J S Afr Vet Assoc. 2023;94(1):1-6
https://doi.org/10.36303/JSAVA.529

J S Afr Vet Assoc
ISSN 2224-9435 EISSN 1019-9128

CONFERENCE REPORT

Life-long learning in laboratory animal science and ethics for veterinary and para-veterinary professionals in South Africa

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Veterinary and para-veterinary professionals working in the animal research sector are critical to ensure scientific quality and the humane care and use of animals. However, there are few focused education and training opportunities available for these professionals in South Africa.

A survey of veterinarians working in animal research, undertaken by the South African Association for Laboratory Animal Science, identified the need for more advanced education and training opportunities beyond the routine Day 1 Skills currently provided for in undergraduate education. These could be broadly categorised into knowledge and skills relating to species-specific husbandry, procedures and clinical approaches, research-related biosecurity and biosafety, and study-specific ethical and animal welfare considerations.

A subsequent workshop, attended by 85 veterinary and para-veterinary professionals in the animal research sector, identified 53 life-long learning needs, each with an associated learning outcome, for this professional community. These were grouped into five overarching themes: Personal development (9); Leadership and management skills (12); Education and training skills (5); Welfare, ethics and clinical skills (20); and Regulations and quality-assurance (7). Of the 53 learning outcomes, 14 were knowledge-based, ten were competencies, and 29 both knowledge and competence.

These life-long learning opportunities, if available and implemented, will address important needs of veterinary and para-veterinary professionals in the animal research sector in South Africa. This would empower these professionals, assist in improving animal and human wellbeing, support high-quality ethical science, and maintain public confidence in the sector, thus enabling a more satisfactory career environment.

Introduction

Animals are used for many scientific purposes, including the development of medicines and vaccines, enhancement of human and animal health and wellbeing, conservation biology, regulatory testing, and education and training. Veterinary and para-veterinary professionals are critical to the humane care and use of animals in these scientific environments. Veterinary and para-veterinary professionals in the animal research sector include veterinarians, veterinary nurses, laboratory animal technologists and animal health technicians, often in technical and management positions. They are employed, or retained, by any institution or organisation that uses animals for scientific purposes. Laboratory animals are defined here as animals that are kept or used for scientific purposes in a research animal facility or study site, including non-human vertebrates (i.e. fish, amphibians, reptiles, birds, and mammals) and invertebrates, encompassing domestic, feral, purpose-bred, farm, and free-living animals.

Their role and involvement in humane animal research extends far beyond the provision of routine veterinary services and animal care (before, during and after experimental procedures), encompassing a much broader animal welfare remit, ethical, scientific and management responsibilities. This includes advising on study design, performing the ethical review of protocols, providing education, training and ensuring the practical competency of staff and researchers involved in animal care and use, engaging in research themselves, and ensuring effective and efficient animal facility management compliant with regulatory requirements (FELASA/ECLAM/ESLAV Joint Working Group on Veterinary Care 2008; Fourie 2022; National Research Council of the National Academies 2011; Poirier 2015).

These varied and extensive roles are increasingly being enshrined, across the world, into legislation, national and international standards, and the requirements of Professional, Statutory and Regulatory Bodies. For example, in South Africa, the South African National Standard for the Care and Use of Animals for Scientific Purposes (SANS 10386:2021) (South African Bureau of Standards 2021) requires institutional animal ethics committees to include a veterinarian with expertise in animal research in its membership to review animal welfare considerations and refinements from a veterinary clinical perspective. The South African Veterinary Council (SAVC; Rule 32 of the Rules Relating to the Practicing of Veterinary Professions, GNR 1082 of 9 Nov 2015) requires a registered veterinarian to act as facility principal, to provide weekly oversight of animal health and welfare, surgical and technical support, and to ensure regulatory compliance and

maintenance of minimum standards. The SAVC requires all non-registered persons who perform veterinary or para-veterinary procedures, to be certified as competent by a veterinarian and authorised by the Council. This in turn requires effective partnerships with all involved parties, to ensure that standards are upheld.

The appropriate education and training of veterinary and para-veterinary professionals is essential to ensure they are competent in all their tasks in the animal research environment, and as a moral imperative, that they are knowledgeable and able to protect the welfare of the sentient animals in their care. As professionals, they promote quality-assurance mechanisms in order to reduce confounding variables in research projects and thus promoting high-quality science.

However, there are currently few education and training opportunities available in South Africa that are specifically tailored to the needs of veterinary and para-veterinary professionals in this sector. For example, undergraduate programmes for the training of veterinarians contain limited coverage of the ethics, care and use of animals for scientific purposes. While employers may provide variable on-the-job training for veterinary and para-veterinary professionals in the research sector, most new veterinary and para-veterinary professionals rely on colleagues already in the animal research field for continued advice and support. Additionally, animal care and welfare science is a continually evolving field, thus the need exists to provide life-long learning opportunities, which share global good practice. There is therefore a need for additional education and training, and the harmonisation of its provision in the community, on an ongoing basis.

The aim therefore was to determine the education and training needs of veterinary and para-veterinary professionals in the animal research sector in South Africa, and to use this information to identify, within the community, the required life-long learning and continuing professional development (CPD) opportunities.

Materials and methods

The South African Association for Laboratory Animal Science (SAALAS) Designated Veterinarian Working Group created a survey to ascertain the education and training needs of animal research veterinarians in South Africa in 2017. Ethical approval was obtained from the Human Research Ethics Committee of the Faculty of Health Sciences, University of Cape Town (HREC Ref 867/2016) and the online survey distributed to all veterinarians known to be employed in the sector in South Africa. Survey responses were received from 25 veterinarians working in the animal research sector, broadly representative of academia and industry.

A follow-up national workshop was held as part of the SAALAS Conference in 2022 to ascertain the life-long learning needs of veterinary and para-veterinary professionals in the animal research sector. Eighty-five persons contributed to the education and training workshop, with participants drawn from the veterinary and para-veterinary professional community. Following a brief introduction to the task, participants were divided into multiple small breakout groups, working within these groups to identify the group's life-long learning needs. Each group recorded their needs, which were subsequently shared with other groups in a plenary session. Following the workshop, the authors collated all identified needs (i.e. learning opportunities), grouped them into themes, and created accessible learning outcomes (i.e. starting with a verb that enables it be assessed objectively) for each learning opportunity in accordance with Bloom's taxonomy of educational objectives (Bloom et al. 1956).

Results

The 25 survey respondents indicated that the undergraduate training which they had received in certain topics, was insufficient to prepare them for the competencies required in the animal research sector. Table I summarises the most commonly identified Day 1 Skills, i.e. the essential skills required to start working in the sector, beyond that which was obtained in undergraduate education; the more advanced training needs; and the CPD needs. Additional shortcomings identified included study design, methodology and statistics; quality management; and objectively assessing the competency of personnel in veterinary procedures.

Table I: Education, training and life-long learning needs of veterinary professionals in the animal research sector in South Africa (2017 survey results); percentages are the fraction of respondents who strongly agreed that additional education and training was required in these fields, as either essential Day 1 Skills, advanced training, or CPD opportunities

Essential Day 1 Skills	Advanced training	Continuing professional development
Husbandry, handling and restraint of relevant animal species (76%)	Microsurgery (60%)	Species-specific anatomy and physiology (48%)
Identification of pain, suffering and distress in relevant species (72%)	Specified pathogen-free facility management (60%)	Welfare monitoring of animals (40%)
Basic biosecurity of animal research and facilities (72%)	Ethical evaluation and serving on animal ethics committee (44%)	Anaesthesia, analgesia, sedation of relevant animal species (40%)
Substance administration and minor procedures in species (64%)	Biosafety (human health and safety) considerations (44%)	Surgical techniques of more advanced nature (40%)
Health monitoring of relevant animal species (56%)	Biosecurity practices of more advanced nature (40%)	Post-mortem examination of research animals (40%)
Sedation and general anaesthesia of relevant species (48%)	Selection of appropriate animal models for research (40%)	Health monitoring of animals (36%)

The 85 participants identified 53 life-long learning (developmental) opportunities, each with an associated learning outcome (LO), for the veterinary and para-veterinary professional community (Table II). These were grouped into five overarching themes: Personal development (9 LOs); Leadership and management (12); Education and training (5); Welfare, ethics and clinical skills (20); and Regulations and quality-assurance (7). Of the 53 learning outcomes, 14 were knowledge-based, ten were competencies, and 29 both knowledge and competence.

Discussion

The initial survey identified the need for specific educational opportunities for veterinarians working in the animal research sector in South Africa, including skills considered essential to

Table II: Learning outcomes for the life-long learning needs of veterinary and para-veterinary professionals in the animal research sector in South Africa (2022 workshop results), identifying five overarching themes for life-long learning

Developmental opportunities	Learning outcomes	*
Personal development		
Personal development resources	Complete personal development opportunities relevant to one's individual role and developmental needs	C
Ethical and cultural awareness	Appraise the ethical issues surrounding animal research, including the perspectives of different societies and cultures, and developing one's own personal informed view	K,C
Communication skills	Demonstrate effective communication and interpersonal skills with all stakeholders (including presentation, negotiation, service orientation, empathy)	C
Coping with and managing conflict	Employ effective approaches to manage conflict between all stakeholders	K,C
Manage stress, develop resilience, maintain wellbeing, prevent burnout	Employ effective identification of stress in one self, stress management practices, awareness of one's own state of wellbeing (physical, mental, emotional), and methods to develop resilience and prevent burnout	K,C
Manage compassion fatigue and develop support networks	Create effective opportunities and support networks, encompassing all stakeholders, to mitigate or prevent compassion fatigue	C
Change-management and managing change	Perform effective and appropriate change management	K,C
Critical assessment of literature and evidence	Demonstrate robust discovery, critical review and evaluation of data or information relevant to one's role	K,C
IT approaches and tools	Employ effective and appropriate utilisation of IT tools and approaches (e.g. information/data management, effective information/literature searches)	K,C
Leadership and management skills		
Leadership and management skills	Practice effective leadership and management, including managing people	C
Financial and resource management and business plans	Perform effective financial and resource management approaches, understand business plans	K
Project management, planning and organisation	Practice effective and efficient project planning, organisation and management	K,C
Mentoring staff career progression	Practice effective mentoring of colleagues relevant to their role and career progression needs	C
Disaster and emergency planning, risk and hazard identification	Conduct effective health and safety, risk and hazard surveys and plan accordingly	K,C
Biosecurity measures and levels of biosecurity	Plan for effective traffic flow, transport of materials and animals to maintain appropriate biosecurity	K,C
Facility management approaches	Employ effective and efficient management of animal facilities and personnel	K,C
Resource-saving approaches	Identify resource-saving approaches, opportunities and networks (e.g. the bulk purchase of consumables)	K
Data management systems	Employ effective and efficient data management tools, systems and approaches	K,C
Understand researcher needs	Appraise the animal care and use requirements of researchers and other stakeholders at one's institution or organisation	K,C
Understand common research areas/approaches	Describe the principal research themes and activities which involve the care and use of research animals in one's institution or organisation	K
New and emerging models/approaches/procedures	Explain new and emerging research animal models, approaches and procedures relevant to the research undertaken at one's institution or organisation	K
Education and training skills		
Education and training of staff	Create and employ effective personal and professional development opportunities for research animal facility staff, tailored to their role and individual developmental needs	K,C
Education and training of scientific community	Employ effective education and training approaches in animal research and ethics for personnel who use animals for scientific purposes	K,C
Perform competency assessments	Conduct effective competency assessments, which assess both competence and enable stakeholders to identify their individual developmental needs.	C
Training for new models/species/approaches/procedures	Create and conduct educational opportunities for different stakeholder communities prior to the introduction of new research animal models, approaches and procedures at one's institution or organisation	K,C
Refresher training for existing models/species/approaches/procedures	Create and conduct life-long learning opportunities for different stakeholder communities on research animals, models, approaches and procedures utilised at one's institution or organisation	K,C

Welfare, ethics and clinical skills		
Good practice in the 3Rs (4Rs), 5 freedoms, animal husbandry	State sources of 3Rs (4Rs) information; employ current good practice in the 3Rs and the 5 freedoms with respect to studies involving research animals	K,C
Good practice in animal welfare standards and welfare assessments	Integrate good practice in animal welfare and welfare assessments across one's institution or organisation	K,C
Ethical review of research protocols and harms-benefit assessment	Perform balanced ethical review of research protocols, based on informed harms-benefit assessments	K,C
Experimental design and impact of welfare on reproducibility of results	Recall the principles of good experimental design of studies involving animals. Recall the impact of good animal welfare on the reproducibility and reliability of studies involving animals; discuss animal welfare interventions that can be implemented to improve or enhance a research study and its outcomes	K.C
Statistics of animal studies	Explain common statistical approaches to analyse and interpret data from research animal studies, and apply this knowledge during ethical review	K
Invertebrate and non-animal models (alternatives) and approaches	Describe current and emerging invertebrate and non-animal (i.e. replacement) models used in research	K
Aquaculture and invertebrates	Employ good practice in the care and use of fish, crustaceans, molluscs and other water-dwelling species and other invertebrates cared for or used in one's institution or organisation	K,C
Environmental control and monitoring, and reporting adverse events	Employ good practice in environmental control and monitoring in all research animal facilities in one's institution or organisation. Recall the regulatory requirements for reporting adverse events	K,C
Anatomy, physiology and ethology/behaviour of different species	Describe the anatomy, physiology and behaviour of all species of research animals cared for or used for research purposes in one's institution or organisation	K
Handling, restraint, and minor procedures in animals	Apply good practice in the handing, restraint and the conduct of minor procedures in all species cared for or used for research purposes at one's institution or organisation	C
Effective and efficient colony management	Employ good practice in effective and efficient colony breeding and management programmes, which fully apply the principles of humane experimental technique (3Rs)	K,C
Health screening of animals or colonies	Employ good practice in the screening and monitoring of the health status of all species of research animals (including "sentinels") cared for at one's institution or organisation	K,C
Understanding medicines and other therapeutic agents	Recall common pharmacological terms and definitions (e.g. efficacy, effect, adverse effect, dose range, etc.)	K
Clinical numerical manipulations	Perform numerical manipulations relevant to research animal sciences (dosage, dilutions, etc.)	C
Anaesthetics and analgesics	Describe the regulations governing the use of scheduled medicines, including sources and availability; demonstrate good practice in the choice and use of anaesthetics and analgesics appropriate to the species and research undertaken	K,C
Surgical procedures and skills	Demonstrate effective aseptic surgical procedures and competencies	C
Pre- and postoperative care	Employ good practice in the pre- and postoperative care of all species used for research at one's institution or organisation	K,C
Euthanasia and humane endpoints	Demonstrate effective euthanasia, appropriate to the species and life-stage; identify and apply appropriate humane endpoints	K,C
Post-mortem examinations	Employ good practice in post-mortem investigations of all species cared for or used for research at one's institution or organisation	C
Pathological/body fluid/sample analysis and diagnosis	Describe approaches and procedures used in the analysis of biological samples or in diagnostic pathology	K
Regulations and quality-assurance		
Legislation, permissions and authorities	Recall all relevant legislation, standards and permissions, including the requirements of all Professional, Statutory and Regulatory Bodies, needed to undertake animal research in one's country; state the principal requirements of the Protection of Personal Information Act	K
Roles and responsibilities	Recall the roles and responsibilities, including legal and regulatory responsibilities, of all those involved in the care and use of research animals	K
Human health and safety, harms of biological agents and chemicals	Describe common risks (to humans or animals) of biological agents and chemical agents	K
Facility requirements and inspections	Discuss the protocols, procedures and regulatory requirements of animal facility inspections	K
Shipment of samples overseas	Recall mechanisms and requirements for the shipment of biological samples nationally and internationally	K
Quality-assurance systems	Conduct and report quality-assurance procedures in accordance with relevant global good practice and national Professional, Statutory and Regulatory Body requirements (including GLP, GCP, SOPs, DOPS, audit documentation, etc.)	K,C
Quality-assurance documentation	Create, implement and audit portfolios of SOPs and DOPS tools relevant to all stakeholders	K,C

3Rs – the three Rs (i.e. to teplace, teduce and tefine the use of animals), 4Rs – the four Rs (i.e. the 3Rs plus responsibility), DOPS – direct observation of procedural skills, GCP – good clinical practice, GLP – good laboratory practice, IT – information technology, SANS – South African National Standard, SOP – standard operating procedure
*Each learning outcome represents Knowledge (K) and/or a Competence (C)

starting working in this field, further advanced training, and CPD needs.

The subsequent workshop addressed the education and training needs of veterinary and para-veterinary professionals in more detail, identifying five overarching themes for life-long learning:

Personal development highlights personal skills and attributes required to work effectively in the animal research sector. It is noteworthy that emphasis was placed on understanding, from an ethical perspective, one's involvement in a sector where animal suffering is often inherent, and maintaining personal wellbeing in the face of a frequently stressful working environment where veterinary and para-veterinary professionals are often the gate-keepers of animal welfare and care standards. Linked to this is the management of compassion fatigue, and the importance of support networks.

Leadership and management skills are critically important, since veterinary and para-veterinary professionals who enter the animal research sector are often required to – or rapidly promoted to positions where they will – manage or direct units, facilities, people, budgets, systems, processes, projects and procedures. It is thus often one's ability to competently adapt to these leadership roles, and to accept these high levels of responsibility, that determines success and job satisfaction in the sector.

Education and training skills are essential since veterinary and para-veterinary professionals are often in charge of educating staff and research personnel in animal care and clinical procedures, including the requirement to formally assess the practical competence of personnel in procedures.

Welfare, ethics and clinical skills are closely related in the animal research sector. Veterinary and para-veterinary professionals are often required to play an advisory role in terms of animal welfare and clinical procedures during the design of research protocols, to formally evaluate these aspects (in combination with study design) during the Animal Ethics Committee's review of the protocol, and to ensure the implementation of the animal welfare standards and clinical competencies during study execution. A significant challenge is the often diverse array of animal species involved, which may include domesticated and/or wild invertebrates, fish, amphibians, reptiles, birds and mammals, and the requirement to understand each species' needs and related clinical aspects and procedures.

Regulations and quality-assurance are important to ensure regulatory compliance, alignment with relevant laws and national standards, as well as quality-assurance systems that may be required to formally document adherence to industry-specific standards of good practice.

The SAALAS conferences and workshops have traditionally been and continue to be, the major face-to-face opportunity for veterinary and para-veterinary professionals in the animal research sector to receive relevant continuing education in South Africa. Although existing post-graduate qualifications and courses in laboratory animal science and ethics can address some of these life-long learning needs, additional or alternative learning opportunities are essential to adequately meet the needs of veterinary and para-veterinary professionals in the sector, in order to effectively deal with the diverse demands of their careers and to achieve job satisfaction. Many professionals already benefit from the use of available open-access (e.g. NC3Rs[a], Norecopa[b], WikiVet[c], or ETRIS[d]) or subscription (e.g. AALAS[e]) resources. Access to a calendar of freely available webinars from around the world would similarly be helpful.

Several of the developmental opportunities (Table II) are inherently experiential in nature, requiring more than (only) education and training to yield competence. Such experiential learning is especially evident for several of the learning outcomes pertaining to the themes of *Personal development,* and *Leadership and management skills*, e.g. those relating to mental wellbeing, empathy, developing resilience, preventing burnout, critically assessing evidence, developing support networks, mentoring skills, directing processes, and insight into paradigms. Such "life-long learning" often refers to learning that occurs outside of formal educational institutes, and may be defined as the ongoing, voluntary, and self-motivated pursuit of knowledge (and skills) for either personal or professional reasons.

The creation of e-learning resources by institutions or associations (e.g. SAALAS) and sharing amongst the community is another option, including consideration of re-purposing open-access resources available elsewhere in the world to optimally suit the African context. Whatever approaches are agreed by the community, will require initial resourcing and mechanisms for sustainability and future development. The latter could come, for example, from a commitment by a collection of institutions or organisations to develop pooled educational resources, in return for free access to the resource collection (a model adopted in Scandinavia by NCLASET, http://nclaset.org). Such initiatives should be overseen by an appropriate body to ensure fairness, quality control, and a central repository. Such a model could also extend beyond borders in collaboration with countries across Africa, and lower- and middle-income countries globally.

The need for additional learning opportunities for veterinary and para-veterinary professionals in the laboratory animal science sector, beyond that historically included in undergraduate programmes for the training of these professionals, raises the opportunity for the stakeholder community to engage with relevant educational institutions and professional bodies, to ensure the curricular inclusion of an appropriate depth of coverage of the ethics, care and use of animals for scientific purposes.

In conclusion, there is a defined need among veterinary and para-veterinary professionals in the laboratory animal science sector, for additional education and training and the harmonisation of its provision. In addition, the life-long learning needs of these professionals include several experiential skills relating especially to personal development, leadership and management skills. A community of practice such as SAALAS creates an environment

a. https://www.nc3rs.org.uk
b. https://norecopa.no
c. https://en.wikivet.net/Veterinary_Education_Online
d. https://www.etris.leeds.ac.uk
e. https://www.aalaslearninglibrary.org

which supports such learning, including the provision of peer mentorship for experiential skills.

Acknowledgements

We express our gratitude to the members of the SAALAS Designated Veterinarians Working Group who contributed to the design of the 2017 survey; to the veterinarians who participated in the survey; and the attendees of the Education and Training Workshop at the 2022 SAALAS Conference.

Conflict of interest

Author AJM was vice-president and member of the Executive Committee of SAALAS at the time of the SAALAS conference. Author JKC declares they have no conflicts of interest that are directly or indirectly related to the research. Author TAF was president and member of the Executive Committee of SAALAS at the time of the SAALAS 2022 conference, as well as chairperson of the SAALAS Designated Veterinarians Working Group. Author KJ declares they have no conflicts of interest that are directly or indirectly related to the research. Author DIL declares they have no conflicts of interest that are directly or indirectly related to the research.

Funding source

This work was supported by a UK Biotechnology and Biological Sciences Research Council Strategic Training Award for Research Skills (grant number BB/T017287/1). The study sponsors were not involved in the study design, collection, analysis or interpretation of data; the writing of the manuscript; or the decision to submit the manuscript for publication.

Ethical approval

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

This article does not contain any studies with animal subjects.

The Human Research Ethics Committee of the Faculty of Health Sciences, University of Cape Town approved the online survey of veterinarians carried out in 2016/2017 HREC Ref 867/2016.

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