

Dentistry, e-health and digitalisation: A critical narrative review of the dental literature on digital technologies with insights from health and technology studies

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Objective: To overview current developments in e-health and digitalisation in dentistry and identify gaps in the dental literature on this topic; **Basic research design:** a critical narrative review of published articles and relevant online materials; **Results:** Four themes are identified as characterising the current dental literature on e-health and digitalisation: 1) the impact of digitalisation on dental surgeries, 2) digital technology and practice management, 3) digitalisation beyond the dental surgery and in dentist-patient communication, and 4) digital technology and education. However, gaps remain in our understanding of the impact of digital technology on dental practice, particularly in relation to its ethical considerations. Following the example of the wider medical literature, the review introduces the field of critical digital health studies and identifies areas for future investigation and exploration based on its four characteristics: devices and software, data materialisation, data practices and data mobilities; **Conclusion and Clinical significance:** Digital technology is changing clinical practice and patient care. Dentistry needs to expand its understanding of how dental apps, digital workflow models and digital health information are transforming and disrupting dental practice in order to anticipate how this digital shift will impact on dentistry. The emerging field of critical digital health studies can signpost ways to improve research and practice on the topic in the future.

Keywords: Dentistry, e-health, m-health, digitalisation, critical digital health studies

Introduction

As sociologists who have extensively studied the use of digital technologies in the field of dentistry, we both have a keen interest in e-health, and digital technologies more broadly. We have a particular interest in tracking as well as contemplating the impact of digital technologies on our understanding of health and relationships to health information. E-health is used here to refer to “the use of information and communications technology (ICT) to provide and create health information and services” (Hardey, 2013, p.133). This includes, for example, electronic patient records and e-mail, and other technologies enabling information and communication used within dental practices, as well as internet-based resources to inform and communicate with patients and the public including websites and social media, for example to reach hard-to-reach populations (WHO, 2016). ‘Digital technologies’ is used here to refer to clinical and diagnostic technologies to deliver health services leading to digitally stored and exchanged information. This includes e-health, but also, for example, digital radiography equipment and intra-oral scanners.

Despite the recent Special Issue of the Journal of Dentistry on “Digital Technologies in Oral & Dental

Research” (Petty and Goodwin, 2018) and our own work in the impact of digital technology on dental practice (Van der Zande *et al.*, 2013; 2018a; b) and dental professionalism (Dobson *et al.*, 2019; Neville, 2015; Neville and Waylen, 2015; Neville, 2017; Van der Zande *et al.*, 2013), we both feel that dental research into e-health and digital technologies has not yet considered the associated social and political factors to the same extent as medical research. Many of the debates around the impact of e-health and digitalisation on general health and medical care have not yet been considered in dentistry, as we will discuss below. However, considering that technological development continues apace and recent industry analysis puts the value of the digital health industry at \$25 billion (£19 billion or €21 billion) (Druggal *et al.*, 2018) we foresee the need for a sustained engagement by dentistry with the concepts of e-health, and more academic probing on the impact of digital technology on clinical practice and patient-centred care. The aims of this article are twofold: first, to review and identify gaps in the literature around the impact of e-health and digital technologies in dentistry, pointing to ways in which these have been addressed in the wider health and technology literature; and second, to trigger reflection and debate on this topic.

Method

A critical literature review was carried out on this fast-moving and expansive topic. While a narrative review offers a descriptive account of the current literature of a topic, a critical review is concerned with identifying the conceptual and/or methodological developments that define the contemporary knowledge on the topic (Brown *et al.*, 2019; Grant and Booth, 2009). As the phenomenon of digital technology cross-cuts disciplinary boundaries, we wanted a method that would enable us to reveal the breadth of the subject area, highlight areas of current scholarly interest and signpost gaps in the literature. As a result, this review has the aim of appraising the conceptual approaches used in the literature on this topic in dentistry and using the literature on the impact of digital technology in medicine and health to point to areas for potential conceptual innovation.

Both authors undertook a literature search using the databases Web of Science, PubMed and Google Scholar with an agreed set of search terms (e.g. “digital technology”, “dentistry”, “dentist”, “dental practitioner”, “dental education”, “e-health”, “m-health”), focusing on studies published between 2009 and April 2019. Articles were included if they discussed the impact of digital technology or e-health on dentistry, in the broad sense of dental education, dental surgeries, dentists, and patients. Articles were excluded if they discussed the impact of digital technology or e-health on other practitioners related to dentistry (e.g. dental technicians), if they discussed digital technology or e-health but not the impact on dental education, dental surgeries, dentists, and patients, or if they were not published in English. References in the articles found were also searched for additional articles, as well as articles citing the included papers. Table 1 details the themes that emerged from the literature search. Both authors independently categorised the data into emergent themes, which were shared, deliberated upon and subsequently refined to four key themes. The authors then set about reading, summarising and analysing the content of articles within each of the themes and shared their findings with each other. The themes identified in the dental literature were analysed and discussed in comparison with the wider literature on the impact of digital technology in medicine and health. As a result, the following review is not exhaustive, but indicative of the ways in which digital technology has impacted on dentistry.

The digitalisation of dentistry: a brief review of leading themes

We reviewed the dental literature by focusing on 1) digital technologies in the dental surgery, 2) digital technology and practice management, 3) the effects of digitalisation beyond the dental surgery and dentist-patient communication, and 4) digital technology and education.

Digital technologies in the dental surgery

The first wave of computerised technological advances in dentistry occurred in the 1980s with the emergence of the personal computer, CAD/CAM and the first intra-oral sensors (Bhambhani and Bhattacharya, 2013). However, it was not until the emergence of social media and Web

Table 1. Categorisation of emerging themes

<i>Theme</i>	<i>Articles</i>
Digital technologies in the dental surgery	Bhambhani and Bhattacharya (2013), Lupton (2016), Chandler and Munday (2011), Vanderburgh (2018), Joda, Zarone, and Ferrari (2017), Wismeijer <i>et al.</i> (2018), Joerd van der Meer, Vissink and Ren (2016), Bonnet <i>et al.</i> , (2017), Schleyer <i>et al.</i> , (2011), Matthews <i>et al.</i> , (2016), Bjørndal and Reit (2005), Locke, Thomas and Drummer (2013), Parashos and Messer (2006), Van der Zande <i>et al.</i> (2013), Araújo <i>et al.</i> (2016), Gallardo <i>et al.</i> (2018).
Digital technologies and practice management	Acharya <i>et al.</i> (2017), van der Zande <i>et al.</i> , (2015), Schwei <i>et al.</i> (2016), Schleyer <i>et al.</i> (2011), Song <i>et al.</i> (2010), D’Cruz and Rattan (2018), Alrqi and Edelstein (2016), Nasseripour, San Diego and Gallagher (2019)
Beyond the dental surgery including dentist- patient communication	National Institute for Health and Care Excellence (NICE) (2015), WHO (2011), My Social Practice and American Academy of Cosmetic Dentistry (2018), Mariño and Ghanim (2013), Andreassen <i>et al.</i> (2018), Shetty <i>et al.</i> (2018), Hardey (2008), Lupton (2018), Ni Riordan and McCreary (2009), Parmar <i>et al.</i> (2018), Van der Zande <i>et al.</i> (2018), Budd <i>et al.</i> (2016), Holden and Spallek (2017), Shuttleworth and Smith (2016).
Digital technology and education	Dragan <i>et al.</i> (2018), Spallek and von Bergmann (2014), Ren <i>et al.</i> (2016), Sabalaic and Schoener (2017), Maltar <i>et al.</i> (2018), Zitzmann <i>et al.</i> (2017). Salajan <i>et al.</i> (2010), Liu <i>et al.</i> (2018), Kateeb <i>et al.</i> (2017), Gratton <i>et al.</i> (2016), Kwon <i>et al.</i> (2015), Kateeb <i>et al.</i> (2017).

2.0 from 2004 onwards (Lupton, 2016) that the process of digitalisation emerged in full. Digitalisation refers to three interconnected processes: 1) The conversion of data from analogue (i.e. graded on a continuum) to digital (i.e. binary) form, 2) the computerisation of information, and 3) the diffusion of such technologies and techniques into all aspects of living and business (Chandler and Munday, 2011, p.104). Each of these interconnected processes has transformed dentistry, impacting on diagnostic abilities and the organisation of dental practices, as well as changing the dentist-patient dynamic.

Perhaps one of the primary areas of innovation associated with digitalisation has been its impact on the development of diagnostic tools. There was quick recognition of the ability of digital diagnostic tools to offer increased sensitivity and cost-effectiveness compared with existing diagnostic tools (Bhambhani and Bhattacharya, 2013). These include digital photographic and radiographic technologies, lasers and intra- and extra-oral scanners. These innovations coincide with dental practices moving from paper to electronic patient records and treatment planning software, enabling a completely digital workflow.

The concept of the digital dental workflow is discussed by Vanderberghe (2018), and refers to all steps in the dental workflow, e.g. from taking patient clinical information, and taking impressions through to the manufacture of a prosthesis being fully digitalised. This is argued to increase efficiencies around costs and timing/duration of dental treatments (Bhambhani and Bhattacharya, 2013). However, it is important to note that digital workflow models are still in development (Joda *et al.*, 2017), with some models varying depending on treatment types, such as implant treatment (Wismeijer *et al.*, 2018), orthodontics (van der Meer *et al.*, 2016) or prosthetics (Bonnet *et al.*, 2017). Similarly, although most patient information is kept in digital records, there are many limitations in using this information for support of a digital workflow (Schleyer *et al.*, 2011). As a result, the implications of digital workflow are yet to be fully considered. Cost, infrastructure, concerns about patient privacy and fit with existing regulations are not yet fully thought out. Nevertheless, more and more parts of patient treatment in dentistry are ‘going digital’.

The degree to which digital technologies have diffused into all aspects of the dental surgery varies. Although the adoption of new technologies including non-digital ones is increasingly investigated (e.g. Matthews *et al.*, 2016; Bjørndal and Reit, 2005; Locke *et al.*, 2013; Parashos and Messer 2006), very few studies have investigated the adoption of digital technologies in dental practice (Matthews *et al.*, 2016). The impact of digital technologies for clinical and diagnostic purposes on patients has also received limited attention. Araújo *et al.* (2016) found that patients’ psychological, behavioural, and clinical outcomes were better when an intra-oral camera was used during periodontal treatment. Similarly, in a systematic review of studies comparing digital to conventional impression techniques, Gallardo *et al.* (2018) found that use of digital technologies was associated with less discomfort and less anxiety among patients in four out of five included studies. Besides these studies, relatively little is known about the impact of digital technologies in dental surgeries on dental patients.

Thus, the first process of digitalisation, the conversion of analogue to digital data, has advanced hugely in most areas of dentistry. The second process, the computerisation of information, has advanced but leaves gaps. Forms of computerised information are not fully integrated, and this makes a fully digital workflow difficult to attain and presents dental teams with the need to fill in gaps in digital information. The third process, the diffusion of digital technologies and techniques into all aspects of dentistry, remains difficult to gauge from the available literature.

Digital technology and practice management

Digital technologies are most widely used in practice administration. Digital administration is principally used for financial administration purposes, and in some countries its use for this purpose is nearly universal (Acharya *et al.*, 2017). Management of practice supply is also available digitally, but not widely used (van der Zande *et al.*, 2015). In addition, patient administration has become largely digital, and this changes the use and availability

of information. In use of patient administration systems, the dental team is more visible than in use of digital technologies described elsewhere in this paper. Entry of information into patient administration systems, and managing the patient flow throughout the day are mainly done by dental assistants and dental hygienists (Schwei *et al.*, 2016), as well as reception staff. However, such information is not yet standardized in such a way that it can be widely compared (Schleyer *et al.*, 2011; Song *et al.*, 2010), limiting its usefulness in informing patient management and clinical practice, and its potential for exchange with other stakeholders. Moreover, ‘cut + paste function errors’ and the use of standardised text can introduce dento-legal risks into electronic clinical record keeping (D’Cruz and Rattan, 2018). The degree of use of information from clinical records for quality management, for example, is highly varied (Alrqq and Edelstein, 2016). Also, these developments leave dental professionals with the professional responsibility to have responsible data management procedures in place (Nasseripour *et al.*, 2019). Although the availability of information thus presents scope for monitoring and learning about current clinical practice, the lack of standardized terminology and the added responsibility for responsible data management across devices and software leaves more advanced use of information for monitoring quality management or for improving clinical practice often unused.

Digitalisation beyond the dental surgery and dentist-patient communication

The digitalisation of dentistry has introduced flexibility and mobility to the delivery of dental services and oral health promotion (National Institute for Health and Care Excellence (NICE), 2015). M-health, or mobile health, refers to “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (WHO 2011, p.6). In countries and regions where access to healthcare services are hindered by geographical distance, m-health initiatives can provide teledentistry to the population, including mobile methods for the mouth to be inspected remotely (Mariño and Ghanim, 2013). Smartphone technology also means that patients can receive reminders about upcoming or overdue appointments, and access dental apps to improve their oral health behaviours, such as toothbrushing (e.g. BrushDJ).

Digitalisation leads to interactions between patients and health care providers becoming 1) respatialized beyond the surgery, 2) reconnected in analogue and digital ways, 3) leading to specific reactions on the part of patients and providers, and 4) leading to reconfigurations of (health care) institutions (Andreassen *et al.*, 2018). These changes are clearly taking place in patient-dentist interaction. For example, Shetty *et al.* (2018) consider the impact of e-health and of extending oral health care from the clinic into the home. The authors argue for an increasing shift of responsibility for oral health from the provider or the insurer to the patient, and a health behaviour, outcome and individual-based oral health care system. Their analysis assumes that e-health will be embraced by patients and providers of oral health care in a consumer-driven way.

The widespread availability of health information online (Hardey, 2008; Lupton, 2018) and the relative ease with which patients can access information about oral health (through smartphones and apps) has re-defined the terms of the dentist-patient relationship. This has led some commentators to posit the emergence of a new patient type. This e-patient or “digitally engaged patient” (Lupton, 2018) will use digital technology to become more empowered about their health. For instance, Ni Riordan and McCreary (2009) found that 34.5% of their survey participants in Ireland had either internet-searched their dental symptoms or had a family member or friend do so on their behalf. Three quarters of these patients would go online again if they had dental problems. More than one third (37%) claimed they would contact a dental practitioner online about symptoms. Digitally engaged patients also use the internet to choose healthcare providers. In their study of 588 patients and 532 dental professionals, Parmar et al. (2018) found that 77% of patients in the United Kingdom expected a website for the dental practice and 47% of patients visited their dental practices Facebook or website.

Unsurprisingly, recent surveys showed that 81% (the Netherlands), 68% (New Zealand) and 44% (Wales) of dental practitioners use a practice website and that 13% (the Netherlands) and 21% (New Zealand) use social media about their practice (Van der Zande *et al.*, 2018; Budd *et al.*, 2016). The content of these websites and social media sites varies (Budd *et al.*, 2016) with some dentists using techniques to increase ‘visits’ to their website in order to strengthen relationships with existing patients and build new ones (My Social Practice and American Academy of Cosmetic Dentistry, 2018). Practice blogs and twitter accounts, video tours of the dental practice and patient testimonials can help introduce prospective patients with their dental team and the services provided. However, dentists will need to ensure that their social media marketing complies with the relevant advertising/professional regulators. The ability of a profession to self-regulate is one of the tenets of dentistry. However, research has thrown doubt on the ability of some dental practices to comply with the regulations. In a study of 266 Australian dental practice Facebook pages, Holden and Spallek (2017) found most were not compliant with the advertising regulations.

The digitalisation of dentistry provides patients with ample information about dental treatments and services. However, the empowered e-patient can also be a mixed blessing, from the clinician’s perspective, and lead to difficult conversations between dentist and patient. This includes managing unrealistic patient expectations and unethical treatment requests, especially if the dentist doesn’t share the patient’s online diagnosis and prognosis. The situation can result in a conflict between the respect for the autonomy of the patient, on the one hand, and respect for the professional’s expertise to adjudicate on the best interests of the patient (Shuttleworth and Smith, 2016).

Digital technology and dental education

Digital technology has also made inroads into dental education, impacting on teaching, learning and assessment of academic, preclinical and clinical knowledge

and skills (see Dragan *et al.*, 2018). Traditionally, dental education adhered to an experiential model of practical skills development based on ‘see, do and repeat’, that placed the instructor at the centre of the learning as the source of expert knowledge and assessor of students’ skill development. However, with the advent of digital technology, such long-standing hierarchies have the potential to be democratised, giving way to more opportunities for self-directed and self-assessed learning (see Spallek and von Bergmann, 2014). Numerous dental education studies have recorded the variety of ways in which digital technology can transform clinical skills development and assessment. Digital microscopes, virtual pathology slides, and digital x-ray images have been found to improve students’ diagnostic skills by allowing students and instructors to view precise clinical data simultaneously (on computer screen), thereby facilitating the sharing of expertise (Ren *et al.*, 2016). Digital simulation training systems and robotic patients introduce force feedback and resistance, allowing students to experience using various dental tools on teeth and mouths before working on actual patients (Ren *et al.*, 2016).

Students and faculty alike appear to be welcoming of digital technology in dental education, despite sometimes having little practical experience of it or training in it (Sabalaic and Schoener, 2017; Maltar *et al.*, 2018). Unsurprisingly, studies show that students report an increase in their motivation and enthusiasm for learning and that digital technology has facilitated more student-staff communication interactions (Ren *et al.*, 2016; Zitzmann *et al.*, 2017). Although a gap has been suggested to exist between students who are more adept in using digital methods and staff, this does not appear to be the case (Salajan *et al.*, 2010). Apart from these impacts, the impact of digital technology on student learning and assessment is open for more debate. Some dental educators have commented that digital technologies have introduced precision, objectivity and less inter-examiner variance for assessments, claiming that assessments become more reliable and efficient than previously (Liu *et al.*, 2018; Kateeb *et al.*, 2017). While some contend that digital technologies enhance self-directed learning (e.g. Ren *et al.*, 2016; Lui *et al.*, 2018) others found little difference between the scores achieved by students who were taught using visual/traditional methods compared with students who were trained using digital methods (Gratton *et al.*, 2016; Kwon *et al.*, 2015; Kateeb *et al.*, 2017).

Towards an agenda for studies of dentistry, e-health and digitalisation

Adding to academic debates about e-health and digitalisation in dentistry

Many articles portray digital technology as a useful innovation that delivers several key efficiencies in time and cost-effectiveness, for example in the detection and classification of dental fluorosis (Liu *et al.*, 2018; Dye *et al.*, 2018), in the study of digital impression techniques and CAD/CAM (Lee and Gallucci, 2013), and in the digital diagnostic tools detailed above. Clearly dentistry has embraced digitalization, however, the process is having

anticipated and unanticipated impacts on dental practice and education. This level of unpredictability is matched by a certain unevenness to these impacts, for students, patients and dentists alike. As a result, there is growing recognition that digitalization is having a ‘disruptive’ impact on dentistry. The ‘disruptive’ potential of digitalisation is acknowledged in many of the studies cited above. In this section we present some of the academic debates raised by the disruption caused by digitalization.

While the ethical implications of digitalisation in dentistry have been contemplated, this often remains separate from considerations of its clinical impact. Cvrkel (2018), for instance, considers the ethical implications of m-health, but those highlighted are generic to the field of healthcare, while no practical examples as applied to dentistry are presented or discussed. Shetty et al. (2018), on the other hand, argue for increasingly shifting responsibility for oral health from the provider or the insurer to the patient. However, the literature on medical technologies and critical digital health shows that the extension of ‘the clinic into the home’ is far more complicated than a tool that increases effectiveness of care (Vassilev *et al.*, 2015). For example, not all ‘tech-savvy patients’ will want to use apps that optimize their oral hygiene routines. As patients use, resist, and adapt to existing technologies in their daily lives, e-health often has many unexpected effects that reach far beyond the behaviours that they intend to promote. Similarly, issues around privacy are often considered separately from studies on the integration of patient information into a dental clinical workflow. Nasseripour et al. (2019) overview these and other ethical challenges raised by digitalisation in the dental profession and signal the need for applying professional standards to digital technology use in dentistry.

Wider academic debates in dentistry then demonstrate that the disruptiveness of digitalisation has contributed to a dualism in thinking, one which reduces the complex issue to a trade-off between clinical efficiencies and ethics. The literature on digital technology in dentistry, on the whole, tends to adopt an instrumental approach (Van der Zande *et al.*, 2013), expressing a concern with its effectiveness or analysing the validity and reliability of its use. Implicit in this approach is the tendency to see the impact of digital technology in dentistry and oral health as unidirectional, with little mention or consideration of the patient’s needs and best interests. This hinders both a sustained consideration of the impact on patients, and the development of digital workflows into clinical practice.

Together, these issues indicate that the clinical and ethical concerns raised by digitalization in dentistry have followed separate trajectories. While both channels of enquiry, the clinical and the ethical, are important, such a dichotomous approach to the topic has the potential to inhibit and limit the field by missing out on key over-lapping concerns, such as the patient perspective. Such a ‘digital dualism’, focusing on the digital at the expense of the human is common in technologies studies. Jurgenson (2012) argues for the need to consider ‘how technology and society, the digital and the physical, media and humans, have imploded and augmented each other. We cannot focus on one side, be it human

or technology, without deeply acknowledging the other’ [p.84]. We contend that dentistry needs to put the patient and the practitioner on equal footing with the clinical developments, using integrative approaches. We propose the emerging discipline of critical digital health studies as offering such an integrative alternative to the digital dualism. In the next section we outline the aims, characteristics and function of critical digital health studies, and point to what it can add to our understanding of digitalisation in dentistry.

Critical digital health studies

The field of critical digital health studies is a relatively new development, concerned with ‘analysing digital health from a sociocultural and critical perspective’ (Lupton, 2016). In other words, patient-provider communication, and the impact of digitalisation on health care providers are central in this approach. It draws on a variety of disciplines, including sociology, media studies, surveillance studies, consumerism and technology studies (Lupton, 2014a) to achieve an inclusive approach to digital technology in health. Critical digital health studies is informed by the assumption that digital technology is primarily a social practice. That is, digital technology is mediated by communication between the patient and the dental team, and it is brokered by a healthcare context, whether that be private practice or in hospital or community settings. It also reminds us of the commercial aspect of digital technology in healthcare, and the effect the introduction of industry and commercial relations may have on health and patient-provider relationships (Lupton 2014a; 2014b; Saukko, 2018).

Its multidisciplinary approach is reflected in its four key interests: ‘devices and software’ (what are their features and impacts on daily life and the working lives of healthcare professionals and organisations?); ‘data materialisation’ (how are digital data represented, made visible and transformed into observable objects?); ‘data practices’ (how do people use, create, share digital data, and what meanings do they attach to these data?) and ‘data mobilities’ (how do digital data circulate, and what impact do social, economic, political, organisational and regulatory agencies have on use and purpose of digital data?) (Lupton, 2016). These four key interests are as relevant for dentistry as they are in wider healthcare. In this respect, the questions critical digital health studies raises for dentistry include, but are not limited to the following:

- Devices and software: If apps are ‘technologies for healthy lifestyle’ (Lucivero, and Prainsack, 2015) then the digital data they generate can help people be more self-caring and pave a way to preventive care (Saukko, 2018). This raises the following questions for dental research to consider: What might its impact be on users? How can we transform this data into oral health interventions and behaviour change? What methods/measures need to be developed to evaluate the patient benefit of dental apps on oral health?
- Data materialisation: Having more in-depth, personalised data available as an app or at the

click of a button is argued to contribute to more shared decision making between patient and dentist/physician. Digital dentistry can facilitate a change in the patient-dentist dynamic and make the organisation of dental services truly patient-centred. However, in dentistry, digital images, electronic records etc continue to be conceptualised as individual data points that are used as ‘store-and-retrieve information’ (Mort and Smith, 2009), rather than as flexible and mobile information. Dental practitioners will need to develop a new way of working with digital health data and making it an active component of every consultation as well as an instructional tool for teaching patients about their mouth and oral health (Lupton, 2014a).

- Data practices: In debates where technologies are presented as a cost- or time-saving device, the work that is needed to ‘make a technology work’ (Nicolini, 2006) is often forgotten. E-health and digital technologies are not simple plug-and-play devices but need concerted efforts and changes to established routines. This may lead to underestimating time needed to learn to use a technology, or its impact on practice management, ultimately adding more rather than less pressure on dental teams and the interactions between dentists and patients. As a result, critical digital health studies raises awareness that there are practical issues associated with ‘going digital’ and its impact on the dental team (Lupton, 2014a).
- Data mobilities: It is important to recognise that technology can also deliver ‘iatrogenic harm’ (Ho and Quick, 2018) by impacting on patient safety. This may include unplanned disclosures of patient information and inaccurate diagnoses etc. In dentistry, these debates are not openly found. For example, what does a digital workflow compared to a more traditional or hybrid workflow, mean for patients’ safety?

Concluding remarks

In our daily lives, questions around the impact of digital technologies are regularly asked: What does automation in car technology mean for road infrastructure, safety, and ethical debates? Does the rise of robotics and digital technologies alter the need for certain types of human employment? And how does online communication change, and relate to, offline communication? In dentistry, similar questions are beginning to be asked, though more work is needed. This article acknowledges that the current state of debate on digitalization in dentistry is defined by a dualism, one that treats the clinical effectiveness of digital technology separate from its ethical implications. We challenge the utility of such a ‘digital dualism’ and propose an alternative way of researching digitalisation, using critical digital health studies. Critical digital health studies allows us to study the digitalisation of dentistry from multiple perspectives. This helps us understand what digital technologies change in oral health care, and points us to current gaps in the literature:

1. Digital technology goes beyond an impact on effectiveness of health care; it changes how oral health care is delivered, and the people delivering and receiving it. Thus, dentists’ work may become more design-driven and information-heavy, and a lot of daily work may go towards operating technology. There is a need for research on these subjects, which will help dentists and dental educators in adapting to and preparing others for these changes.
2. Digital health often shifts the responsibility for ‘healthy lives’ from health professional to patient. What does that mean for the role of dentists towards engaging with patients? How do dentists maintain their commitment to delivering high-quality care when the responsibility is shifted to patients?
3. Not every patient will engage with e-health, and not every dentist will engage with digital technology. Then, digitalisation in oral health care will have different effects for those who use digital health to varying degrees. One of the main questions that this raises is: What happens with patients who are unable to or not wanting to engage in digital health? How will dental professionals adapt to varying levels of digital engagements among their patients?

These questions, first and foremost, require more attention in dental research. At the same time, these gaps also raise important issues for dentists working in dental public health and for policymakers relating to the three gaps detailed above. This includes

1. Integration of digital technologies and e-health into curricula in dental education and continuing education. This includes preparing dental students for a profession that is increasingly geared towards design (for example within digital workflows) and large amounts of information. How can this information and these skills be used to improve patients’ care, and ensure it remains accessible to all?
2. While using the extended reach made possible with e-health to engage with patients, rethinking how to assist those who cannot or do not want to shoulder the increased emphasis on patients’ responsabilisation for ‘healthy lives’. This includes ensuring that patients’ understanding of e-health information is taken seriously and talked about in the dental setting, as well as sensitivity to individual patients’ wishes and abilities to be involved in their own oral health. How can these be used for patient groups such as those from more deprived areas, while maintaining access for all?
3. Making digital health as accessible as possible to patients who wish to use it, e.g. by making sure information is suitable for patients with low literacy skills. In addition, how will dental care and supporting information for patients remains available in analogue formats?

Addressing these issues calls for a multidisciplinary approach to thinking about and developing digital innovation in 21st century dentistry.

Competing interests

Both authors confirm that they have no competing interests to declare.

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