

One Health Une santé

Collaborative co-design and development of a smartphone application to promote veterinary antimicrobial stewardship

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Background and problem

Antimicrobial resistance (AMR) has been classified as a serious global health threat (1), with unique and irreversible characteristics (2). Induced largely by antimicrobial use (AMU) in humans, animals, and plants, AMR is exacerbated by inappropriate use and overuse in all contexts. Many antimicrobials used in veterinary medicine are considered of critical or high importance in human medicine, and may drive selection of resistant microbes across animal and human domains, either directly or through a shared environment (3) by means of wastewater, contamination, or antimicrobial pollution. As such, the concept of One Health has grown to focus on the importance of multidisciplinary communication and collaboration to address key public health issues such as AMR (4). International organizations including the World Health Organization, Food and Agriculture Organization of the United Nations, and the World Organisation for Animal Health have expressed the importance of developing national action plans for combatting AMR using a One Health approach (5). Strong partnerships among stakeholders in all areas of the One Health triad are necessary to collectively contain the spread of AMR.

Guidelines for AMU have been developed by several organizations across the globe as a strategy to promote appropriate prescribing practices and optimize treatment regimens in both the veterinary and human medical sectors. With the growing body of scientific evidence on the association between AMU and AMR, knowledge translation, as well as a process to recognize various perspectives and motivations surrounding AMU, are all crucial to developing sustainable antimicrobial stewardship initiatives (6). Applying these principles may promote integrated approaches to reducing AMR, with greater global impacts.

A recent synthesis of systematic reviews that addressed impacts of digital interventions on antimicrobial stewardship noted a significant evidence gap in sociotechnical aspects associated with such interventions as a means of understanding and evaluating their impact (7). We developed a veterinary version of a clinical decision support tool to deliver antimicrobial guidance to promote antimicrobial stewardship in veterinary medicine, with an evaluation strategy that considered AMU behaviors and feasibility of digital stewardship interventions.

Firstline CVMA

Originally developed for use in human medicine, Firstline (formerly Spectrum) (8) is a clinical decision support platform that supports creation and delivery of localized antimicrobial stewardship guidance to healthcare providers at point-of-care. Since its successful implementation for human medicine (9), Firstline has expanded to deliver the Canadian Veterinary Medical Association (CVMA) Guidelines for Antimicrobial Use (10) to veterinary professionals across the country, as “Firstline CVMA.” Species-specific treatments tailored to the Canadian context are offered at point-of-care to veterinarians and other users of antimicrobial guidelines to facilitate evidence-based prescribing decisions (11). The digital format facilitates quick and efficient content updates that incorporate recent policy changes and scientific study results that may prompt a change in antimicrobial guidance, or other advancements within the veterinary community. The goals of Firstline CVMA are to optimize antimicrobial prescribing for common conditions in a variety of animal species and to educate users on antimicrobial prescribing principles. We aim to provide the veterinary community with a tool to improve AMU in veterinary practice, with

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the intention that this version of the app will generate a positive One Health impact on AMR.

Firstline CVMA species groups include dogs, cats, horses, cattle — beef and calf, cattle — dairy > 20-months old, poultry, and small ruminants. Swine and aquaculture guidelines are currently being populated and should be available to users later this year. Within each species group, conditions are organized by body system to group diseases and their specific treatments in a facile and navigable manner. Gastrointestinal, musculoskeletal, respiratory, and urinary are examples of body systems that are common among species groups. In addition, the app includes sections that provide pathogen-specific and antimicrobial-specific information. For convenience, applicable antimicrobials and pathogens are linked within treatment guidelines to allow users to quickly access the necessary information for making treatment-related decisions. Withdrawal times are also included in antimicrobial guidelines for food-producing animals as important considerations for antimicrobial use within these species and for human consumption of food animal products.

As AMR is an international issue, antimicrobial prioritization categories for Firstline CVMA were adapted with infectious disease expert consultation (JSW, JMC), considering the European Medicines Agency, World Health Organization, and Canadian Veterinary Drug Directorate guidance to best preserve critically and highly important antimicrobials and account for discrepancies in international categorizations. The app utilizes a novel “traffic light” approach to highlight the degree of importance of each antimicrobial in human medicine and implications for AMR development. The traffic light system includes green, yellow, and red color coding, indicating medium, high, and very high importance, respectively. It is the goal that, when possible, green antimicrobials (*e.g.*, tetracyclines) will be used over yellow (*e.g.*, aminoglycosides) or red (*e.g.*, fluoroquinolones) antimicrobials. Although not currently populated, Firstline CVMA can also display antibiogram data, a feature that could be used in the future for site-specific microbiological concerns.

Implementation and evaluation

Creating, assembling, and implementing Firstline CVMA required co-design and collaboration from an interdisciplinary team that included the CVMA, academics in Alberta and Ontario, and Firstline Clinical. As Phase 1 of our study, we used the Participatory Action Research (PAR) qualitative research methodology, which fosters collaboration among participants and researchers, to conduct a multi-method survey for veterinarians, veterinary technicians/technologists, and veterinary students, *Multimethod Questionnaire for the Co-Design of Spectrum DVM Using a Multidisciplinary One Health Approach*. Interviews were conducted to gather information on quantitative demographic information and qualitative aspects relating to barriers to antimicrobial use and prescribing practices, use of technology in veterinary medicine, and opinions regarding One Health, to inform the layout and organization of the app. This portion of the study was approved by the Research Ethics Board at the University of Calgary (REB19-1997). The full questionnaire for Phase 1 interviews is in **Supplementary File 1** (online version only). In addition, all antimicrobial guidelines

included within Firstline CVMA were overseen by CVMA subject matter experts specific to each species, and all pathogen and antimicrobial content were based on reliable and peer-reviewed sources. Users will notice that content within each species group may differ to properly capture all antimicrobial recommendations according to species-specific conditions identified by each subject matter expert.

A soft launch was conducted from November 1 to 17, 2021 before the official launch of Firstline CVMA to allow a small number of users ($n = 46$) from the veterinary community to provide initial feedback and test the user interface. This feedback was then incorporated in preparation for the official launch, strategically scheduled to coincide with the 2021 World Antimicrobial Awareness Week beginning on November 18, 2021. During that week, our subject matter experts provided demonstrations and brief presentations on how to navigate the app and its various guidelines (links to these are webinars provided below). As of July 2022, the number of unique registered CVMA users that have accessed the app since the soft launch is 689.

Comments and suggestions from users within the veterinary community are strongly encouraged *via* feedback links provided throughout the app to ensure that information is reliable and accurate. Phase 2 of our study, *Usability Testing of the Firstline Content Management System and Application*, is ongoing. Users are encouraged to complete the survey located in the guidelines section of the app. This portion of the study was also approved by the Research Ethics Board at the University of Calgary (REB18-1311). The structured questionnaire was developed by the University of Calgary in collaboration with infectious disease specialists in the Netherlands, Switzerland, and Sweden, as a version of the original *AB-assistant Questionnaire* that was used to evaluate the implementation and impact of the Firstline platform in an international clinical trial (12). Evaluating physicians’ experiences with using the app enables barriers to the uptake of digital antimicrobial stewardship interventions such as inefficient user friendliness and lack of integration into clinical workflows to be addressed and monitored (12). For our purposes, we adapted the AB-assistant Questionnaire to reflect veterinary language and other veterinary-specific evaluation criteria to properly assess the app in a veterinary setting.

Our questionnaire was designed to capture user demographics, as well as user experiences with questions related to credibility, user friendliness, efficacy, outcomes, and social norms using a 6-point Likert scale. The questions will help us understand socio-technical aspects associated with digital stewardship initiatives and identify barriers to adopting digital initiatives into practice. As we are interested in evaluating barriers, most statements in the questionnaire are negatively framed, with “completely agree” and “completely disagree” on either end of the Likert scale. As such, preliminary results from survey responses to date indicated that the **majority of respondents disagreed** that: i) they are hesitant towards applying recommendations from apps in their work; ii) using the app disrupts their workflow; iii) using the app will decrease their knowledge of appropriate antimicrobial use; and iv) using the app adjacent to colleagues is unprofessional or impolite. In addition, respondents indicated that they would

recommend Firstline CVMA to a colleague and/or others in the veterinary community. Ongoing recruitment of participants is occurring through voluntary participation *via* an embedded link to the survey within the app. We have also encouraged participation through push notifications that are sent to users that allow such app notifications to their smartphone. Survey data and app analytics will be used to iteratively improve Firstline CVMA and the guidance that it offers. The full questionnaire for Phase 2 is in **Supplementary File 2** (online version only).

Outcomes and impacts

An app-based approach to antimicrobial stewardship serves as a novel method to improve access to antimicrobial guidance, facilitate rapid and efficient guideline updates, and reach a large number of users of antimicrobials. Firstline CVMA aims to address gaps in stewardship knowledge and offers a way to access disease-specific treatments using an efficient and convenient platform. By increasing knowledge of appropriate treatment choices on a national scale for a wide range of species, we have the potential to optimize treatment regimens and subsequently reduce inappropriate prescribing practices and development of AMR.

It is our intention to expand the content within Firstline CVMA in scope, location, and media to improve existing content through iterative user feedback, which is encouraged by all users. To date, Firstline CVMA has been widely accepted, gaining international attention from various veterinary professionals and organizations. By guiding veterinarians to choose the most appropriate antibiotic treatments for specific conditions, AMR may be reduced on a scale that positively impacts the health of animals, humans, and the environment, making Firstline CVMA a true One Health innovation.

Additional information

Firstline CVMA is available as a free download for veterinarians, veterinary technologists/technicians, and veterinary students across Canada who are CVMA members and can be accessed using a registered CVMA email address. Please visit <https://firstline.org/cvma/> for more information. In addition, webinar demonstrations of the Firstline App are at <https://savi.canadianveterinarians.net/en/demonstration-of-firstline-app-amu-guidance-for-companion-animals-equine/> for companion animals and horses and at <https://savi.canadianveterinarians.net/en/demonstration-of-firstline-amu-guidance-for-production-animals/> for production animals.

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