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Embracing technology for improving dental records and record keeping in the Republic of South Africa. A review.

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ABSTRACT

Forensic odontology (FO) techniques are used to identify unknown remains and play an integral role in dental-legal cases. The utility of FO relies on accurate antemortem records – the creation and management of which continues to be a global challenge, albeit more acutely presenting in developing countries. Inadequate record keeping and management by the dental fraternity has made application of FO techniques for identifying unknown remains challenging. In addition, dental-legal cases such as in homicides, rapes, patient mismanagement and fraud are sometimes unresolved due to record keeping and health system shortcomings. This current status quo affects families and society: bereaved families are deprived of closure, and protracted litigations ensue, leading to various socioeconomic consequences.

Digital technology-based solutions can potentially mitigate challenges associated with poor dental record creation, maintenance and storage. The solution offered by introducing digital technology in other sectors of developing countries can similarly benefit oral health services and, by extension, the practice of forensic odontology.

This review aims to highlight the inadequacies in dental record keeping in the Republic of South Africa and propose ways to improve the systems by incorporating digital technologies, ensuring a sustainable, efficient and universally accessible method of record keeping.

Introduction

A dental record is an official document that corroborates a patient's contact with a healthcare provider.[1] This can be in a paper or electronic format, and includes information such as the patient's details, clinical notes, investigation results and clinical correspondence.[1] Dental records can also be used to provide antemortem information for forensic investigations, evidence for legal proceedings and establish patient care continuity.

The regulations governing the enforcement of dental record keeping vary across nations, regions and legislatures worldwide. However, there is insufficient literature on the enforcement of the stipulated guidelines related to dental record keeping.[2-4] In the US, dental record keeping enforcement and guidelines differ across the states, while in England, the Care Quality Commission was established as an independent regulatory body that ensures adherence to the National Health Service standards of dental care and record keeping.[5] In contrast, the oral health services in African countries are characteristically plagued by inadequate policies and strategic plans affecting the frameworks and guidelines on dental records.[6,7]

In the Republic of South Africa (RSA), dental records are mandated by the Health Professions Council of South Africa (HPCSA) through detailed statutory guidelines.[8] The guidelines mandate practitioners to store records for at least six years from the date the contact with the patient becomes dormant, and longer for mentally incompetent individuals and minors.[8] HPCSA guidelines emphasise the need to create records that will "improve clinical outcomes, reduce waste and ensure stakeholder engagement and satisfaction", as part of the expected standards of the dental team in the treatment and management of patients.[9,10]

Dental records are also expected to comply with the other legal instruments such as the National Health Act [No.61 of 2003].[11] The National Health Act is a framework that structures a uniform health system and service delivery in RSA.[11] The Act outlines a practitioner's obligation to create, protect and maintain records for a minimum of six years, failure of which may result in a fine, up to one year's imprisonment, or a combination of the two.[11]

RSA has additional legislative frameworks that are relevant to dental records. These include The Electronic Communication and Transaction Act [No.25 of 2002]; Protection of Personal Information Act [No. 4 of 2013]; National Archives of South Africa Act [No. 43 of 1996]; Promotion of Access to Information Act [No. 2 of 2000]; Copyright Act [No.98 of 1978]; and The Protection of State Information Bill, B6-2010.[11] The Occupational Health and Safety Act (No. 85 of 1993) states that health records must be retained for 20 years after treatment commenced.[8] Although the country

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has adequate legislations, the effective execution as guided by the frameworks remains a challenge.[2]

The potential role of dental records in forensic investigations

South Africa is plagued by numerous social issues, such as unemployment, inadequate infrastructure, an overburdened health care system, high unemployment and crime, to name a few. As one of Africa's premier economic hubs, the country accommodates between 2 and 4.2 million legal and illegal migrants.[12] Economic expansion will result in rural-urban migration, projected to be as high as 71.3% of the population by 2030, resulting in further displacement of people.[12] As an example of crime statistics in South Africa, 9,516 rapes, 6,424 murders, 65,636 thefts and 11,000 cases of grievous bodily harm were reported between April and June 2022.[13,14] Internal migration, societal fragmentation, the population's high mobility, poor documentation of citizens, undocumented individuals and a homeless community of 100,000 to 200,000 have led to an exponential rise in the number of unidentified bodies in forensic services of major urban centres.[15-18] The Gauteng Department of Health recorded 898 unidentified individuals between 2020 and 2021.[14] The Western Cape reported 472 unclaimed bodies in the same period.[15] The forensic odontology identification techniques could be critical in aiding the nation's forensic scientists and the authorities.

The collaboration between forensic services, investigating authorities and forensic odontologists is hampered due to insufficient dental antemortem data.[16]It is essential to investigate and evaluate the causative factors leading to inadequate dental records. Additionally, the review will examine the potential of digital technologies in dental record keeping, and advocate for the introduction of the aforementioned technology as a means to improve practitioner compliance.

The role of dental records in disaster management

Natural, man-made and hybrid disasters are ever increasing globally, leading to loss of lives and widespread destruction of properties.[18] When available and adequate, dental records provide an inexpensive, fast and reliable means of identification in disaster scenarios.[19] The Australian bushfires of 2009 led to 173 casualties, 60% of which were identified with dental records input, while 40% of individuals were identified using dental records alone.[20] When complete, dental records assist with victim identification, bite mark analysis, age, gender and race determination.[19] The South Asian Tsunami disaster of 2004 affected countries along the coast of the Indian Ocean, resulting in the deaths of 217,000 individuals.[21] The availability of antemortem data enabled the successful identification of 67.6% of victims by forensic odontologists (FOs).[22] The identification success was exceptionally high (90%>) for victims from the developed regions of Europe, North America and Oceania. In comparison, only 2% of Thai victims were identified using dental records, with the outcome attributed to the poor state of record keeping by Thai dentists.[22] The higher success in the identification of victims from developed countries was due to numerous legislative and regulatory mandates on dental records, utilisation of digital technology and state-instituted financial incentives.[23]

The disaster victim identification (DVI) protocols were developed by the International Criminal Police Organization (Interpol) in 1988 to assist with disaster victim identification.[24] DVI protocols have ensured international uniformity, standard methodology and guidelines, culminating in high victim identification rates.[24] In the terrorist attacks, 17.05% (n=21) of total victims (n=129) were identified using dental records.[25] In this disaster, advanced DVI operation techniques involving forensic odontologists were employed.[25] The techniques included the use of computerised tomography (CT) scans for extraction of maxillofacial data to link to odontological records, principles of double examination to ensure validity of odontological records, reconstruction of 3-dimensional scans to replicate antemortem radiological data and registration of dentists' private contact numbers onto a national dental council registry in the event of a forensic emergency.[25] The forensic odontology community is urged to use Interpol DVI protocols for victim identification. The protocols reduce the challenges associated with differences in dental codes among nations, unreliable and inconsistent antemortem records, and a lack of digitised records.[25] These protocols can be amended and adopted to suit regional needs, to allow for speed, coordination and accurate results.[25]

The state of dental record keeping practices

The state of dental record keeping remains inadequate in many regions of the world, with little to no difference between developed and developing countries.[3,6] In a study from Australia, 74% of practitioners summoned for Professional Standards Panel (PSP) hearings for various complaints had inadequate records.[26] In Worcestershire, England 87.5% of dental records could be used in forensic investigations. However, incomplete information was prevalent, with 36% of the dentists failing to record information related to soft tissues; 30% did not report patient periodontal status; and 27% failed to perform a radiographic review (n=184).[27] In the studies from the Indian subcontinent, Astekar *et al.* described insufficient record keeping where (62%) of dentists in Rajasthan State, India (n=100) failed to maintain complete records.[28] Only 32% recorded patients' personal details.[28] In those with patient details recorded, the information on drugs prescribed, telephonic conversations, referral letters or personalised denture markers was not available.[28] Sohail *et al.*[29] reported 45% (n=350) of dental practitioners in Lahore, Pakistan did not maintain dental records with only 1% of the practitioners having a record retention of 10+ years.[29] In Croatia, Pavicin *et al.*[27] noted that while 87% of respondents (Croatian dentists) recorded the dental status in the first visit, only 46% recorded additional data of forensic value (abrasion, erosion, attrition and other dental anomalies), with only 33% of respondents keeping X-rays longer than five years.[29]

The reports on the status of dental record keeping in RSA have revealed various inadequacies, ranging from inconsistencies in records creation and management to the fabrication of dental records. Van Niekerk and Bernitz[30] reported on the adequacy of dental records in a series of 40 cases requiring antemortem record analysis. The records revealed a failure to adhere to the requirements stipulated by the HPCSA guidelines on dental records.[30] The state of dental records at academic institutions do not fare any better. A quality assurance study by Kopsala and Rudolph at the University of the Witwatersrand revealed subpar record keeping standards.[31] In a recent study conducted at the Medunsa Oral Health Centre, Mthethwa and Matjila[32] described an unsatisfactory completion and poor retention

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of dental records. Only 3.6% of the records sampled (n=543) were fully completed, with half being less than 80% complete. The records of a third of the patients seen at the oral health centre more than six years prior to the study were missing.[32] This situation, in a teaching institution, can be very detrimental to forensic services in the country as future oral health practitioners from the institution are likely to have poor skills in record keeping, leading to the likelihood of patient mismanagement, compromised patient safety and care, and may result in adverse outcomes in case of litigation.[33,34]

In a study comparing the country security status classifications and dental records retention time in the military health services South Africa, a medium risk country, was reported to retain the dental records for a minimum of 11 years. While the study highlighted that the long retention period increased the probability of identification, it did not report the dental records' forensic acceptability.[35] Opperman[36] investigated dental record keeping practices in the private sector in Cape Town Metropolitan, South Africa. Despite the limited sample size (n=34), the investigation demonstrated only 25.3% of dental files contained complete odontograms; 32.1% of the files had dental codes, denture identification was never recorded, while a dismal 14.7% of the practices retained dental records after 10 years.[36]

The reasons suggested for the poor state of dental record keeping in South Africa include high patient volumes, poor management of records [missing, misplaced and duplicated files], lack of interplay between the various departments, lack of standardised record keeping practices in the various facilities, complacent staff and budgetary constraints.[32,37-39] The World Health Organisation (WHO) recommends a dentist-to-population ratio of 1:7,500 in developing countries.[40] In South Africa, this ratio is 1:8,817, with the dental specialist to population ratio being 1:118,947.[41] These ratios make it difficult to maintain quality records and attend to clinical matters as the system is under immense strain. Binarti and Fitriyan[42] summarised five main factors affecting the quality of medical records: man, material, method, machine and other factors. The other factors include poor communication, crippling workload, the absence of checklists to ensure the completeness of records, and an absence of guidelines, policies and standard operating practices.[42] Health workers also highlighted poor motivation to complete dental records due to the absence of benefits for this duty.[42]

Advances in electronic dental records

A digital dental record is the recording and storage of patient-centred health information in a patented, digital format.[43] Digital dental records are a comprehensive platform where all social, demographic, medical and dental information is stored on the facility's hardware and/or in the cloud, should the need to restore or replicate patient information arise.[36] Other advantages of digital dental records include the increased ability to coordinate care, more data for research and decision making, improved coordination between practitioners and ease of identifying individuals.[44]

A study conducted by Schwei *et al.*[45] revealed that the use of electronic dental records (EDRs) is prevalent in first-world countries. By 2009, 85%> of dental practices in the US possessed computers (n=166 000), with 14.3% of standalone practices and 14.3% of group practices using EDRs.[45] The affordability of EDR systems was described as a barrier preventing the mass roll-out of electronic records in lower-income countries.[45] Electronic dental records save the healthcare sector money by reducing healthcare inefficiencies, although the true economic value of this technology will be difficult to express as some healthcare factors cannot be translated monetarily.[46]

The provision of oral health services relies on clinical and laboratory procedures and modalities that have benefited from digital technology platforms.

Technological modalities such as intra-oral (digital) photography, speech recognition, digitised diagnostic aids (study models, digicephs, xero-radiography, digital radiography, CT and MRI scans, 3D facial imaging, intra-oral scanning and CAD/CAM technology, fluorescence imaging and digitally guided implant surgery), artificial intelligence and information management have been identified as adjuncts to dental charting.

The widespread adoption and integration of these technologies to health information systems, particularly electronic dental records, aims to streamline forensic odontology investigations, reduce duplication of information, enhance digital/paper-based or mixed records, reduce instances of lost records and aberrant clinical decisions.[47] The adjunct technology may have the additional benefit of improving the usability of health information systems. These advancements may address issues of concern for end-users such as poor customisation of information systems to suit dental departmental needs, consumption of time (particularly to dental charting and overall system usability) and excess burden to clinicians.[47] Ultimately, the adjuncts must serve three critical functions: create stability during periods of continuous system enhancements, enable implementation into a wider electronic health record, and encourage standardisation of dental records for forensic investigations.

Introduction of eCharts technology in South Africa

In the 2000s, the South African government proposed a National Electronic Health Record (*eHR.ZA*), whose primary goal was integrating patient data between the public and private sectors. By 2009, the programme was halted as the national department cited expenditure-related issues with suppliers and had no desire for software systems that needed to be interoperable.[48] The eHealth Strategy of South Africa 2012-2017 was developed to create a coordinated and interoperable system.[48] Currently, South Africa's Digital Health strategy (2019-2024) is a top priority digital health programme aiming to ensure that quality healthcare service is delivered.[49] Therefore, good monitoring of patient outcomes is vital, necessitating the need for exceptional electronic health records. Thus far, the Department of Health has approved the National Health Normative Standards Framework (HNSF) to allow for interoperability in eHealth.[49] This framework will outline how eHealth systems will function, interoperate and ensure patient-centred continuity of care at all levels between the private and public health sectors.[49] Ultimately, the eHealth solution should enhance the National Health Insurance (NHI) initiative.

Currently, South Africa has an excess of 40 separate health information systems.[50] More than half of these do not adhere to local or international standards, with a further 25%> of

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these being individual platforms that fail to share information locally or externally.[50] Local standards include the need for open source software, a standardised reporting system to be submitted on a monthly or quarterly basis, user-friendliness, storage systems for data collected, integrated data repositories that are accessible at all levels, data security and integrity, creation of unique patient identifiers, creation of mobile systems to improve information system efficacy, and access control.[51] Health information systems in developing countries are often uncoordinated and create replication of functionality across departments.[52] As a result, information is incoherent, inconsistent, inefficient and often contradictory.[52] Fragmentation and duplication of healthcare systems is often due to numerous donors and development partners participating in a country's healthcare sector. Market suppliers often create systems that aren't customised to the local health environment, are preferred by a particular stakeholder, or fail to consider the financial obligations of the various provinces.[52] Legislation, enforcement and monitoring by agencies such as HPCSA or even the Independent Communications Authority of South Africa (Icasa), if deemed appropriate, will greatly assist in regulating this industry.

Digital transformation in records-intensive services sectors in developing countries

Globally, significant strides in digital transformation are observable across various services-based sectors and industries. Between 2000 and 2015, 130 countries introduced digitised identification (ID) systems.[53] Digital transformation has streamlined social protection for citizens, improved access to services and allowed linkages into different platforms and datasets.

The introduction of digitised ID systems allowed countries to expand social programm es while mitigating costs. According to Lowe[53], linking unique ID numbers to social program databases has saved Argentina $143m over an eight-year period, while Botswana saved $1.7m by removing 25% of fraudulent transactions.[53] In the same note, the potential of linking ID systems with digitised dental records will not only advance the corroboration of state information between various departments, but will assist with victim identification and the resolution of forensic cases.

The benefits of digital transformation are evident in other service-based sectors with wide reach in the population. In RSA, digital transformation and the introduction of biometric cards in the management of social grants saved the country more than R11.8bn.[54] The South African Revenue Service (SARS) commenced with digitisation of tax processing in 2007 with further upscaling being rolled out in 2013. This move encouraged taxpayers' compliance and drastically reduced tax-related fraud.[54] The collaboration between the two departments, SARS and the Department of Labour's U-Filing system, has allowed workers and employers to contribute, apply and access the Unemployment Insurance Fund.[54] Other e-Government services benefiting from digital transformation include ENaTIS (an online system that allows motorists to pre-book for learner's and driver's licence renewals); National Student Financial Aid Scheme (NSFAS), an online system that allows thousands of low to middle-income students to apply for financial aid; and the Department of Home Affairs' online booking system (BABS) that allows citizens to make online appointments to apply for passports, identity documents and other services.

In Africa, digital transformation has offered notable benefits in governance areas such as the electoral processes, census and financial services. Twenty-seven African countries have partial or fully digitalised elections with concomitant benefits of transparency and accountability in the electoral process. In the recent Kenyan election, the utilisation of digital technology in voter registration, verification and result transmission assisted in curbing electoral insufficiencies and ensured free and fair elections.[55]

Digital transformation in the services sector was of particular importance during the Covid-19 pandemic, to ensure that marginalised communities had continued access to social protection and assistance programmes.[53] In the wake of the Covid-19 pandemic, academic institutions also had to adapt to new teaching conditions modalities – coping with closures, social distancing and remote learning activities. Onsite lectures and practical activities were replaced by online lectures and e-learning technologies. Augmented reality (AR) and virtual reality (VR) systems were also employed to simulate environments by creating artificial interactions in third and fourth dimensions through users' visual, auditory and motor sensations.[56,57] A review of the educational quality enhancements from digital transformation in the dental curriculum demonstrated that digitalisation offers great potential to revolutionise the dental curriculum and education overall.[58] This includes implementing 24/7 facilities, virtual reality systems and web-based knowledge transfer.[57]

The development in digital technologies such as software programs, wide-reaching and accessible fibre and Wi-Fi connectivity, improved data transfer speeds and continuous development have supported the exponential rise of mobile banking services.[54] The constant threat of fraudulent third-party attacks in the vulnerable online banking sector has led banks to utilise biometrics to protect sensitive information.[59] Tyme Bank, South Africa's first digital only bank, has 685 biometric kiosks in the country that require the use of a high-resolution camera, fingerprint and ID document scanning to access personal data.[54] The rapidly evolving, cutting-edge digital technologies could be applied to digital dental records to limit access to patient files, maintain patient confidentiality and standardise the transfer, processing, storage and protection of information. While dental record keeping remains paper-based in many developing countries such as South Africa, the abovementioned large-scale digital transformations demonstrate that a nationally implemented electronic health record is achievable, and may have a positive and wide-ranging impact on the healthcare system and the practice of forensic odontology.

Challenges in the adoption of electronic health records

RSA has developed policies and frameworks that generally govern dental and medical records. The implementation and enforcing of the guidelines and concomitant quality of dental records has faced challenges, whose true extent remains unknown.[60] This, coupled with maladministration, lack of infrastructure, budgetary constraints, poor accountability by legislative agencies and technological innovation are some factors that result in poor dental record keeping.[42,60] Most public centres still employ paper-based dental records systems, despite eHealth strategies.[61] The development of digital dental records will alleviate the abovementioned administrative and clinical challenges. Data received from the platform will raise awareness and priority for oral health,

enable the formulation of additional digital regulatory frameworks, and encourage innovation and adaptive management.

Reports from developing countries allude to paper-based records as the most predominant records and storage modality.[60,61] The predominancy of paper-based records may result from convenience, affordability and lack of home-grown technological solutions. Two studies in India found that most dentists still used pre-printed forms: 53% (n=38) and 62.8% (n=242) of dentists, with only 56.2% keeping the dental records for future retrieval.[62,63]

Electronic dental records stand to benefit immensely from the continent's migration into a digitally-mediated era. Additional support from the internet of medical things (IoMT), internet and communication technologies, social media, augmented and virtual reality, and artificial intelligence further streamlines oral health care by facilitating workflow, decreasing cost, relieving dentist and dental auxiliary staff from routine and laborious tasks, and also igniting a participatory approach in personalised oral health care.[47] Notable disadvantages of digitisation include cost implications; restricted access in remote geographical areas; usability; questionable reliability; possible breaches in data security and external factors such as power outages and internet access.[45]

The introduction of digital technologies and health information systems in dental records will culminate in efficient service delivery. It will lead to a decrease in administrative delays (as locating patient files will be easier), improved patient management, treatment outcomes and overall health of the population.[47] Medico-legal cases will be well regulated, with adequate documentation to correlate any incidents.[65] The data collected by the health information systems can also be used to conduct research and population studies, improving monitoring, facilitate surveillance and optimise budgeting of resources towards oral healthcare.[65]

CONCLUSION

This review has demonstrated that the current dental record keeping practices in RSA are – similar to other developing countries – inadequate, inefficient and unlikely to assist in forensic identification and resolve dento-legal cases. The introduction of digital technology platforms can address the limitations associated with inadequate dental record keeping practices. This will bridge the gap between technology, oral health care and proper record keeping. The digitisation of medical records will likely save the time required to generate adequate dental records, assist in alleviating the patient burden, increase patient turnover and improve the rendering of oral healthcare. Finally, as the South African health sector prepares to migrate towards universal health care, digital dental records will make integrating with other health information systems easier and reduce associated costs.

KEYWORDS

South Africa, forensics, forensic odontology, dental records, digital technologies in dentistry

CONFLICT OF INTEREST

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Online CPD in 6 Easy Steps

The Continuing Professional Development (CPD) section provides for twenty general questions and five ethics questions. The section provides members with a valuable source of CPD points whilst also achieving the objective of CPD, to assure continuing education. The importance of continuing professional development should not be underestimated, it is a career-long obligation for practicing professionals.