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Knowledge, Attitudes, and Practices of Antimicrobial Use and Resistance among Livestock Producers in Cambodia

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Abstract

The development of antimicrobial resistance (AMR) due to over or misuse of antibiotics/antimicrobials is a globally increasing public health concern. This study was conducted to assess the current knowledge, attitudes, and practices (KAP) of swine and poultry producers on antimicrobial use (AMU) and antimicrobial resistance (AMR). A total of 254 swine and poultry producers of 5 provinces in Cambodia were purposively surveyed using validated KAP questionnaires, a useful tool for promoting the rational use of antimicrobials in livestock. Collectively, this study found out that livestock producers in Cambodia have a low level of knowledge, neutral rather than positive attitudes, and employed poor practices on the AMU and AMR. Thus, there is a need to promote among producers the rational and responsible use of antimicrobials. Furthermore, public awareness of the AMR implications on public health can contribute to the prevention or reduction of AMU and AMR in Cambodia.

Keywords

Antimicrobial Usage, Antimicrobial Resistance, Attitudes, Knowledge, Practices

1. Introduction

The use of antibiotics (ATBs) or antimicrobials in livestock production is considered a major driver of AMR on both local and global scales [1]. ATBs or antimicrobials are widely used for prevention and growth promotion in livestock;

however, it has been reported that the increasing use of these drugs in livestock production greatly contributed to the emergence of antimicrobial resistant bacteria (ARBs) or AMR bacteria that affect human or public health [2]. ARBs or AMR bacteria of animal origin can be transmitted to humans/animals through the food products [3], environment [4], and agricultural workers by direct contact [5]. Two-thirds of the estimated future growth of usage of antimicrobials is expected to occur within the animal production sector, with the use in swine and poultry production predicted to double [2].

Rapidly developing regions such as Southeast Asia are considered as one of the hotspots for AMU and AMR, partly attributed to livestock commercialization in response to the increasing regional consumer meat demand [6]. Recently, AMU is not monitored in most countries. In most Southeast Asian countries, AMU in food animals is poorly monitored and antibiotic consumption is not measured [6]. It has been reported that the antimicrobials are used in swine and poultry in low- and middle-income countries [7]. Moreover, AMU studies in South East Asian region (mostly from Vietnam) indicate very high usage levels of most types of antibiotics, including beta-lactams, aminoglycosides, macrolides, and quinolones [8].

Study in Thailand indicated that majority of livestock producers (swine and layers) had a low level of knowledge, neutral positive attitudes, and employed poor practices towards AMU [9]. However, swine producers in Vietnam indicated a high level of knowledge, more favorable attitudes, and employed good practices towards AMU [1]. In Cambodia, farmers focused on the benefits of food animal production rather than concerns about the consequences of AMU [10]. [11] reported that the household swine farmers have a low awareness of the risks and consequences related to AMU and AMR leading to a higher prevalence of AMR and highlighting the need for professional animal health systems that involve medically the rational use of antimicrobials in emerging economies. However, no data on knowledge, attitudes, and practices (KAP) of small and medium swine and poultry producers; could contribute to the country's economy. To the authors' knowledge, this is the first large scale farm level survey on KAP among swine and poultry producers in Cambodia. Thus, to provide a foundation on which to identify future opportunities for further research and initiatives, which focus on inappropriate AMU and prevention of AMR in Cambodian livestock sector, this study surveyed the KAP of livestock producers regarding AMU and AMR.

2. Materials and Methods

2.1. Study Location

The present study was carried out in five provinces of Cambodia including Kampong Spue, Takeo, Kandal, Prey Veng, and Svay Reing where there were high concentrations of swine and poultry production in Cambodia indicated in the annual report by [12] (**Figure 1**). The study was conducted from August

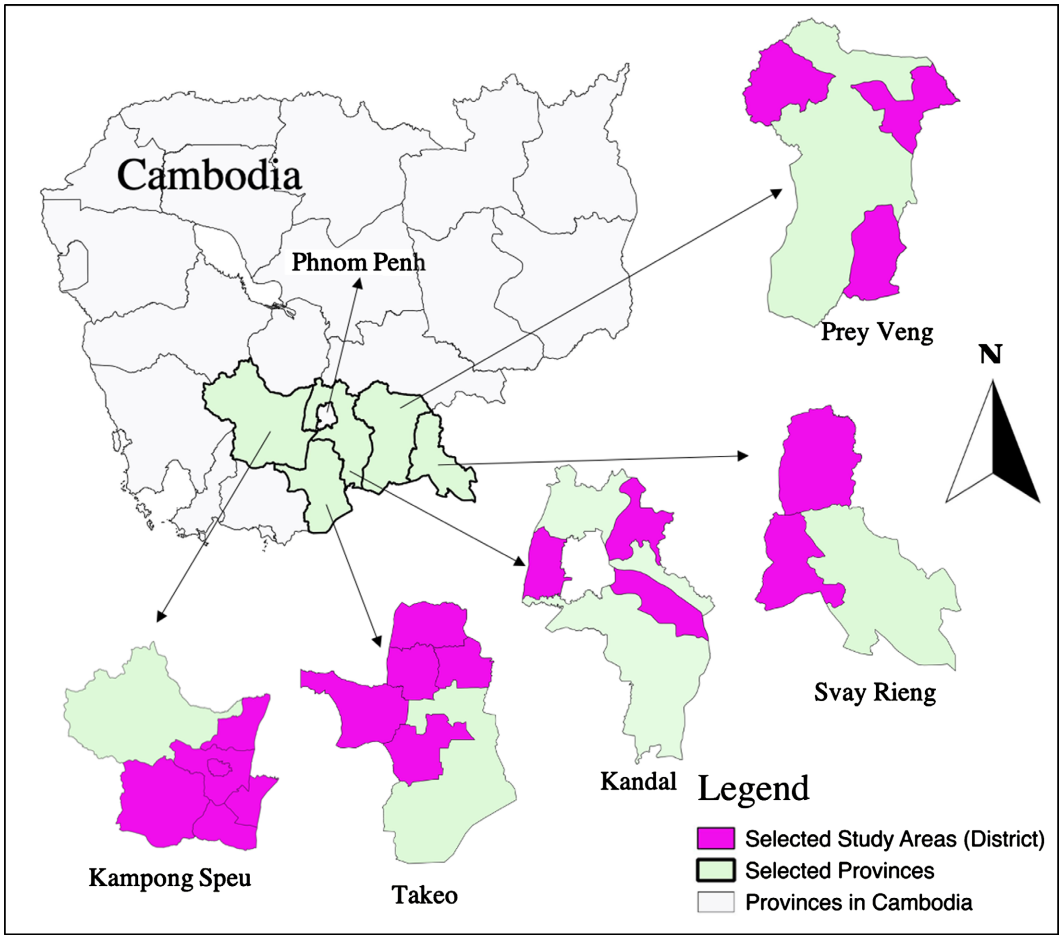

Figure 1. Geographical map of the 5 provinces where the study was conducted.

to November 2020.

2.2. Study Design and Sample Size

The KAP survey questionnaire was used to generate cross-sectoral insights from producers involved in swine and poultry production which were relatively used of antimicrobials compare to other livestock including cattle, dairy, sheep and goat, etc. Respondents were selected for an interview using the KAP questionnaire to explicit their knowledge, attitudes, and practices with regard to AMU and AMR.

A single proportion estimation was applied from sample size calculation based on [13], with a 95% confidence interval, 5% margin of error, and an assumption of that 20% ($p = 0.5$) of producers involving ATB use in swine and poultry production. The sample size required was 246 respondents. In the present survey, a total of 254 swine and poultry producers (92 swine and 162 poultry) have been interviewed.

2.3. Respondent Selection

In each province, three districts or more with high levels of small and medium

farms were selected. Within those districts, the farm selection in communes with rural and per-rural commune groups with high density of farms were selected. The farms were selected based on the voluntary within an indication by the district veterinarian at each province. The survey teams requested information from each farm around the household members who are involved in the livestock production activities. By using the information provided, the person who was judged to have the most responsibility over livestock production was invited to participate in a survey.

2.4. Survey Tool Development

Survey questionnaires were designed (both Khmer and English) containing both positive and negative statements to investigate the individual KAP of respondent. A consensus regarding the contents and wording of the questionnaire was achieved during the consultative workshop of experts from research university, government, and NGO who work closely related to AMU and AMR field. Questionnaire was orally administered as one-on-one interview technique by trained research team and students from the Faculty of Veterinary Medicine, Royal University of Agriculture (RUA), Phnom Penh, Cambodia. The survey was administered orally to gain more reflective answers, and to maintain a quality control measure over response rate. Additionally, an observational assessment was conducted in farms in order to examine the general environmental settings if applicable.

2.5. Data Collection

The swine and poultry producers were selected based on the farm scale (small and medium) as stated in the Prakas of General Directorate of Animal Health and Production (GDAHP) either registered or non-registered at the GDAHP. The interview lasted for 40 minutes including the photos if allowed. The questions on the survey include 1) General information (e.g. age, gender, education, and role in the farm) and their farm status, production scale and production type, etc. 2) Knowledge about AMU and AMR (e.g. key term about AMU and AMR, antibiotic residue, withdrawal period, and non-therapeutic use). 3) Attitudes towards AMU and AMR (e.g. awareness of AMR effects, potential AMU, potential of using antibiotics in disease prevention or growth promotion, and veterinary advice and proper management. 4) Practice on AMU and AMR (e.g use of antibiotic in both therapeutic and non-therapeutic use, first measure undertaken when livestock are sick, administration antibiotic to animals, storage and disposal of antibiotics).

2.6. Data Analysis

Data obtained from interviews were entered into the MS Excel spread sheet for cleaning, processing, and further analyzation. All data regarding demographic characteristics and current KAP on AMU and AMR were analyzed through de-

scriptive statistics. KAP key individual's answers were scored. One point was given for each correct answer and zero point for each wrong or do not know response for the knowledge assessment. The total knowledge score was categorized into three levels following Bloom's cut off point (60% - 80%); low level (score less than 60%), moderate level (60% - 80%), and high level (more than 80%). For the individual's attitude response assessment, positive statements were scored from five points to one point relatively ranging from "Strongly Agree" to "Strongly Disagree", while reverse scoring was used for negative statements. The total attitude scores were categorized into three levels similar to the knowledge following Bloom's cut off point which is not concerned (score less than 60%), neutral (60% - 80%), and concerned (more than 80%). Lastly, the individual's practices assessment, positive statement responses were rated from five to one point ranging from "Very Often" to "Never". Reverse scoring was used for negative statement as similar calculation mentioned above. The practice scores of key individuals were also categorized into three levels following Bloom's cut off point (60% - 80%); *i.e.*, poor practice (less than 60%), fair practice (60% - 80%), and good practice (more than 80%).

2.7. Results

A total of 254 swine and poultry producers were interviewed with 74% being male and 26% female (Table 1). About 80% were owners while less than 20% were farm manager and farm employer being interviewed. In terms of production type, 68% were small producers and 32% were medium producers. The number of small poultry producers was higher compared to swine producers and vice versa for the medium type of production. In addition, most of the farms were contract (62%) while others are running their own farms (35%). Very few producers were involved both contracted or owned farms.

Producers had low knowledge of ATBs and their use (Table 2). One fourth of producers could only identify correctly the ATBs used in their farms. However, most of them (95%) missed perception that the ATBs are used for the treatment of inflammation. Half of them considered to pay attention to withdrawal period when using ATBs. Half of the producers indicated that there will be consequences when use of ATBs in the form of non-therapeutic. Only 38% of producers realized that antibiotic resistant bacteria may be attributed from the use of ATBs. Most producers understand correctly how to store ATBs properly; while full dosage and duration of ATBs used in animals should be applied (64%).

Table 3 provides the inclusive summary of the attitudes of producers toward AMU and its related consequences. Overall, producers' attitude was neutral (68%). Interestingly, most of the producers were much concerned that proper management, using vaccination, veterinarian's advice, and correct dosage of ATBs are the key in preventing/proper use of ATBs in animals. Unlikely, the non-therapeutic use of ATBs is preventing and growth promotion was not much concerned (61%). Furthermore, producers were not much concerned about the

adverse effects on animals, human, and environment due to the misused of ATBs (47%).

About 60% of respondents would use ATBs without animal health's consultation. However, most of them usually used ATBs in accordance to the instruction in the product or veterinarian advice. About half of the respondents used ATBs as a part from treatment and being used as first option to treat sick animals. About two thirds of the respondent used ATBs for all animals if only one or few got sick.

Table 1. Demographic information of swine and poultry producers in study area.

Description	Swine producers (N = 92)	Poultry producers (N = 162)	Total (N = 254)
Gender			
Male	70 (76)	117 (72)	187 (74)
Female	22 (24)	45 (28)	67 (26)
Employment type			
Owner	67 (73)	139 (86)	206 (81)
Manager	18 (20)	9 (5)	27 (11)
Employee	7 (7)	14 (9)	14 (8)
Education			
Never attended school	4 (4)	30(18)	34 (13)
Completed Primary school	20 (22)	55(34)	75 (30)
Completed Secondary school	30 (33)	45(28)	75 (30)
Completed High school	15 (16)	17(10)	32 (12)
Completed undergraduate program	22 (24)	14(9)	36 (14)
Completed graduate program	1 (1)	1(1)	2 (1)
Age (year)			
	41.58 ± 9.76	38.08 ± 10.58	39.83 ± 10.17
Production type			
Small	30 (33)	143 (88)	173 (68)
Medium	62 (67)	19 (12)	81 (32)
Farm type			
Contract farm	78 (85)	79 (49)	157 (62)
Own farm	14 (15)	76 (47)	90 (35)
Both contract and own farm	0 (0)	7 (4)	7 (3)
Raising experience (year)			
	6.32 ± 5.21	6.22 ± 5.38	6.27 ± 5.29

Note: N = total number; () = percentage.

Table 2. Frequency of corrected responses of key individual's knowledge on AMU in the study.

Statement	Numbers of individual's corrected response		
	Swine producers (N = 92)	Poultry producers (N = 162)	Total (N = 254)
Antibiotic drugs are used for treatment only bacterial disease.	28 (30)	35 (22)	63 (25)
Antibiotic is compound used for reduce inflammation.*	5 (5)	8 (5)	13 (5)
Using lower dosage than recommended effect to antibiotics efficiency.	28 (30)	50 (31)	78 (31)
Antibiotics can stop immediately when sick animals not show any signs.*	51 (55)	111 (69)	162 (64)
Antibiotics withdrawal periods should be adhered to avoid drug residues in meat and its products.	56 (61)	74 (46)	130 (51)
The non-therapeutic use of antibiotics does not cause any consequences.*	49 (53)	77 (48)	126 (50)
Antibiotics can cause antibiotic resistance bacteria	42 (46)	55 (34)	97 (38)
Antibiotics can store at any place where easy to use.*	74 (80)	134 (83)	208 (82)
Rate of mean corrected responses	**(45)**	**(42)**	**(43)**

Note: N = total number; () = percentage. * Statement reverse respond score.

Table 3. Frequency of corrected responses of key individual's attitude on AMU in the study.

Statement	Numbers of individual's agreement		
	Swine producers (N = 92)	Poultry producers (N = 162)	Total (N = 254)
Proper management (including good biosecurity) are more important than ATBs to protect animals from diseases.	91 (99)	151 (93)	242 (95)
Using vaccines to prevent the diseases is contributed to prevent/reduce the use of ATBs.	83 (90)	143 (88)	226 (89)
Veterinarian's advice is necessary before using ATBs.	90 (98)	150 (93)	240 (94)
Proper using dosage and duration of ATBs is important.	79 (86)	138 (85)	217 (85)
Giving ATBs to animals that are not sick will prevent them from becoming sick.*	75 (82)	102 (63)	177 (70)
Giving ATBs to animals that are not sick can help them grow bigger, faster, fatter, boost egg production/size.*	59 (64)	79 (49)	138 (54)
After using ATBs on an animal, you should wait sometime before you sell or consume the products from it, such as meat/eggs/milk.	71 (77)	83 (51)	154 (61)
Improper/over antibiotic uses can cause adverse effect on animals.	68 (74)	114 (70)	182 (72)
Improper/over antibiotic uses can cause adverse effect on human health (yourself, your family, your workers and your consumers).	42 (46)	77 (48)	119 (47)
Improper/over antibiotic uses can cause adverse effect on environment.	23 (25)	32 (20)	55 (22)
Rate of mean corrected responses	**(73)**	**(65)**	**(68)**

Note: N = total number; () = percentage. *Statement reverse respond score.

Table 4. Frequency of corrected responses of key individual's practice on AMU in the study.

Statement	Numbers of individual's routines		
	Swine producers (N = 92)	Poultry producers (N = 162)	Total (N = 254)
You consult with an animal health professional before using ATBs.	23 (25)	55 (34)	78 (31)
You only use ATBs following product's instruction or veterinary prescription/advice.	87 (95)	146 (90)	233 (92)
You use ATBs for other purposes apart from treatment.*	56 (61)	86 (53)	142 (56)
You use ATBs as first option to treat sick animals.*	16 (17)	28 (17)	44 (17)
You use ATBs to all animals (herd/flock) when only one or few of them is sick.*	37 (40)	17 (10)	54 (21)
You use ATBs by mixing in water or feed frequently incorrected.*	24 (26)	13 (8)	37 (15)
You use ATBs larger dose than recommended.*	44 (48)	95 (59)	139 (55)
You use ATBs smaller dose than recommended.*	78 (85)	136 (84)	214 (84)
You stop using ATBs immediately when sick animals not showing any clinical signs.*	48 (52)	95 (59)	143 (56)
You use expired ATBs on your animals.*	91 (99)	152 (94)	243 (96)
You read administration guidelines before using an antibiotic.	45 (49)	84 (52)	129 (51)
You keep ATBs at the farm follow product instruction.	87 (95)	146 (90)	233 (92)
You buy antibiotics drugs without prescription.*	79 (86)	102 (63)	181 (71)
Rate of mean corrected responses	**(60)**	**(55)**	**(57)**

Note: N = total number; () = percentage. *Statement reverse respond score.

Table 5. Rate of corrected responses of key individual's knowledge on AMR in the study.

Statement	Numbers of individual's corrected response		
	Swine producers (n = 76)	Poultry producers (n = 120)	Total (n = 196)
Inappropriate antibiotics use can cause emergence of resistant bacteria.	32 (42)	44 (37)	76 (39)
More frequent use of antibiotics in animals will increase their adverse effects in the future.	43 (57)	67 (56)	110 (56)
There is no relationship between antibiotic use in animals and development of resistance.*	32 (42)	36 (30)	68 (35)
Antibiotic resistance in animals is not important for public health.*	30 (39)	45 (38)	75 (38)
Antibiotic resistance is linked from animal (and/or agriculture) to human and environment	18 (24)	38 (32)	56 (29)
Rate of mean corrected responses	**(41)**	**(39)**	**(39)**

Note: N = total number; () = percentage. * Statement reverse respond score.

Most of respondents used ATBs in water or feed and more than 60% used in larger dose. Most of respondents kept ATBs in proper mode.

The assessment of AMR knowledge was mainly on misused and the consequences. 83% of swine and 74% poultry producers have heard about AMR term. However, the knowledge on AMR appeared to be low (Table 5). About half or

less of producers indicated that improper use and more frequently use of ATBs would cause the adverse effects like emergence of resistant bacteria. Only 38% or less of them realized that antibiotic resistant bacteria found in animals could contribute to public health risk or even connected from animals to others including human and environment.

3. Discussion

The KAP of farm's key individual, farm owners or manager or worker, on AMU and AMR were evaluated in this study. We found that knowledge regarding to AMU and AMR appeared to be low and poor in practice on AMU but neutral on attitude regarding to AMU among the producers.

In the present study, we found that knowledge regarding antibiotic and its use appeared to be low among small and medium scale producers. Similar studies have been reported in Cambodia with household/small scale farms [10] [11] and in the region [1] [9]. Only 25% of producers were able to know the use of ATBs for bacterial infection correctly. However, most of them (95%) considered ATBs use as the same choice of treatment for inflammatory diseases. Basically, ATBs overcome an infection by killing or inhibiting the bacterial growth, advising that it could play a role in limiting the inflammatory response [14], while inflammation is one of the body immune responses against trauma or foreign invasion turning out the be harmful [15]. This misperception may come from producers who are non-medical practitioners.

About 70% of producers wrongly understood that administration of antimicrobial can be reduced from the recommended dosage without reducing its efficiency and about half had the misconception that using antimicrobial drug in the form of non-therapeutic purposes; e.g., as preventive treatment or growth promoter cannot result in any consequence which includes the emergence of AMR bacteria. These results were in agreement with livestock producers in Thailand [9].

About 40% of producers were not well understood about full course (complete dosage and duration) when considering on antimicrobial administration. Generally, producers cared about financial issue as they may think that continue using would spend more while their animals are getting much better. It is reported that poor adherence to recommended instructions may increase the risk of AMR [16] [17] and has been reported to be a common problem in countries with non-prescription access to antimicrobials [18].

If withdrawal period is not followed there is a risk of antimicrobial residues remaining in the meat at slaughter age [19] [20]. About half of producers were not well comprehended about withdrawal period when using antimicrobials. This could contribute to public health risk if antimicrobial residues remain present in animals' products especially at the slaughter age. Data has not shown, 60% of producers consumed or sell when their animals were under withdrawal period after antimicrobial administration. In low- and middle-income countries, com-

pliance with withdrawal period is not monitored and analysis of animal products is not routinely practiced. Studies in Vietnam have found sulfamethazine [21] and tetracycline [22] residues from pork at wet markets in 8.8% and 5.5% respectively.

Regarding attitude toward AMU and its related consequences, producers worried less about the consequences of AMR bacteria which can affect animals, human, and environment. This suggest that both swine and poultry producers should be more aware of AMR specifically on its causes and its relative consequences.

In the present study, swine and poultry producers believed that proper management including biosecurity and use of vaccines on animals could prevent/reduce the use of antimicrobials. If they put these into practices always, such antimicrobials will be reduced and then substantially decrease the emergence of AMR. Such good animal husbandry and welfare practices including appropriate management, housing, feeding, and water supply, effective external and internal biosecurity, and efficient and relevant vaccinations would rather be preventing the infectious diseases without antimicrobials [20] [23].

One of the many reasons on the use of antimicrobials is veterinary consultation or based on disease diagnosis by a veterinarian or animal health professional [23]. We found that not many producers get consult with animal health professional prior to the use of antimicrobials. However, most of them would follow their advice if any conversation were met. The majority of the farms were contract farms, thus the antibiotic use in the farms may come from the decision of private veterinarians of the contract companies that required to comply with. We also noticed that the owned farms usually use the private veterinarians for their farm well. Although most of respondents were aware that administration of antimicrobials in farms should be based on veterinarian prescription or advice, but they disregarded that in practice. We found inappropriate use of antimicrobials by producers including using as non-therapeutic, disrespect of treatment dosage and durations, use as first option to treat sick animals. The non-rational use of antimicrobials contributes to increased prevalence of AMR bacteria. Furthermore, a study in Cambodia indicated that higher prevalence of AMR was found on swine farms which are administering antimicrobials as a prophylactic and in farms that normally treated the entire group or herd in the disease event [11].

Most of the respondents (80%) have heard about AMR. This has been agreed with the recent study by [1] in Vietnam and in Cambodia [11]. Although respondents were familiar with AMR, its occurrence and consequences were not clearly understood. As a result, about half of producers did not know about AMR bacteria resulting from the improper use of antimicrobials *e.g.*, use antimicrobial as a growth promotor, preventive treatment, inaccurate dosage and durations, and more frequently use. About 35% of producers aware that AMR coming from the animals would rather contribute for human and its related en-

vironment. Misconception on AMR could contribute in the spread on animal, human, and environment.

This present study has several limitations. Data in this study were collected from participants using KAP questionnaire. While the KAP survey tool enables large amounts of data collection from participants for a short period of time, data collected can misrepresent true dispositions and practices. As respondent self-report outlooks and previous behaviors, such data may be detrimentally affected by inaccurate recall or confirmation bias, particularly if the subject matter concerns a contentious topic or practice as well as their understanding of the individual questions.

4. Conclusion

Overall, we found that majority of Cambodian swine and poultry producers have a low level of knowledge, neutral attitudes, and employed poor antimicrobial practices. Such misconceptions, wrong beliefs, and inappropriate practices can be considered as one of the significant contributing factors in the development/increasing AMR. Understanding of the current KAP levels could potentially be used to inform researchers and policy makers to develop more effective interventions in the rational use and appropriate use of antimicrobials in farms to prevent the misuse of antimicrobials and the development of antimicrobial resistance.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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