

## **REPORT OF THE ECCVT EXPERT WORKING GROUP ON THE IMPACT OF DIGITAL TECHNOLOGIES & ARTIFICIAL INTELLIGENCE IN VETERINARY EDUCATION AND PRACTICE**

### *Final Report*

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#### **Introduction**

The European Coordination Committee on Veterinary Training (ECCVT), having considered the outcomes of the workshop on the use of digital technologies in veterinary practice that took place in May 2018, has decided on the establishment of a joint working group of experts to reflect on the opportunities, risks and overall impact of digital technologies and artificial intelligence (DT&AI) in veterinary education and veterinary practice.

The above experts were in particular asked to reflect on 6 thematic areas and deliver an opinion, which will be considered by ECCVT and its Member organisations in preparation for their strategies for the future, namely on:

1. Preparing a SWOT<sup>1</sup> analysis on the use of DT&AI in veterinary education and practice by:
  - 1.1. Reviewing the literature and available information;
  - 1.2. Assessing the impact of the use of DT&AI in veterinary education;
  - 1.3. Assessing the impact of the use of DT&AI in veterinary practice;
  - 1.4. Proposing a SWOT analysis.

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<sup>1</sup> Strength – Weakness – Opportunities - Threats

2. Making recommendations about necessary competences that veterinary graduates need to have by the day of their graduation (Day One Competences) to ensure a good understanding and responsible use of DT&AI;
3. Making recommendations about competences that can be enhanced by DT&AI;
4. Making recommendations about trends in the way veterinarians communicate in their practice;
5. Making recommendations about teaching methods undergraduate and post-graduate;
6. Making recommendations about Quality Assurance linked to DT&AI.

The expert group completed their work as mandated and present below their opinion.

## **1. SWOT analysis on the use of DT&AI in veterinary education and practice**

Ensuring animal health, animal welfare and public health is at the core of the mission of the veterinary profession. The working group, being strongly anchored to those principles, reflected on how DT&AI may impact veterinary education and practice in the future.

### **1.1. Review of the literature and available information on the use and impact of DT&AI in veterinary education and practice**

The members of the working group have reviewed the literature on this topic.

Most publications currently available concern human medicine, diagnostic imaging, telemedicine and potential problems linked to GDPR, ethic and lack of policy.

Few publications are specifically devoted to veterinary education and practice.

A list of most relevant references is provided at the end of this document.

### **1.2. Assessment of the potential impact of the use of DT&AI on veterinary education (undergraduate, postgraduate and continuous professional development)**

Two aspects need to be taken into account, i.e. the ability of DT&AI to improve the quality and efficiency of the learning and teaching processes, and the core training required for adequate use of DT&AI in veterinary practice.

It is generally well acknowledged that DT&AI can improve the quality of theoretical and practical teaching through virtual reality and augmented reality. It may also contribute to the implementation of the 3Rs (Replacement, Refinement, Reduction) of live animals used for training purposes. It may increase sustainability and efficiency of used resources at many levels and enhance animal welfare by improving the quality of the training of veterinarians who will take care of the animals. It may be particularly useful in cases when practical training is reduced, e.g. in case of small numbers of available live animals or carcasses, imposed measures due to outbreak of diseases, etc.

Nevertheless, it is fundamental that undergraduate and postgraduate students are ensured sufficient hands-on training on animals to acquire all Day One Competences. The use of DT&AI should therefore complement and enhance the theoretical and practical training, instead of replacing it.

DT&AI allow for individualization of the learning process, taking into account students' communication, learning preferences (most students nowadays reportedly prefer remote learning) and learning channels. Hence it increases efficiency through optimised learning, e.g. repetition at own pace, and encourages the students to be the actors in control of their education, which may enhance their responsibility and motivation.

At the same time, educators could be better equipped for supervising individuals and providing an individualised tutoring of all of them. Remote training facilitates reflective practice and a standardised and constructive feedback from students.

DT&AI can provide a more efficient teaching and in that way also improves wellbeing and motivation of teachers.

The use DT&AI for continuing professional development (CPD) of veterinarians is also seen as a great opportunity as it allows for cost-efficient CPD, since online CPD is usually cheaper, and increases availability of CPD opportunities for all veterinarians, e.g. even the ones practicing in rural and remote areas. While hands-on training cannot be fully completed by remote training or other forms of digital tools, CPD should become more flexible, e.g. the theoretical part can be provided online/remotely ahead of the practical work.

However, it is noted that the value of physical contact and interactions between participants cannot be fully replaced by online webinars.

DT&AI may also :

- facilitate the harmonisation of the learning outcomes for any study programme, e.g. by evaluating teaching, learning and assessment processes;
- facilitate the feedback from students and stakeholders for further improvement of the curriculum;
- enhance the availability of innovative tools and facilitate their sharing between Veterinary Education Establishments (VEEs);
- increase accessibility of learning and widen participation;
- increase economic, social and green sustainability of learning and make it more affordable/cost effective while improving quality;
- provide updated tools and challenges, especially via AI auto-improvement processes;
- enhance interdisciplinary and 'One health' collaboration.

Further to the use of DT&AI for teaching and learning purposes, the core curriculum should familiarise and prepare students for their use in veterinary practice, e.g. for the implementation of telehealth and telemedicine which are more and more used in the field (see item 2).

### **1.3. Assessment of the potential impact of the use of DT&AI in veterinary practice**

DT&AI could be more and more integrated in all kind of veterinary practice and could:

- Improve the prevention, diagnosis and treatment of animal and zoonotic diseases;
- Improve the understanding of the respective impact of the genome, exposome and microbiome on animal health, welfare and production, on public health and on One health concept;
- Develop precision (individual) medicine, e.g. via technology-based prevention, diagnosis and treatment protocols;
- Improve Herd Health Management (including prevention, sustainability production, performance, reproduction,);
- Reduce the non-essential use of antibiotics and other drugs in the interest of animals, humans and environment;
- Improve pharmacovigilance reporting;
- Improve communication and information transfer with clients and stakeholders;
- Improve cross-sectoral and interdisciplinary collaboration with stakeholders involved with animal health, public health and environment sustainability;
- Enhance the development, availability and better use of new prevention strategies, drugs and vaccines;

- Promote consumer protection and public health by improved traceability, e.g. from ‘farm to fork’;
- Improve reliable and continuous animal welfare, e.g. through animal surveillance during transport;
- Improve feedback from clients and stakeholders in order to improve the quality and adequacy of services.

Nevertheless, the above opportunities come together with the acknowledgement that the veterinary profession is not yet ready to fully incorporate those technologies in practice due to the non-existence of appropriate policies at national and EU level. There is indeed a need for the establishment of a clear and transparent European regulatory framework, which would put in place strategies for:

- the independent evaluation, certification and regulation of DT&AI-based tools: there is a need for availability of reliable new technologies through a proper authorisation process before their placement on the market;
- the ownership and use of generated data: the use of such technologies in veterinary practice requires and generates a huge amount of data. Practitioners should be able to take advantage of those big data as they are actually the ones generating or interpreting data; preferably these data should be open source although in agreement with GDPR;
- the establishment of ethics and deontology to clearly frame responsibilities, accountability and borders in the use of DT&AI;
- ensuring cybersecurity during the use of DT&AI and a framework for cases of infringement.

#### **1.4. SWOT analysis on the future increased use of DT&AI in veterinary education and practice**

##### **Strengths:**

- ) Willingness to enhance effective and sustainable veterinary education and practice
- ) High ability to use tools for DT&AI, especially among students and young graduates
- ) Availability of computers and smart phones for most teachers, students, practitioners, clients
- ) Availability of big data for population medicine
- ) Harmonised veterinary education in Europe due to ECCVT

##### **Weaknesses:**

- ) Poor knowledge and/or reluctance of teachers and practitioners about opportunities and threats of DT&AI
- ) Not enough collaborations between disciplines, e.g. medical computer and life sciences
- ) Few tools/applications currently independently validated, officially authorised and fully available for education and practice
- ) Few legislation, policy and ethical/deontological regulations about efficient, safe and legal use of DT&AI
- ) Poor availability of accurate and harmonised data for testing the algorithms
- ) Difficulty to improve soft skills via distance learning

##### **Opportunities:**

- ) Enhanced quality of veterinary education and practice in many disciplines
- ) Improved communication with students, clients and other stakeholders
- ) More individualised education and precision medicine
- ) Improved animal health, welfare (including better implementation of 3Rs) and production
- ) Sharing of tools between VEEs for efficient, harmonised and cost effective e-learning

- ) Better use of big data analysis to the benefit of animals, humans and environment
- ) Cost efficient CPD and extended availability to all veterinarians

**Threats:**

- ) Over-reliance on DT&AI and over-looking the complementary need of human assessment
- ) DT&AI used as substitutes (instead of tools) for good teaching and clinical practices and social interactions
- ) Insufficient hands-on training and acquisition of Day One Competences if practical training replaced by digital
- ) Non-respect (or insufficient knowledge) of GDPR and ethics may lead to misuse of the data, online harassment and cyberthreats
- ) Inaccessibility to the applications/tools, e.g. because of poor internet connection

**2. Day One Competences to ensure a good understanding and responsible use of DT&AI**

Learning outcomes about DT&AI should build upon knowledge acquired through basic education and create a continuity from bachelor towards master in veterinary curricula. Day One Competences for graduate veterinarians should include:

- Basic knowledge in bio-informatics
- Conceptual knowledge and understanding of terminology of DT&AI
- Conceptual understanding on how applications/tools are generated, processed and potentially used for all aspects of veterinary medicine
- Knowledge on recording, harmonisation, storing, protection and validation of data from all disciplines of veterinary medicine
- Knowledge of the potential applications and limitations of DT&AI in all aspects of veterinary medicine (when, where and how to use it or not)
- Understanding of the triangular interaction between the client, the AI and the veterinary professionals
- Practical training with digital applications/tools, e.g. all aspects of telemedicine
- Soft skills linked to the use of DT&AI
- Deontology and ethics linked to DT&AI, including compliance with GDPR and related regulations

**3. Competences that can be enhanced by the use of DT&AI**

The following skills and competences could be complemented and enhanced by the use of DT&AI:

- Image, video, sound and smell analysis
- Trace and recording analysis
- Biological data analysis (omics, epidemiology, herd health, continuous monitoring of individual animal behaviour, animal interaction, time budgets of animals..)
- Understanding and optimisation of the use of available data on genome, exposome and microbiome
- More adapted prevention, diagnosis and treatment for both individual medicine and herd management, with consequently positive effects on animal health, welfare and production, on public health and on sustainable environment
- precision (individual) medicine
- Communication and information transfer with clients and stakeholders
- Improved clinical reasoning and decision through validated tools and efficient decision trees

#### **4. Trends in the way veterinarians communicate in their practice**

Currently veterinary practices involved with DT&AI use:

- E-mail, social networks, messaging apps, websites, ..
- Chatbot for communication with clients
- Telemedicine
- Mobile phone applications
- Wearable devices
- Remote monitoring sensors
- Pattern analysis of patients behaviour
- Observation and surveillance of patients via webcams
- Programmes for differential diagnosis and decision-making trees
- Electronic patient record system of animals under their care

#### **5. Teaching methods undergraduate and postgraduate**

Different teaching opportunities are already available and successfully used both undergraduate and post-graduate, such as:

- E-learning, M-learning, computer-assisted learning
- Mooc, podcast
- Wearable technologies
- Audience response systems
- Interaction with virtual medical situations, digital games, simulations
- Learning pattern analysis
- Access to software (e.g. used for herd management) and data of commercial farms

#### **6. Quality assurance (QA) linked to DT&AI**

Standard Operation Procedures for QA in veterinary education and practice should consider:

- Adaptation of the traditional QA loops to DT&AI
- Feeding the algorithms with high quantity and high quality data in agreement with GDPR (open source versus confidentiality, big data versus big rapta)
- Understanding and control of the decision-making processes proposed by AI algorithms (full understanding versus full black box)
- Interaction between the client, the applications/tools and the veterinary professionals
- Interaction with all stakeholders for achieving scalable, customisable, and ethical solutions
- Easier and faster feedback from all stakeholders for continuing improvement of the procedures
- Individualised education and precision medicine via DT&AI

#### **Conclusions**

Undoubtedly, DT&AI are entering into the veterinary world, both in education and practice, with a lot of opportunities but also a lot of threats. Ignoring it would be deleterious for the future of the veterinary profession.

Because of the drastic and fast changes in the availability of new technologies and in the subsequent requirements from the society, it is urgent to prepare the veterinary profession to

face the challenges of DT&AI through adequate and continuously updated training, either at the undergraduate, postgraduate and CPD levels.

Furthermore, it is urgent for the relevant authorities to develop policies and regulations to ensure efficient, safe, ethic and legal use of DT&AI in veterinary medicine.

## References

*A survey of knowledge and use of telehealth among veterinarians. Watson et al. BMC Veterinary Research (2019) 15:474 <https://doi.org/10.1186/s12917-019-2219-8>*

*Veterinary Telehealth: The basics. American Veterinary Medical Association. 2019. <https://www.avma.org/PracticeManagement/telehealth/Pages/telehealth-basics.aspx>*

*Telemedicine. American Veterinary Medical Association. 2019. <https://www.avma.org/KB/Policies/Pages/Telemedicine.aspx>.*

*How will artificial intelligence impact the veterinary profession? by Veterinary Practice 04 November 2019*

*Precision livestock farming technologies for welfare management in intensive livestock production. Scientific and technical review of the OIE by Berckmans(2014). <https://doc.oie.int/dyn/portal/index.seam?page=alo&aloId=31755&fonds=0&cid=7>*

*Smart technologies for detecting animal welfare status and delivering health remedies for rangeland systems. Scientific and technical review of the OIE by Rutter (2014) <https://doc.oie.int/dyn/portal/index.seam?page=alo&aloId=31754&fonds=0&cid=7>*

*[https://www.oie.int/onehealthconference2019/wp-content/uploads/2019/10/One-Health-for-the-Mediterranean-Region-in-the-Big-Data-age\\_OIE\\_Programme-2.pdf](https://www.oie.int/onehealthconference2019/wp-content/uploads/2019/10/One-Health-for-the-Mediterranean-Region-in-the-Big-Data-age_OIE_Programme-2.pdf)*

*<https://www.vivet.org.uk/wp-content/uploads/2020/03/Survival-in-the-New-Normal-the-Impact-of-Digitisation-on-Customer-Behaviour-slides.pdf>*

*[https://teachonline.ca/sites/default/files/tools-trends/downloads/ten\\_facts\\_about\\_artificial\\_intelligence\\_0.pdf](https://teachonline.ca/sites/default/files/tools-trends/downloads/ten_facts_about_artificial_intelligence_0.pdf)  
<https://www.onlineuniversities.com/blog/2012/10/10-ways-artificial-intelligence-can-reinvent-education/>*

*<https://www.lequotidiendumedecin.fr/actus-medicales/esante/un-du-en-intelligence-artificielle-lille>*

*<https://odf.parisdescartes.fr/fr/formations/feuilleter-le-catalogue/sciences-technologies-sante-STS/diplome-d-universite-1/du-intelligence-artificielle-ia-appliquee-en-sante-JXMZBK41.html#programContent420228f3-13f2-4626-a7e0-c8c0bdd960e9-1>*

*<https://ec.europa.eu/digital-single-market/en/news/training-future-proof-doctors-digital-society-how-smart-health-changing-profession-our-doctors>  
<https://ec.europa.eu/digital-single-market/en/news/digital-transforming-medical-doctors-daily-work-deans-and-student-doctors-agree-common>*

<https://clinicallibrary.nadis.org.uk/>

<https://www.cpme.eu/index.php?downloadunprotected=/uploads/adopted/2019/CPME.Board.Nov19.FINAL.EN.AIinhealthcare.pdf>  
*'Embracing digital technology in veterinary practice'*

[https://www.eca.europa.eu/Lists/ECADocuments/JOURNAL20\\_01/JOURNAL20\\_01.pdf](https://www.eca.europa.eu/Lists/ECADocuments/JOURNAL20_01/JOURNAL20_01.pdf)

<https://www.feam.eu/wp-content/uploads/AI-Summary-report-15-Apr-2019-FV.pdf>

<https://ec.europa.eu/futurium/en/ai-alliance-consultation>

<https://ec.europa.eu/futurium/en/ethics-guidelines-trustworthy-ai/stakeholder-consultation-guidelines-first-draft#Top>

<http://data.consilium.europa.eu/doc/document/ST-6177-2019-INIT/en/pdf>

*The Medical devices Regulation*

*The Cyber Security Schemes legislation and*

*The Information System Directive*

[https://www.eesc.europa.eu/sites/default/files/files/presentation\\_martin\\_harris\\_hess\\_artificial\\_intelligence\\_in\\_and\\_for\\_europe.ppt](https://www.eesc.europa.eu/sites/default/files/files/presentation_martin_harris_hess_artificial_intelligence_in_and_for_europe.ppt)

[https://www.eesc.europa.eu/sites/default/files/files/presentation\\_jelena\\_malinina.pdf](https://www.eesc.europa.eu/sites/default/files/files/presentation_jelena_malinina.pdf)

[https://www.eesc.europa.eu/sites/default/files/files/presentation\\_karl\\_stoger.pptx](https://www.eesc.europa.eu/sites/default/files/files/presentation_karl_stoger.pptx)

<https://www.nines.com/>