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Dentistry — Artificial intelligence (AI) and augmented intelligence (AuI) based 2D radiograph analysis — Data generation, data annotation and data processing

Médecine bucco-dentaire — Analyse des radiographies bidimensionnelles basée sur l'intelligence artificielle (IA) et l'intelligence augmentée (IAu) — Génération, annotation et traitement des données

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Artificial intelligence (AI) and augmented intelligence (AuI) systems have gained growing prominence in the field of dentistry. These systems enhance both clinical decision support (CDS) and administrative operations and improve the accessibility, quality and efficiency of dental care. These systems are designed to guide clinical decisions related to disease prevention, management and surgical interventions, so specific consideration is needed to differentiate between normal, pre-pathologic and pathologic radiographic findings and manage them appropriately. Regulation plays an important role in ensuring the safety of patients and users as well as in commercialisation and market acceptance.

AI and AuI systems regularly involve supervised and unsupervised machine learning (ML) and, specifically, deep learning, and can be used for computer vision. Machine learning involves training computing systems to look for patterns in data to build models. Deep learning utilizes the neural networks of computing systems to discover and analyse complicated patterns in large “big data” databases. Computer vision can involve the use of deep learning to recognize patterns in images or videos.

One focus of current efforts around AI and AuI in dentistry is dental radiograph analysis, in particular, the analysis of 2-D dental radiographs like panoramic, bitewing or periapical or cephalometric radiographs. For these use cases, AI and AuI provide diagnostic support, but also facilitate documentation (reporting) and communication. The focus on 2-D radiograph analysis is due to the following:

— in dentistry, operators produce a high volume of radiographic images;

— the accuracy of dental practitioners when interpreting these images is limited (e.g. the sensitivity for the detection of early caries lesion on radiographic images is <50 %)[14], high inter- and intra- practitioner variability with human operators (e.g. influence of the circumstances of the day, resources available at one location)[15];

— a systematic and comprehensive diagnosis and documentation of the diagnosis results is time-consuming.

AI- and AuI-based software applications regularly detect non-pathological and pathological structures on radiographic images (e.g. teeth, anatomical structures, restorations, caries lesions). The functionality, performance specifications and safety of AI- and AuI-based medical software applications, including those for 2D radiographic image analysis in dentistry, are significantly influenced by the underlying data. Data generation, annotation and pre-processing raise technological, methodical and ethical questions. They also raise questions about data protection, safety and the law. There is a need for appropriate mechanisms that ensure the performance, compatibility, safety and efficacy of AI- and AuI-based medical software applications. Domain-specific aspects and particularities of dental data, in particular radiographs, and clinical requirements to analyse these data are expected to be taken into account when regulating AI- and AuI-applications. For example:

— there are usually several images of the same patient in one data set, these images can stem from the same time point (cross-sectional) or different time points (longitudinal);

— there is severe clustering of pathologies and statistical units;

— there is a range of levels on which data can be analysed and results be reported, like image, tooth, site or pixel level.

This document adopts recommendations by the Focus Group on Artificial Intelligence for Health of the International Telecommunication Union and World Health Organization towards regulating data generation, annotation and processing around AI- and AuI-based medical applications.