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Current and Emerging Economic Trends in Big Data analytics for Oro-Dental HealthCare and CranioMaxilloFacial Surgery as part of healthcare analytics in American economy

1. **Dr Samrat Ray,Dean, IIMS,Pune**

Keywords: Artificial Intelligence; Biomaterials; nanoDenistry; Cranio-MaxilloFacial Surgery; 3D printing; Regenerative Medicine; bioSensing; Drug Delivery; Digital Dentistry; Trends.

Précis– *Dentistry is an ever-evolving field that has seen significant advances in recent years. This article sheds light onto some of the current and emerging trends in oral health care, includingdigital dentistry, regenerative medicine, and the use of lasers. For example, digital dentistry involves the use of computer-aided design and manufacturing technology, which enables more accurate and efficient production of dental devices. On the other hand, regenerative medicine andnanoDentistry can be considered a promising area that combines the use of stem cells, growth factors, biomaterials, and nanotechnology to regenerate damaged tissue and improve treatment outcomes. Lasers are increasingly being used in dentistry for a range of applications, including treatment of gum disease and teeth whitening. Other developing technologies such as 3D printingand artificial intelligence are also being increasingly incorporated into dentistry, providing improved treatment options for our patients. Last yet definitely would/will not be least, controlled drug delivery systems are being developed to deliver drugs to specific target sites in a localized and sustained manner, reducing the risk of adverse effects. Overall, these emerging trends are transforming the landscape of odontology, providing new opportunities for improved patient care***.**

GRAPHICAL ABSTRACT

Just like any other field or specialty, dentistry/odontology/stomatology/dental medicine is subject to constant evolution, with new technologies continuously advancing and redefining the way dental and oral healthcare is practiced and delivered. There is a plethora of exciting and hot topics in today, hence, this communication aims to provide an overview of a few emerging trends in dentistry: artificial intelligence (AI), biomaterials, tele-dentistry, and 3D printing, amongst others of similar if not more importance or significance to our practise. Herein, is a brief presentation and discussion of the potential applications of such evolving technologies and their implications for the future of dentistry.

Emerging Trends in Dentistry (Technologies / Applications)		Key features
nanoTechnology	nanoparticles, nanotubes, nanofibers, nanocomposites	High surface area-to-volume ratio, tunable physico-chemical properties, enhanced mechanical and biological properties
Controlled Drug Delivery	Nanocapsules, hydrogels, liposomes, micelles	Controlled release of drugs, improved bio-availability, targeted drug delivery
Tissue Engineering	Scaffolds, hydrogels, layer-by-layer films, cell sheets	Mimic extracellular matrix, provide mechanical support, promote cell adhesion and proliferation
Regenerative Medicine	Stem cell therapy, gene therapy, tissue engineering	Replace, restore, repair or regenerate damaged tissues or organs

BioFilmControl		Anti-microbial peptides, Silver/Copper nanoparticles, coatings, enzymes
bio-Sensing	Biosensors, nanosensors, microarrays, lab-on-a-chip	Detect biomolecules, monitor physiological parameters, diagnose diseases
bio-Imaging	Optical imaging, MRI, CT, PET, SPECT	Visualize anatomical structures, track cellular processes, diagnose diseases
Lasers	Erbium lasers, CO_2 lasers, diode lasers, Nd:YAG lasers	Cut, ablate, coagulate, and sterilize tissues, promote *in situ* wound healing

Note: *This is not exhaustive and is only meant to provide examples in current or emerging areas.*

AI

AI, the artificial simulation of human intelligence, is rapidly advancing in many fields, including dentistry and oral surgery. AI has the potential to revolutionize many aspects of oral and dental healthcare, from diagnosis to treatment planning to predicting and simulating patient outcomes. For example, AI-powered imaging software can help dentists detect dental caries earlier, leading to more effective treatments and better patient outcomes [1]. AI can also help us create more personalized treatment plans thattake into account the unique needs and preferences of each patient. Additionally, AI can assist oral and maxillofacial surgeons in the detection and diagnosis of oral cancer [2]. As AI technological abilities, readiness and accessibility continues to advance, it is likely that its utility in the oro-dental and cranio-maxillo-facial complex will only continue to expand.

Biomaterials

With advances in materials science and nanotechnology, dental biomaterials are constantly evolving. Briefly, biomaterials are materials designed for use in the body; an area of rapid innovation in dentistry, oral surgery, and cranio-maxillo-facial reconstruction, regeneration, and repair. New biomaterials, such as anti-bacterial coatings and smart/intelligent formulations that respond to changes in the oral environment, are being developed for use in practice. These have the potential to improve patient outcomes, reduce the risk of infection, and improve the longevity of dental restorations and implants. Additionally, biomaterials that can support *in situ* tissue regeneration, leading to improved healing after dental and/or surgical procedures are being developed [3]; will more than likely become an increasingly essential tool for dentists and surgeons. Bio-ceramics, bioactive glasses, and resin composites are examples of biomaterials that are commonly used in dental applications. For instance, bio-ceramics are widely used today in endodontic treatments for repairing and regenerating damaged pulp tissues, while bioactive glasses can help re-mineralize and repair dental caries. Resin composites, on the other hand, have unique properties such as durability, esthetics, and biocompatibility that make them ideal for restorative dental applications. Advancements in biomaterials research have led to the development of newer materials with enhanced properties and improved clinical outcomes [4-6].

Tissue Engineering

Dental tissue engineering aims to repair and/or regenerate damaged tissues using a combination of biomaterials, cells, and growth factors [7, 8]. Dental tissue engineering

has demonstrated promising results in bone and cartilage regeneration, as well as salivary gland regeneration [7-9].

Biofilm

Biofilm formation on dental implants is a major cause of implant failure and peri-implantitis [10]. New strategies are being developed to prevent biofilm formation, such as the use ofanti-microbial coatings (such as copper-based nanoparticles) on implant surfaces [10, 11].

Biosensing

Bioimaging technologies have advanced significantly in recent years, with potential applications in oral and dental health. Biosensors can be used to detect and monitor specific biomolecules in saliva or oral fluids, enabling the diagnosis and management of oral and dental diseases [12]. For instance, biosensors can be used to detect the presence of bacteria, viruses, and other pathogens in oral samples (such as saliva, mucosal transudates and gingival crevicular fluid), facilitating the early diagnosis and treatment of infectious diseases, amongst other conditions. Additionally, bioimaging techniques such as optical coherence tomography or OCT and confocal microscopy canprovide high-resolution images of the oral and dental tissues, aiding in the diagnosis of various oral pathologies. These technologies have the potential to significantly improve the diagnosis and management of diseases, leading to superior patient outcomes [12, 13].

Tele-dentistry

The COVID-19 pandemic has accelerated the adoption of tele-dentistry, allowing dentalproviders to provide virtual consultations and care. Tele-dentistry, nonetheless, is an emerging trend that is changing the way dental care is delivered. With tele-dentistry, patients can access dental care remotely, allowing for greater convenience and improved access to care [14]. Tele-dentistry can also improve patient outcomes by providing faster access to care, reducing the need for travel, and allowing for more frequent monitoring of oral health; while minimizing the risk of infection. Additionally, tele-dentistry can improvethe efficiency of dental practices, allowing dentists to see more patients and improve their bottom line [15].

3D Printing

3D printing technology has revolutionized the field of dentistry, allowing for the rapid production of custom dental implants, crowns, and other devices [16]. 3D printing is transforming how we practise dentistry by allowing for the rapid production of custom dental implants and crowns. With 3D printing technology, dentists can create precise, customized dental restorations that fit the unique needs or each patient [17]. Additionally, 3D printing technology allows for faster turnaround times, reducing the time patients need to spend in the chair. This technology (and hybrids thereof) will continue to advance, to significantly enhance patient outcomes and reduce costs for our patients and practices.

Lasers

Lasers have become an increasingly popular tool in dentistry due to their precision and minimally invasive nature. There are several types of lasers used in dentistry, including diode, carbon dioxide, and erbium: yttrium-aluminum-garnet (Er:YAG) lasers [18]. Lasertechnology can be used in a variety of dental procedures, including cavity removal, gumdisease treatment, teeth whitening, and oral surgery. Laser therapy offers several advantages over traditional techniques, including reduced bleeding, swelling, and discomfort, as well as faster healing times. Additionally, lasers can be used for more precise and conservative treatment, preserving more of the healthy tooth structure or gum tissue [19]. As the technology continues to advance, it is likely that more dental procedures will incorporate lasers, providing our patients with even better outcomes and experiences.

Oral Surgery and Cranio-Maxillo-Facial Applications

Computer-aided design and manufacturing (CAD/CAM) has also been applied in oral surgery, particularly in cranio-maxillo-facial procedures [20, 21]. Using CAD/CAM technology, surgeons can create precise 3D models of the affected area and plan surgical interventions in advance. This approach can improve the accuracy and safety of surgeries, reduce the risk of complications, and lead to better functional and aesthetic outcomes for patients. Additionally, 3D printing technology can be used to create

patient- specific implants for cranio-maxillo-facial reconstruction, which can improve the fit and stability of the implant and reduce the risk of complications. The use of digital technologies in oral and cranio-maxillo-facial surgery is expected to continue to expand in the coming years, with the potential to revolutionize the field and improve patient outcomes [22, 23].

nanoDentistry and Controlled Drug Delivery

Nanotechnology involves the use of particles that are smaller than 100 nanometers in size [24]. In dentistry, nanotechnology can be used to create materials with enhanced properties, such as improved strength, durability, and anti-microbial activity. Nanoparticles can also be used to deliver drugs or other therapeutic agents directly to the affected area, providing targeted and more effective treatment [24, 25]. Likewise, controlled drug delivery systems are designed to deliver drugs to specific target sites in a controlled and sustained manner. In dentistry, controlled drug delivery can be used (gels, films, etc...) for a range of applications, including pain management, anti-microbial treatment, and tissue regeneration. These systems can be designed to release drugs locally at a specific rate and duration, reducing the risk of adverse effects and improving treatment outcomes [25].

CLOSING REMARKS– The link between oral, dental, cranio-maxillo-facial health and systemic health has also become increasingly recognized in recent years. Implications for dental and surgical practice and public health are therefore, very relevant and timely. In conclusion, emerging trends such as AI, biomaterials, digital- and tele-dentistry, and 3D printing are transforming our clinical and surgical practise. These technologies have the potential to improve patient outcomes, reduce costs, and increase access to care. It will be thrilling to witness the transformative effects of these evolving trends in the future.

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