

Potential paths for the introduction of risk analysis to improve the veterinary epidemiology curriculum in Ukraine

This paper (No. 12072021-00180-EN) has been peer-reviewed, accepted, edited, and corrected by authors. It has not yet been formatted for printing. It will be published in issue **39** (3) of the *Scientific and Technical Review*, in 2021.

V. Yustyniuk ^{(1)*}, V. Nedosekov ⁽¹⁾, O. Kepple ⁽²⁾, V. Melnyk ⁽¹⁾, V. Polischuk ⁽¹⁾, M. De Nardi ⁽³⁾ & M. Correa ⁽⁴⁾

(1) Department of Epizootology, Microbiology and Virology, Faculty of Veterinary Medicine, National University of Life and Environmental Sciences of Ukraine, 16 Potekhina Str., Kyiv 03127, Ukraine

(2) Ukrainian Laboratory of Quality and Safety of Agricultural Products of NULES of Ukraine, 7 Mashinobudivnykiv Str., Chabany Village, Kyiv 08162, Ukraine

(3) SAFOSO, Waldegstrasse 1, CH-3097 Liebefeld, Switzerland

(4) Department of Population Health and Pathobiology, North Carolina State College of Veterinary Medicine, 1060 William Moore Drive, Raleigh, NC 27607, United States of America

*Corresponding author: yustyniuk_valeriia@nubip.edu.ua

Summary

The main purpose of veterinary education institutions is to prepare qualified, well-trained and knowledgeable professionals ready to serve local and global communities. Veterinary programmes vary within and among countries, creating a disparity in competencies. In lesser developing economies, adhering to the World Organisation for Animal Health (OIE) ‘Day 1 competencies’ and following their ‘Guidelines for a Model Core Veterinary Curriculum’ may decrease this discrepancy. The authors offer a comparison of Ukraine’s veterinary epidemiology curriculum with the OIE suggested ‘Core Veterinary Curriculum’, particularly for infectious disease pathology in which epidemiology is taught, and propose different paths to structure advanced educational programmes in epidemiology. This

course is relevant for the development of international animal trade and expansion of markets for animal products in Ukraine.

Epidemiology is essential for the recently developed risk analysis departments at the State Service of Ukraine for Food Safety and Consumer Protection (SSUFSCP) and the Department of Food Safety and Quality of the Ministry for Development of Economy, Trade and Agriculture of Ukraine. Professional training is paramount and veterinarians graduating from Ukrainian institutions will have the basic knowledge to start working on animal trade and products and in public service. The long-term goal is to improve the Ukrainian veterinary curriculum through modifications in epidemiology lessons and to develop and share a template for evaluation of veterinary schools' epidemiology content taught elsewhere in the country.

Keywords

Day 1 competencies OIE – Model Core Veterinary Curriculum OIE – Risk analysis – Veterinary curriculum – Veterinary epidemiology.

Background

In Ukraine, specialists in the different facets of risk analysis join the State Veterinary Service within the newly established risk analysis departments under the State Service of Ukraine for Food Safety and Consumer Protection (SSUFSCP) and the Department of Food Safety and Quality of the Ministry for Development of Economy, Trade and Agriculture of Ukraine. Currently, epidemiology teaching does not include training in risk analysis. In order to determine how to include relevant topics to aid specialists entering public service, the authors first offer a description of the Ukrainian veterinary curriculum. Second, they describe how this is aligned with the guidelines of the World Organisation for Animal Health (OIE), including risk analysis in epidemiology courses. Finally, different paths are proposed for inclusion in the curriculum and possible additional postgraduate training.

Disease control and prevention work requires specific qualifications (1). However, veterinary schools traditionally produce omnicompetent veterinarians at graduation (2). Therefore, veterinary education needs to be adapted to the changes in labour market requirements due to globalisation and trade. The veterinary curriculum provides clinical skills and covers many scientific disciplines (1) that

may not suffice for those considering a career in public service. These veterinarians will require additional training in globalisation, trade in animals and animal products, risk analysis, policy including welfare, and other traditionally non-veterinary areas such as statistics and disease modelling (3). With this purpose, some veterinary schools have included these topics in their veterinary curriculum in core courses or added short courses for credit. Some universities have established graduate and postgraduate certificate programmes in Veterinary Public Health, One Health and Veterinary Epidemiology.

Besides the introduction of new courses, there is a need for periodic reviews of professional, socio-economic, cultural and governmental needs. Cyclic quality management models have been proposed, including quality management programmes focusing on the curriculum's endpoint with well-defined measurable outcomes, repeated cycles of review, consistent review protocols and acceptability studies for schools' faculty and administrators (4).

The OIE's 'Day 1 graduates' recommendations for the competencies of graduating veterinarians are meant to improve the quality of the public and private components of National Veterinary Services (5). The OIE offers guidelines for developing the 'Model Core Veterinary Curriculum', which include the principal components for developing a veterinary curriculum to achieve certain levels of competency after graduation (3). Applying the OIE's 'Standards and Recommendations' to veterinary education and Veterinary Statutory Bodies (VSBs) ensures quality in the delivery of professional services, increases credibility of the Veterinary Services and contributes to the development of good governance (6).

In an OIE twinning project between the Veterinary Faculty of Lyon, France (VetAgro Sup) and Bila Tserkva National Agrarian University (BTNAU) of Ukraine, the need to revise the veterinary epidemiology curriculum was stressed (7). According to the OIE's 'Guidelines for a Model Core Veterinary Curriculum', the epidemiology curriculum should include all components of risk analysis, such as hazard identification, risk assessment, risk management and risk communication. These epidemiological approaches are mentioned in epidemiology courses but rarely included as part of the curriculum. Risk analysis plays an essential role in allowing Veterinary Services to complete many of their functions, including qualitative/quantitative studies for import and export requirements for animals and animal

products. Many aspects of risk analysis contribute to the design of surveillance systems and veterinary inspection. Thus, the introduction of risk analysis into the veterinary curriculum becomes relevant for the training of specialists.

Materials and methods

An overview of the Ukrainian veterinary education structure is presented, including university degrees leading to veterinary graduation and data on enrolment. The type and duration of different educational programmes were obtained through a survey (available upon request from the corresponding author) of the administrative units of ten accredited veterinary schools in Ukraine. Using the 'OIE Guidelines on Veterinary Education Core Curriculum', the authors focused on infectious disease pathology and epidemiology courses where risk analysis is recommended. In this study, differences were highlighted between the curriculum of the leading veterinary school in the country, the National University of Life and Environmental Sciences of Ukraine (NULES of Ukraine), and the proposed OIE guidelines. The study was completed with four different paths to improve the Ukrainian veterinary curriculum in order to enhance the training of veterinarians involved in public service.

Results

Schools of veterinary medicine in Ukraine

All higher education institutions are subject to a mandatory evaluation procedure. At the end of February 2019, the National Agency for Higher Education Quality Assurance was established to ensure the quality of educational programmes (8). According to the Regulations on Accreditation of Study Programmes in Higher Education, the accreditation certificate is issued for the first time for a period of five years, and during the second and subsequent accreditations for a period of ten years (9). The overview of programmes offered by ten accredited veterinary schools in Ukraine is presented in Table I. The path to a veterinary degree and academic career from secondary education is shown in Figure 1.

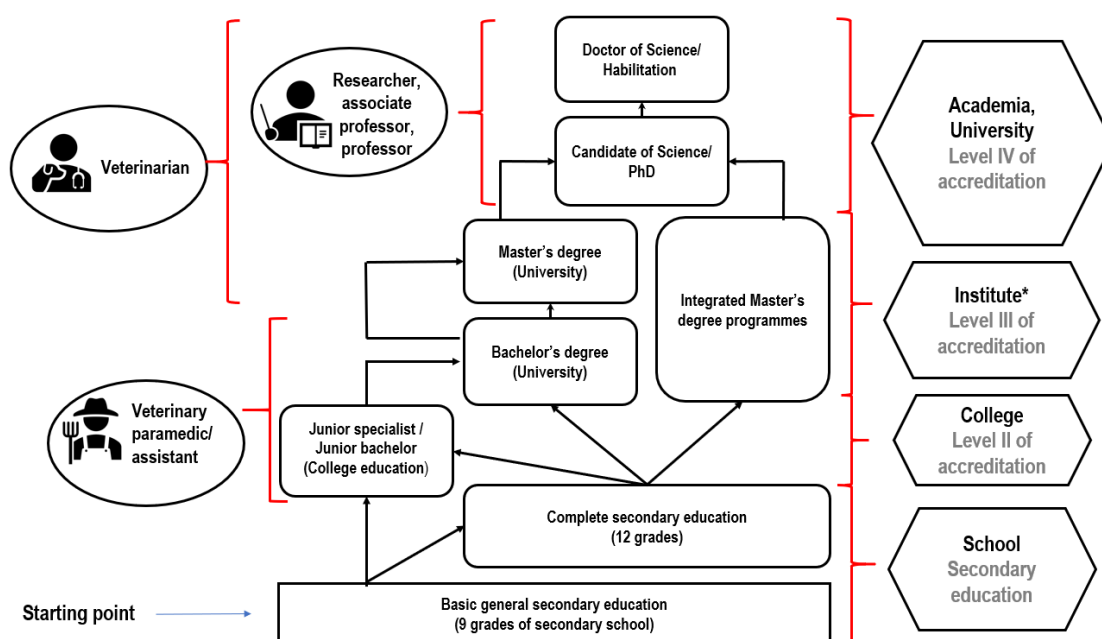


Fig. 1

Flowchart describing paths from secondary-school education to veterinary medicine and an academic career in Ukraine

* According to the established levels of accreditation, institutes belong to levels III and IV of accreditation, but veterinary schools are represented only in institutions at level IV of accreditation, namely universities and academies that provide BS, MS, PhD and DSc degrees.

BS: Bachelor's degree

DSc: Doctor of Science

MS: Master's degree

PhD: Doctor of Philosophy

Veterinary schools provide both undergraduate bachelor (BS) and graduate degrees, in particular one at the master's (MS) and two at the doctoral levels: Doctor of Philosophy (PhD) and the habilitation for the Doctor of Science (DSc). The initial degree (BS programme) is identical across the schools. In order to achieve qualification as a veterinarian it is necessary to obtain an MS. For those interested in academic or research careers, there are post-veterinary degrees. The Master's degree is followed by the PhD programme. The Doctor of Veterinary Science (DVSc) habilitation allows veterinarians, after completion of the PhD, to continue towards the DVSc. In 2018 ten accredited veterinary schools in Ukraine graduated approximately 2,270 veterinarians with BS and MS degrees, while the number of graduates with doctoral degrees was 40, with the ratio of PhD to the DVSc being 7:1 (10).

Table I**List of accredited veterinary schools in Ukraine with duration of programmes as of May 2018**

Veterinary school	Duration of bachelor's programme in months/240 ECTS credits	Duration of master's programme in months/90 ECTS credits/360 ECTS credits	Duration of PhD programme in months/36 ECTS credits	Duration of DVSc habilitation in months/non-applicable
Bila Tserkva National Agrarian University (Bila Tserkva)	48	24*	48	48
Dnipropetrovsk State Agrarian and Economic University of Ukraine (Dnipro)	48	24*/72	48	24
Kharkiv State Zooveterinary Academy (Kharkiv)	48	18*/72	48	24
National University of Life and Environmental Sciences of Ukraine (Kyiv)	48	18*/72	48	24
Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies (Lviv)	48	18*/72	48	24
Odesa State Agrarian University (Odesa)	48	18–24*/72	Not offered	Not offered
Poltava State Agrarian Academy of Ukraine (Poltava)	48	18*/72	48	Not offered
State Agrarian and Engineering University in Podillia (Kamianets-Podilskyi)	48	18*	48	Not offered
Sumy National Agrarian University (Sumy)	48	17*/72	48	24
Zhytomyr National Agroecological University (Zhytomyr)	48	22*/72	48	36

* Duration of master's programme (MS) after bachelor's programme (BS)/after completed secondary education

DVSc: Doctor of Veterinary Science

ECTS: European Credit Transfer and Accumulation System (number of ECTS credits is presented according to the National University of Life and Environmental Sciences [NULES] of Ukraine curriculum and may vary among other schools)

PhD: Doctor of Philosophy

As stated in 2002 by the Ukrainian Law on Higher Education, the accreditation level of a higher education institution is determined in part by the types of programmes offered. Thus, higher educational institutions of the third level of accreditation deal with graduate professionals with bachelor's and master's qualifications, while institutions at the fourth accreditation level award BS, MS, PhD and DSc degrees.

All veterinarians, including public service veterinarians and private practitioners, are required to undertake additional professional development courses or partake in continuing education. Some of these activities take between 72 and 500 hours to complete and are required to be completed every five years. This is part of a certification process, awarding qualifications for different levels of assignments, and demonstrating compliance with the requirements of professional titles (11). Courses of continuous education are provided by the veterinary schools of the third and fourth accreditation levels; NULES of Ukraine is accredited at the fourth level and provides training for 600–700 veterinarians per year.

Compliance of Ukrainian veterinary epidemiology curriculum with the World Organisation for Animal Health Model Core Veterinary Curriculum

The OIE has developed 'Recommendations on the Competencies of Graduating Veterinarians' and 'Guidelines on Veterinary Education Core Curriculum' to ensure that graduates of different veterinary schools worldwide have the necessary knowledge and skills to work in their national Veterinary Services. These recommendations and guidelines can help primarily developing and in-transition countries adjust their curricula and, if needed, compare them with the European education system's requirements and standards (3, 5). With a deep understanding of society's needs, and the economic and political differences among countries, the OIE does not require one general curriculum for universities worldwide. The guidelines are recommendations to help countries to improve the quality of veterinary education. National Veterinary Services benefit from this overall change in the curriculum (3).

About 70% of the curriculum is shared among all Ukrainian veterinary schools, including the epidemiology syllabus. Although there are some differences, none of them covers all aspects of the OIE

recommendations. In this study, the authors compared the curriculum of NULES of Ukraine with those of other Ukrainian schools and the OIE's 'Model Core Veterinary Curriculum'.

Epidemiology is taught under the name 'general epizootology' at NULES of Ukraine. The course starts in the fourth year of study and lasts for one semester, providing 2.5 European Credit Transfer and Accumulation System (ECTS) credits. According to the study plan, there are a total of four hours in-class work and one hour of autonomous study per week, giving an overall 75 hours per semester. The course includes 15 credit-hours of lectures and 54 of practical classes where students get hands-on experience in issues covered in lectures. Students learn general aspects of infectious disease prevention and control, including disease transmission, diagnosis and control measures. This is followed by a course on infectious diseases of animals ('special epizootology'), which includes zoonoses. Overall, students receive 10 ECTS credits after completion of both courses.

As specified by the OIE guidelines, epidemiology is a specific and advanced competency (5). Students should learn about study design, analytical methods, outbreak investigation, and disease control and prevention during the epidemiology course. They should also be exposed to data collection, data quality and assurance, and statistical approaches to data analysis, but these important topics are not covered in the above-mentioned courses. Within the advanced epidemiology course, students should be introduced to all facets of risk analysis, surveillance/monitoring, the Three Sisters to the World Trade Organization (WTO) and public policy. However, the NULES of Ukraine veterinary epidemiology course is focused on the general aspects of infectious diseases, a subject referred to by the OIE guidelines as more akin to pathology than epidemiology. No principles of risk assessment, management or communication are taught, either in epidemiology or in other disciplines related to infectious disease pathology. Yet these epidemiological principles are fundamental for the profession in a global economy.

Proposal for improvement of the Ukrainian veterinary epidemiology curriculum and integration of risk analysis

To develop alternatives for the epidemiology course and the integration of risk analysis, the authors considered four possible paths

and described the advantages and disadvantages of each path (Table II).

Making changes in the veterinary curriculum as a whole may take six years or even more (12). Additional time will be required to homogenise the curriculum across all accredited veterinary schools. In Table II four paths are presented for possible addition of topics and training needed for public service.

Table II

Changes to the curriculum, with advantages and disadvantages for veterinary epidemiology course

Changes	Advantages	Disadvantages*
1. Revision of the current study programme and epidemiology course syllabus and replacement and/or addition of risk analysis topic	Quick implementation at no additional cost, focus on expanding knowledge base for graduates	Less time consuming, superficial coverage of the topic due to limited number of lecture hours, expertise needed
2. Introduction of short-term courses for graduate students at the MS level	Focus on students with necessary background or interested in a career in public service including Veterinary Services	Less time consuming, multiple levels of administrative approval and expertise needed
3. Establishment of a new MS programme on 'Veterinary Public Health'	Preparation of veterinarians within the One Health concept attuned with socio-economic factors and global economy	Time consuming, multiple levels of administrative approval and expertise needed
4. Introduction of continuing education in epidemiology, virology and bacteriology	No additional cost needed, cover topics focusing on public practice and service	Mid-range in time and expertise needed, fewer layers of administrative approval

* For the time involvement required for these changes, we have used an arbitrary scale: time consuming implying an unknown number of years, mid-range in time implying a couple of years, and less time consuming indicating probably within 18 months of initiation. Multiple layers of approval refer to approval of changes by faculty, university administrators and different governmental units.

MS: Master's degree

While revision of current courses, removing redundant topics taught elsewhere in the curriculum and addition of new topics such as risk analysis (option 1) do not require additional funding, one drawback of this option is that there is no time for the implementation of a

practicum for students interested in the area, owing to the limited number of hours currently assigned per course. However, students will be introduced to the trade in agriculture and animal trade language, including risk assessment.

The introduction of short-term courses (option 2) focusing on special topics aimed at careers in public service seems to be a practical way to add new material to the current curriculum. This would prioritise educational modules that expand the area of expertise in surveillance in animal health and production, statistics for epidemiology and population health, modelling and the dynamics of infectious diseases, and epidemiological approaches for food safety. Such courses would be mandatory for all students regardless of their future career plans but, at the same time, they would provide in-depth knowledge for those interested in public service. Implementation of this option requires more time for the preparation of study materials, and funding should be foreseen for faculty training and internships in highly specialised issues, and to provide software and course materials.

Establishing a new MS programme on ‘Veterinary Public Health’ (option 3) requires involvement of international experts and collaboration with foreign institutions. In addition to the six years required for curriculum changes, many more years may be required to complete all stages of adoption and conduct post-programme adoption evaluations. However, veterinary public health programmes at the MS level have been accomplished in developing nations. One example is the Geographic Information System (GIS) course at the University of Ibadan in Nigeria, focusing on disease ecology and ecosystem dynamics (13). Supported by the United States Agency for International Development (USAID), a network of seven schools of public health and seven veterinary schools formed the One Health Central and Eastern Africa (OHCEA) group and have engaged in curriculum review with area integration in mind (14). One Health oriented programmes may graduate professionals versed in multiple areas necessary to respond to emerging infectious diseases, global agricultural problems and concerns at the human–animal interface. The major obstacle to establishing a new programme is the work required for planning and approval, and continued review. Furthermore, administrative and financial support is required, along with participation of many area experts. Gathering all that is required to start the planning stage and maintain momentum to continue

through different stages of programme development may not be feasible in the short term (4).

Considering a class of up to 700 veterinarians involved in public service, the introduction of risk analysis in all its facets, international trade issues, and aspects of disease control and prevention into continuing education courses (option 4) seems the easiest way to expose and train professionals and career specialists for the specific work in Veterinary Services and the SSUFSCP.

Conclusion

For all paths presented in Table II and previously discussed, there is one constant factor required for success in a global economy: professionals prepared in different aspects of epidemiology, public health and public policy, and the search for new educational modalities to fulfil the requirement. The starting point for any process is to review the veterinary curriculum, map its content, reduce and increase teaching hours in some areas, reassign priorities, and find places to introduce recommendations from the OIE guidelines on risk analysis, and other epidemiological topics.

To ensure comparability with standards and the quality of higher education qualifications, Ukraine became one of the signatory members of the Bologna Process and ratified the Lisbon Convention on the Recognition of Higher Education Qualifications. These were the first steps towards reforming the higher education system in Ukraine (15, 16). As part of the ratification process there are internal and external quality assurance mechanisms that need to be developed for higher education institutions; these have not been fully completed. External quality assurance in the form of state-controlled institutional accreditation (17) was replaced by an independent body for programme accreditation. On the one hand, this newly established institution encourages transparency and accountability. On the other hand, internal quality assurance mechanisms and academic rewards systems are not based on international standards (18). Overall, the authors found the OIE's recommendations for the veterinary curriculum to be a starting point for consideration of what additional topics and courses, or additional education, are needed in epidemiology. The adoption mechanism is challenging; it is for school administrators and government policymakers to decide, and this may take many years to complete. Regional issues such as new, emerging,

foodborne or vector-borne diseases add more complexity to epidemiology training, beyond trade. In the interim, the authors advocate for short-term solutions such as presented in options 1 and 2 with the addition of short courses to fill the void.

Acknowledgements

The authors would like to express their gratitude to the Defense Threat Reduction Agency (DTRA) and Biological Threat Reduction Program (BTRP) in Ukraine for their support in developing this publication. While DTRA/BTRP did not support the research described in this publication, the programme supported the writing mentorship provided within the Science Writing Mentorship Programme and the publication effort. The content of this publication is the responsibility of the authors and does not necessarily reflect the views of DTRA or the United States Government.

References

1. Pastoret P.-P. & Vallat B. (2009). – Essential veterinary education in infectious diseases of livestock and related scientific disciplines. *In* Veterinary education for global animal and public health (D.A. Walsh, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **28** (2), 537–544. <https://doi.org/10.20506/rst.28.2.1895>.
2. Fernandes T.H. (2005). – European veterinary education: a bridge to quality. *Vet. J.*, **169** (2), 210–215. <https://doi.org/10.1016/j.tvjl.2004.09.001>.
3. World Organisation for Animal Health (OIE) (2013). – Veterinary Education Core Curriculum: OIE Guidelines. OIE, Paris, France, 11 pp. Available at: www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/docs/pdf/AF-Core-ANG.pdf (accessed on 14 June 2021).
4. Van Sluijs F.J. (2010). – Topic C: Veterinary education: quality assurance & accreditation. Quality assurance in veterinary education: requirements for effectiveness. *In* Proc. 13th Association of Institutions for Tropical Veterinary Medicine (AITVM) Conference, 23–26 August 2010, Bangkok, Thailand, 7. Available at: www.aitvm.org/wp-content/uploads/2011/08/Proceedings.pdf (accessed on 16 July 2020).

5. World Organisation for Animal Health (OIE) (2012). – OIE recommendations on the Competencies of graduating veterinarians ('Day 1 graduates') to assure National Veterinary Services of quality. OIE, Paris, France, 13 pp. Available at: www.oie.int/fileadmin/Home/eng/Support_to_OIE_Members/Vet_Edu_AHG/DAY_1/DAYONE-B-ang-vC.pdf (accessed on 16 July 2020).

6. Rassow D. (2013). – OIE standards and recommendations for veterinary education and veterinary statutory bodies (VSBs) and their role in good governance. *In Proc. 3rd OIE Global Conference on Veterinary Education and the Role of the Veterinary Statutory Body: 'Ensuring excellence and ethics of the Veterinary Profession'*, 4–6 December 2013, Foz do Iguazu, Brazil. OIE, Paris, France, 12 pp. Available at: <https://slideplayer.com/slide/14615785/> (accessed on 14 June 2021).

7. Rublenko M., Prouillac C. [...] & Leblond A. (2018). – Implementation of the OIE recommendations in Ukrainian veterinary education. OIE, Paris, France, 9 pp. Available at: www.oie.int/fileadmin/Home/eng/Links/docs/pdf/Implementation_of_the_OIE_Recommendations_in_Ukrainian_Veterinary_Education.pdf (accessed on 27 October 2020).

8. National Agency for Higher Education Quality Assurance (NAQA) (2019). – Strategy of the national agency for higher education quality assurance to 2022. NAQA, Kiev, Ukraine, 6 pp. Available at: <https://en.naqa.gov.ua/wp-content/uploads/2020/04/Strategy-to-2020.pdf> (accessed on 16 July 2020).

9. Ministry of Education and Science of Ukraine (2019). – Regulations on accreditation of educational programmes for higher education. Order No. 880/33851, Verkhovna Rada of Ukraine, Legislation of Ukraine, Kiev, Ukraine. Available at: <https://zakon.rada.gov.ua/laws/show/z0880-19#Text> (accessed on 16 July 2020).

10. National Agency for Higher Education Quality Assurance (NAQA) (2020). – Annual report of the National Agency for Higher Education Quality Assurance for 2019. NAQA, Kiev, Ukraine, 244 pp. Available at: <https://naqa.gov.ua/wp-content/uploads/2020/02/%D0%97%D0%B2%D1%96%D1%82-2020.pdf> (accessed on 25 November 2020).

11. Ministry of Agricultural Policy of Ukraine (2004). – Regulations on postgraduate education of veterinary doctors in Ukraine. Order No. 1041/9640, Verkhovna Rada of Ukraine, Legislation of Ukraine, Kiev, Ukraine. Available at: <https://zakon.rada.gov.ua/laws/show/z1041-04#Text> (accessed on 16 July 2020).

12. Bíreš J. (2009). – Requirements on veterinary education related to integration of animal and public health. *Folia Vet.*, **53** (3), 120–123. Available at: www.cabdirect.org/cabdirect/abstract/20103057040 (accessed on 28 October 2020).

13. Olugasa B.O., Ijagbone I.F. & Esuruoso G.O. (2012). – It is over three decades of graduate education in epizootiology at the University of Ibadan, Nigeria (1975–2011): is there a need to revise the curriculum? *Pan Afr. Med. J.*, **12**, 70. Available at: <https://pubmed.ncbi.nlm.nih.gov/23024829/> (accessed on 28 October 2020).

14. Amuguni H.J., Mazan M. & Kibuuka R. (2017). – Producing interdisciplinary competent professionals: integrating One Health core competencies into the veterinary curriculum at the University of Rwanda. *J. Vet. Med. Educ.*, **44** (4), 649–659. <https://doi.org/10.3138/jvme.0815-133R>.

15. Luchinskaya D. & Ovchynnikova O. (2011). – The Bologna process policy implementation in Russia and Ukraine: similarities and differences. *Eur. Educ. Res. J.*, **10** (1), 21–33. <https://doi.org/10.2304/eeerj.2011.10.1.21>.

16. United Nations Educational, Scientific and Cultural Organization (UNESCO) & the Council of Europe (2019). – Monitoring the implementation of the Lisbon recognition convention. Council of Europe Higher Education Series No. 23. UNESCO, Paris, France and the Council of Europe, Strasbourg, France, 111 pp. Available at: www.gcedclearinghouse.org/sites/default/files/resources/190185eng.pdf (accessed on 28 October 2020).

17. Filiatreau S. (2011). – Ukraine's participation in the Bologna process: has it resulted in more transparency in Ukrainian higher education institutions? *Int. Res. Rev.*, **1** (1), 49–64. Available at: www.phibetadelta.org/images/stories/4_FILIATREAU-Bologna_reforms_Fall_2011.pdf (accessed on 28 October 2020).

18. Schiermeier Q. (2006). – Ukraine scientists grow impatient for change. *Nature*, **440** (7081), 132–133. <https://doi.org/10.1038/440132a>.
