technologies used in practice and the potential for new data science–driven diagnostic and treatment approaches that can improve oral health. Digitalization of dental, oral, and craniofacial health care delivery is quickly promoting the development of precision medicine. Multiple digital technologies are guiding individualized diagnosis and treatment for patients and can significantly optimize their efficiency. Distancing from the "one-size-fits-all" concept, digital dentistry provides a paradigm shift to deliver a more nuanced and personalized approach. In this category of digital, we include novel imaging modalities, 3D printing, robotics, and augmented and virtual reality (AR/VR). What has emerged in this field are the different ways that we can deploy dentistry.

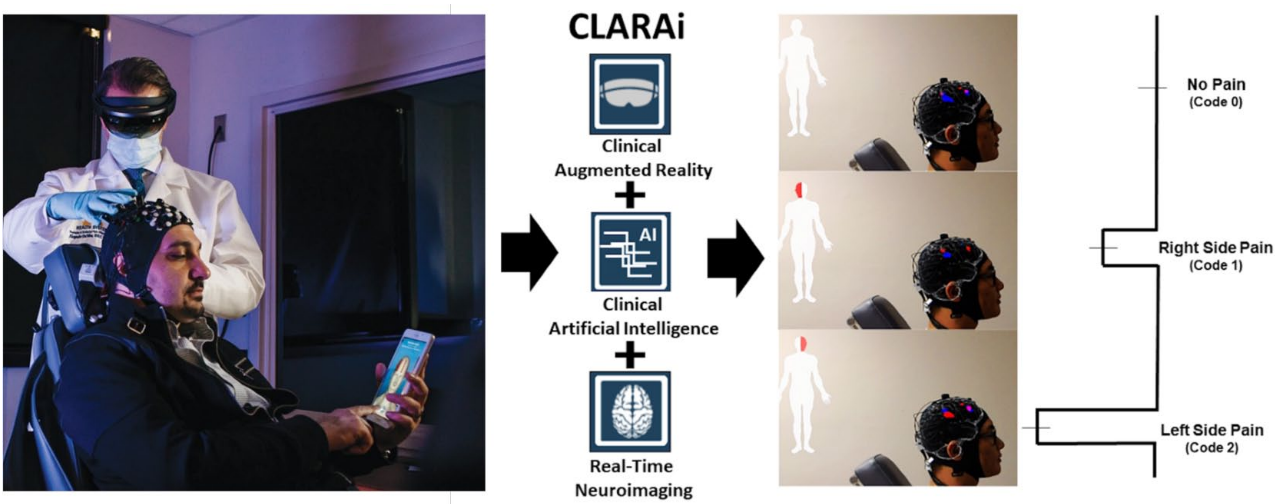
Imaging Modalities

Several different imaging modalities are under investigation or early use in dentistry, including ultrasound or ultrasonography. They use reflection or echoes of ultrasound signals to provide imaging that has a significant benefit in that it is nonionizing radiation, very easy to deploy, and portable. Recent studies have demonstrated its use in evaluating perio-implantitis and planning of implant placement (Barootchi et al. 2021). For instance, Doppler ultrasonography can now evaluate blood flow for estimation of tissue perfusion at implant and palatal donor sites following soft tissue augmentation with the connective tissue graft (Tavelli et al. 2021). One day, they will certainly be sensitive enough to provide an accurate and time-efficient 3D mapping of the entire sulcus or periodontal pocket around teeth. In the future, this would enable the imaging of the entire periodontium architecture and assist in assessing periodontal depth without traditional probing. All of these advances require developments from the standpoint of imaging technology and the processing of the generated data.

Three-Dimensional Printing

Three-dimensional printing physical models are rapidly becoming an integral part of prosthodontics, orthodontics, and surgery (Dawood et al. 2015). They have been used chiefly for interim prostheses and flippers for surgical and occlusal guides. Its clinical applications also extend to working models and main applications in the fields of oral implantology, with the benefits of high material utilization (Guerrero-Girones et al. 2022) and the ability to manufacture complex geometries (Shen et al. 2020). Nevertheless, 3D printing has expanded to more permanent applications as the technology and materials developed. As discussed above, there is a significant initial investment from academic institutions in collaboration with industry, but the cost has lowered with the escalation of use, and in many cases, it is undoubtedly lower than conventional

Figure. Clinical augmented reality and artificial intelligence (CLARAi) framework that integrated clinical real-time neuroimaging, augmented reality, and artificial intelligence provides an augmented clinical environment by displaying neuroimaging data with predicted and localized pain from patient. The classification codes for no pain, right side pain, and left side pain were defined as 0, 1, and 2, respectively, for model training purposes (Hu et al. 2019).



lab fees. Hence, 3D printing will likely be blossoming in the next period of years, not only in private dental practices but also in more complex tissue reconstruction and engineering of organs with the utilization of multiple biomaterials and cell types (Tavafoghi et al. 2021).

Robotics

Robot technology has been demonstrated in many fields of dentistry, for example, in implantology, restorative dentistry, and education (Fang et al. 2021; van Riet et al. 2021a, 2021b). Some robotic solutions have become commercially available in recent years, such as the robot "Yomi" (Neocis) for implant placement, especially in edentulous patients, and have received 510(k) clearance from the FDA. Robotics is one of many areas of medicine and dentistry that have developed rapidly with the improvement of procedure planning, augmented anatomical visualization, and haptic-guided surgery, all contributing to reducing human errors in the delivery of care. Even the utilization of a humanoid robot in the pediatric emergency department waiting room has shown a positive impact on caregiver satisfaction and anxiety (Sivakumar et al. 2021).

Augmented Reality and Virtual Reality

Advanced visualization techniques are becoming accessible to the mass market. However, step by step, they are contributing to dental education, research, and treatment. For example, data from brain imaging of patients during pain can be visualized by students in virtual reality to have a more immersive educational experience (DaSilva et al. 2014). The same applies with orthognathic surgical simulation methods when combined with traditional records, showing positive attitudes from the students toward higher-fidelity tools concerning visualization, manipulation, and enjoyment of the task (Sytek et al. 2021). When applied directly in the clinic, the best mixed reality technologies are the ones that do not interfere with the dentist–patient communication and improve our ability to assess patients' conditions with more precision. Researchers have developed a portable neuroimaging-based framework with clinical augmented reality and artificial intelligence (CLARAi) to objectively detect pain and its localization directly from the patient's brain (Hu et al. 2019) (Fig.).

Most important, such a framework predicted when and where there is physical pain based on the patients' brain activation with the simultaneous display of the data on a 3D-brain template. Furthermore, a recent study demonstrated a virtual reality breathing (VRB) protocol with virtual 3D-lungs that synchronized with the participants' breathing cycles in real time, providing the participant with an immersive visual-auditory experience. When exposed to the VRB, the subjects decreased their pain sensitivity in the same manner as the participants using traditional meditative breathing but with opposing brain mechanisms for analgesia (Hu et al. 2021). The rising visual-auditory sensations brought by the immersive VR experience cut off the connection between the competing pain inputs and a selective mind–body disconnection. The implementation of technologies perceived as futuristic is turning into reality the objective measuring and modulation of orofacial pain.

Real-Time Optimization of Information Technology

Data analyzed from our electronic health records (EHRs) can potentially optimize patient care and institutional efficiency, as well as even decrease the in-hospital mortality rate (Wilk et al. 2020; South et al.

2021). This goal is achieved by fostering the development of structured electronic learning health systems (LHS) to monitor, analyze, and interpret disparate data sets seamlessly, including from each patient treated and student/resident trained, with rigorous outcome measurements and alternative research methodologies. Whether in the clinic, classroom, or bench, from mobile phones and wearables, these systems can integrate knowledge and insights into ways to promptly improve and innovate our existing processes, creating a culture of feedback loops for best academic practices. Electronic health records were developed for the purpose of billing and expanded for the documentation of patients' care over time. We have underappreciated their use to improve decision-making and patients' treatment outcomes. Machine learning algorithms can ensure resulting outcomes that remain suitable for real-time application in the clinical dental environment. However, challenges in health information technology still exist. A study comparing medication reporting in dental and medical records highlights the disconnect between medical and dental records (Tenuta et al. 2021). There is a great need to better integrate dental and medical EHRs, develop a consistent way to enter information that patients bring (e.g., genetics), improve natural language processing ("talk into the record"), and train more data scientists in dentistry. Such integration and expansion of the effective use of data will continuously benefit patient care. One good example is the recent offer of options in EHR systems for limited or total integration and access to patients' dental and medical records (e.g., EPIC, Axium). This is certainly the right path in health care, including dental, oral, and craniofacial, keeping all critical information under one umbrella and making possible the delivery of a more thorough, holistic, and multidisciplinary treatment.

Conclusion

In dentistry, some innovations are advancing quickly, and by necessity, our profession has accelerated their implementation, which is the case of teledentistry after COVID-19. The embracing of such new treatments and technologies also depends on the shift of our mind-sets, which tends to be conservative in health care. New policies, better infrastructure, and lower upfront costs can accelerate their adoption and win over initial resistance (Schleyer et al. 2012; Chaudhary et al. 2022; Tiwari et al. 2022). However, these challenges are multifactorial and might also be based on the behavior of each stakeholder in our health care community. For instance, there is research evidence that women providers generally are more explicitly reassuring and encouraging than are male clinicians, which might influence patients' adoption (Elderkin-Thompson and Waitzkin 1999; Riley et al. 2014). Nonetheless, these novelties need to be backed with solid research. Although it is exciting to see things evolving and moving forward to provide better options in dentistry to patients, clinicians, and students, we need a way to effectively determine their evidence and efficiency. We must not get caught up just in technology for the sake of novelty and remember that the clinician–patient human connection, empathy, and compassion are essential in our professional work. Finally, we need to ensure that such new treatments and technologies will improve outcomes and expand care for all our diverse population, independent of social-economic status.

Author Contributions

A.F. DaSilva, contributed to conception and design, data interpretation, drafted and critically revised the manuscript; M.A. Robinson, W. Shi, L.K. McCauley, contributed to conception and design, data interpretation, critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: A.F. DaSilva is the co-creator of PainTrek and CLARAi, which were developed at the University of Michigan.

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