



Research Article

Antimicrobial Use Practices and Resistance Risk in Cattle Farming in Korhogo, Ivory Coast

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Abstract

Cattle farming is a key sector for food and economic security in Côte d'Ivoire. However, inappropriate practices regarding the use of antimicrobials to treat cattle are prevalent among some farmers in several regions of the country. A survey assessing antimicrobial use practices in cattle farming was conducted in the Korhogo department using the Kobocollect digital questionnaire tool. This cross-sectional study of 215 cattle farmers in Korhogo, Côte d'Ivoire, reveals the widespread and unregulated use of antimicrobials in livestock farming. The most frequently used antibiotics were tetracyclines (39.91%) and sulfonamides (23.95%), while the most common antiparasitic agents were diminazene (33.26%) and albendazole (29.3%). These molecules are primarily used to treat conditions such as mastitis, skin infections, digestive disorders, respiratory diseases, foot rot, fluke and trypanosomiasis. Additionally, almost one-third of farmers purchase supplies from markets or street vendors. Of these farmers, 65.9% do not follow dosage instructions, 25% interrupt treatment prematurely, and only 30.8% consult a veterinarian. Around 56.1% of livestock farmers self-medicate to treat parasitic diseases, a practice encouraged by low levels of education, empirical experience and limited access to veterinary services. These practices, combined with a heavy reliance on informal distribution channels, significantly increase the risk of antimicrobial and antiparasitic resistance emerging and spreading in the region. The study therefore highlights the urgent need to strengthen veterinary services, regulate the drug market, and educate livestock farmers in the responsible use of antimicrobials.

Keywords

Antimicrobial Misuse, Cattle Farming, Self-Medication, Informal Markets, Korhogo

1. Introduction

The use of antimicrobials in livestock farming is crucial for managing herd health, especially in developing countries where agriculture and livestock farming form the backbone of the economy. In cattle production systems, these substances are used to treat infections, prevent disease and boost productivity, helping to meet the growing demand for animal protein [1]. This practice is crucial in regions where

environmental and health issues, such as parasite infestations or epidemics, jeopardise the viability of livestock farming. In sub-Saharan Africa, extensive livestock farming predominates, with an increased reliance on medicines to preserve animal health and ensure food security for rural populations [2]. Therefore, studying antimicrobial use practices in these systems is essential for optimising resources

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Received: 27 November 2025; Accepted: 3 February 2026; Published: 25 February 2026



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and promoting sustainable herd management.

In Africa, livestock farming makes a significant contribution to the rural economy and food security, but it faces challenges relating to the limited availability of skilled veterinary services. Surveys in different African countries reveal that farmers often use antimicrobials to treat common cattle diseases, such as respiratory or digestive infections, without consulting a vet first [3]. In Kenya and Ethiopia, where livestock farming is more extensive, farmers administer these drugs independently, based on informal advice or past experience [4]. The most commonly used classes of antimicrobial include tetracyclines and penicillins, which are administered either orally or by injection. Prophylactic treatments are predominant during transhumance or periods of environmental stress [5]. While these practices are effective in the short term, they emphasise the importance of increased monitoring to prevent overuse and encourage the adoption of alternatives, such as vaccination and improved hygiene conditions [6].

In Côte d'Ivoire, cattle farming is crucial for the agricultural economy, providing significant contributions to rural livelihoods and food security [7]. The country has an estimated cattle population of over 1.5 million, primarily found in the northern savannah zone where extensive and transhumant systems are predominant [8]. Korhogo, in the Savanes region, is a key location for cattle production and is home to local trypanotolerant breeds such as the N'Dama and the Baoulé [9]. Livestock farmers in this region practise family-based or semi-intensive farming, which is characterised by seasonal transhumance and integration with crop production. This exposes their herds to multiple health risks [10]. Local studies indicate that self-medication is common for treating parasitic and bacterial infections, which are often administered by the farmers themselves due to the scarcity of veterinary services [11]. Despite awareness-raising initiatives supported by national and international organisations, self-medication and the unregulated procurement of medicines remain widespread [12]. These practices highlight the need for targeted studies to identify the factors that influence the use of antimicrobials, such as market access, farmers' knowledge and logistical constraints. The present study aims to analyse antimicrobial use practices in cattle farming in the Korhogo department of Côte d'Ivoire. The specific objectives are to determine the types of molecules used, the pathologies targeted, the modes of administration and the factors influencing these practices.

2. Materials and Methods

2.1. Materials

Our study used questionnaires developed with the Kobocollect tool and installed on a tablet. These survey forms were used to collect information on cattle farming in the Korhogo department.

2.2. Methods

2.2.1. Study Area

The study was conducted in the Korhogo region of northern Côte d'Ivoire. Spanning 12,500 km², it is located in the Sudanese savanna zone (with rainfall ranging from 1,000 to 1,400 mm, and a dry season from November to April). This important cattle-raising area is located 635 km north of Abidjan and is home to both sedentary and transhumant herds. It is characterised by high cattle density, limited veterinary coverage and large informal drug markets. Seven sub-prefectures were surveyed, including Korhogo, Karakoro, Komborodougou, Napiéolédougou, Sirasso, Kombolokoura and Niofoin (Figure 1).

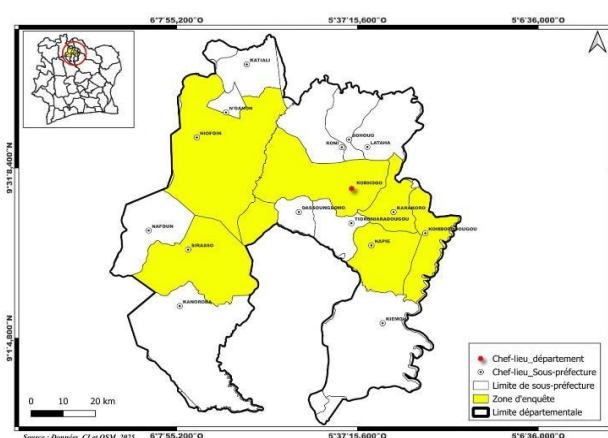


Figure 1. Study sites in the Korhogo department.

2.2.2. Study Methodology

The study examined the use of antimicrobials by cattle farmers, looking at the types of antimicrobials used, the infections encountered in cattle and how these antimicrobials were acquired and used. The survey was conducted through direct interviews with farmers, and the responses were digitised using the Kobocollect tool. Farmers were unable to identify the families of antimicrobials. The antimicrobials used for treatment were identified by referring to the instructions for use on the bottles or packaging.

2.2.3. Selection Criteria

The criteria took both inclusion and exclusion into account.

The inclusion criteria were as follows: Any person aged 18 or over who resides in Korhogo, has raised livestock for at least five years and has given their consent to participate in the study.

Exclusion criteria: Individuals under the age of 18; individuals who had been raising cattle for less than five years; individuals who lived outside the Korhogo department; and individuals who did not consent to participate in the study.

2.2.4. Calculating the Sample Size

The sample size for cattle farmers in the Korhogo department was calculated using standard statistical formulas, in particular the one developed by Lemeshow [13].

$$n = \frac{N \cdot Z^2 \cdot p(1-p)}{e^2(N-1) + Z^2 \cdot p(1-p)}$$

n: The calculated sample size.

N: The total population of livestock farmers in Korhogo (1,000).

Z: The Z-score corresponding to the confidence level. For a standard confidence level of 95%, the Z-score is 1.96.

p: The expected proportion. In a survey covering a variety of practices, $p = 0.5$ (50%) is often used to obtain the largest, most representative sample size possible.

e: The desired margin of error is 5%, or 0.05.

The calculated sample size is approximately 278. Of these, 215 farmers in the Korhogo department agreed to participate in the survey.

2.2.5. Statistical Analysis

A statistical analysis of the data was performed using R software (version 3.2.2). Means and standard deviations were calculated for quantitative variables and proportions for

qualitative variables. Graphs were created using Excel. Associations between sociodemographic variables among cattle farmers in the Korhogo department were analysed using the chi-squared test (p-value and interpretation measure).

3. Results

3.1. Socio-Demographic Characteristics of Livestock Farmers in the Korhogo Department

Analysis of the survey results revealed that there were 225 livestock managers, comprising 215 farmers and 10 animal health workers. These individuals were spread across seven sub-prefectures in the Korhogo department: Korhogo, Karakoro, Komborodougou, Napieledougou, Sirasso, Kombolokoura and Niofoin. The surveyed livestock farmers were aged between 31 and 81. The 45–60 age group was the most represented (43.26%), while only 4.19% of respondents were over 75. The majority of respondents were foreign nationals (55.35%). The survey revealed that more than half of those interviewed (57.21%) worked in livestock farming. Salespeople came second with 30.7% of respondents, followed by farmers with 12.09% (Table 1).

Table 1. Sociodemographic characteristics of livestock farmers.

Variables	Farmers Number (N=215)	Percentage (%)
Age		
[30 - 45]	40	18,60
[45 - 60]	93	43,26
[60 - 75]	73	33,95
[75 et plus]	9	4,19
Nationalité		
Ivorian	96	44,65
Non-Ivorian	119	55,35
Level of education		
Schooled	62	28,84
Not schooled	153	71,16
Main activity		
Farmer	26	12,09
Livestock breeder	123	57,21
	66	30,70

3.2. Determination of the Families of Antimicrobials Used in Cattle Farming in the Korhogo Department

Analysis of the survey results revealed the proportions of two commonly used families of antimicrobials in cattle farming: antibiotics and antiparasitics. Regarding antibiotics, health workers in the Korhogo department primarily favoured tetracyclines (39.91%), followed by sulfonamides (23.95%) and beta-lactams (19.16%). In contrast, macrolide use was lower (8.27%), as were beta-aminoglycoside (6.68%), polypeptide (5.81%) and quinoline (5.22%) use. As for antiparasitics, diminazene and albendazole dominated this class with respective proportions of 33.26% and 29.30%. Isometamidium (20.91%) and triclabendazole (16.51%) were the least used (Figure 2).

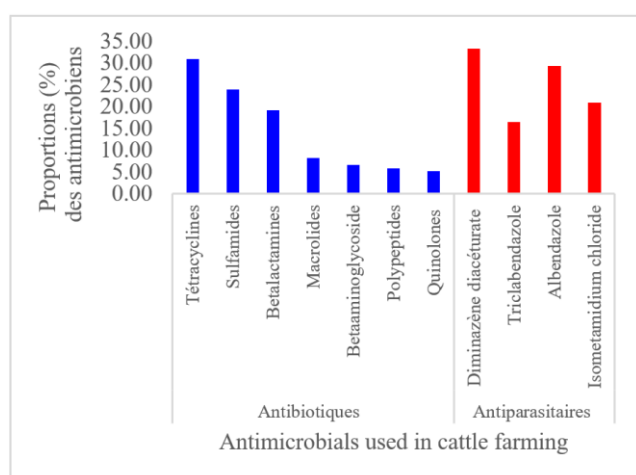


Figure 2. Families of antimicrobials used in cattle farms in the Korhogo department.

3.3. Determination of the Types of Infection Observed in Cattle Farms in the Korhogo Department

Analysis of the results revealed two distinct groups of infections on cattle farms in the Korhogo department. The highest rates were for fluke infestations (26.82%), followed by skin infections (18.55%) and mastitis (16.29%). Foot rot

accounted for 14.04% of cases, while digestive diseases accounted for 10.28%. By contrast, respiratory diseases were less prevalent (7.77%), as was trypanosomiasis (6.27%) (Figure 3).

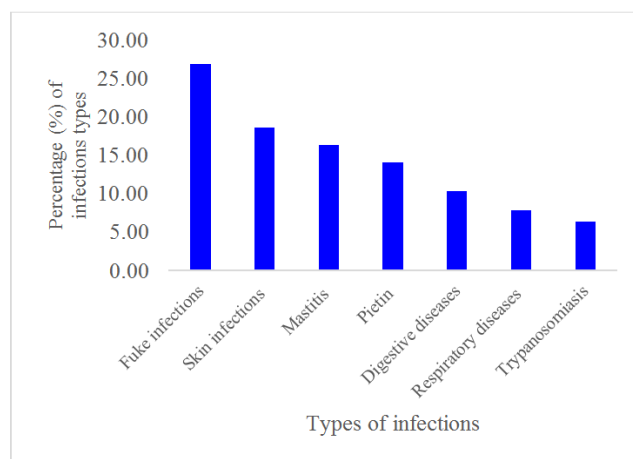


Figure 3. Prevalence of bovine diseases in Korhogo.

3.4. Use of Antimicrobials According to the Type of Infection in Cattle Farms in the Korhogo Department

The results reveal clear trends in the use of different antibiotic and antiparasitic families. Tetracyclines are primarily used for treating bacterial infections, including mastitis (53.85%) and skin infections (66.22%). They dominate the treatment of respiratory diseases, accounting for 45.16% and 41.16% of foot rot cases, respectively. Beta-lactams are primarily used to treat digestive disorders (63.41%), though they are rarely used to treat respiratory infections (22.28%). Macrolides occupy a secondary position, accounting for 20% of treatments for mastitis and skin infections, and 4.51% of treatments for foot rot. Regarding parasitic diseases, the main treatments for flukes are albendazole (55.14%) and triclabendazole (44.86%). Albendazole and triclabendazole are the main treatments for flukes, accounting for 55.14% and 44.86% respectively. For trypanosomiasis, diminazene acetate was the preferred choice of 76.3% of farmers, followed by isometamidium chloride at 24% (Table 2).

Table 2. Antimicrobial use by type of infection in Korhogo.

Types of infection	Antimicrobial families	Number (N)	Proportions (%)
Antibiotics			
Mastitis	Tétracyclines	35	53,85
	Bêta-lactamines	17	26,15

Types of infection	Antimicrobial families	Number (N)	Proportions (%)
skin infections	Macrolides	13	20
		65	
	Tétracyclines	49	66,22
	Bêta-lactamines	16	21,62
	Macrolides	9	12,16
Respiratory infections		74	
	Tétracyclines	14	45,16
	Sulfamides	10	32,26
	Bêta-lactamines	7	22,28
		31	
Piétiens	Tétracyclines	23	41 073
	Bêta-lactamines	14	25
	Sulfamides	12	21,43
	Macrolides	7	12,5
		56	
digestive diseases	Sulfamides	15	36,59
	Bêta-lactamines	26	63,41
		41	
Pesticides			
Gills	Albendazole (Albex 10%)	59	55,14
	Triclabendazole	48	44,86
		107	
trypanosomiasis	Diminazène diacétates	19	76
	chlorure d'isomémidium	6	24
		25	

3.5. Determination of Antibiotic Use Practices in Cattle Farming in the Department of Korhogo

In the Korhogo department, the use of antibiotics in cattle farming is characterised by an uncontrolled supply and a lack

of veterinary supervision: only 24.06% of farmers consult a professional. Many do not comply with prescription instructions, particularly regarding dosages (68.48%), and prematurely interrupt treatment (23.93%). Analysis of the survey results showed that 37.83% of antibiotics are supplied outside the official channel, with 33.33% originating from markets and 4.5% from street vendors (Table 3).

Table 3. Antibiotic use practices in cattle farms in the Korhogo department.

Practices when using antibiotics		Nombre (N)	Percentage (%)
Supply locations	Veterinarian pharmacies	69	62,16
	Markets	37	33,33

Practices when using antibiotics		Numbre (N)	Percentage (%)
Adherence to dosage	Street vendors	15	4,5
		111	
	Never	63	68,48
	One day	18	19,57
	always	11	11,96
Criteria for discontinuing treatment		92	
	Duration of treatment	69	58,87
	Improvement	28	23,93
	Recovery	20	17,09
Attitudes toward a sick animal		117	
	Treat the animal	46	56,1
	Call the veterinarian	32	24,06
	Sell the animal	4	4,88
		82	

3.6. Determination of Practices for the Use of Antiparasitic Drugs in Cattle Farming in the Department of Korhogo

Analysis of practices reveals several cases of the misuse of antiparasitic drugs. A significant proportion of farmers obtain their supplies from unregulated sources, such as markets

(28.85%) and street vendors (1.92%), thereby exposing their animals to potentially dangerous products. Nearly 65.86% of farmers report that they never follow the recommended dosage, indicating a widespread failure to comply with dosage instructions. Similarly, treatment is often discontinued based on apparent improvement or recovery in the animal without waiting for the full duration of the prescribed treatment. Furthermore, over half of farmers (65.41%) self-medicate without consulting a vet (Table 4).

Table 4. Practices for using antiparasitic drugs in cattle farms in the Korhogo department.

Pesticide use practices		Number (N)	Proportions (%)
Where purchased	Veterinarian pharmacies	72	69,23
	Markets	30	28,85
	Street vendors	2	1,92
Adherence to dosage		104	
	Never	81	65,86
	One day	26	21,14
	always	16	13,56
		123	
Decision to discontinue treatment	Compliance with treatment duration	67	68,48
	Improved animal health	24	24,49
	Recovery	7	7,14

Pesticide use practices		Number (N)	Proportions (%)
Attitude toward a sick animal		98	
	Treat the animal	87	65,41
	Consult a veterinarian	41	30,83
	Sell the animal	5	3,76
		133	

3.7. Characteristics of Livestock Farmers According to Antimicrobial Use Practices in the Department of Korhogo

The geographical area of study was found to be the predominant factor influencing almost all of the observed animal health practices. It significantly impacted compliance

with prescriptions ($p = 0.001$), the frequency of treatment administration ($p = 0.001$), dosage adjustment ($p = 0.004$), where antimicrobials were purchased ($p = 0.012$) and the criteria for stopping treatment ($p = 0.001$). Furthermore, changes in dosage correlated with the education level of livestock farmers ($p = 0.036$). Finally, nationality was found to mainly influence the duration of prescriptions ($p = 0.041$) and dose adjustments ($p = 0.008$) (see Table 5).

Table 5. Characteristics of farmers and abusive practices of cattle breeders in the Korhogo department.

Explanatory variables	Pratiques d'usage des antimicrobiens											
	Respect prescription		Modified duration		Frequency Modified		Dosage Modified		Place of purchase		Stop criterion	
	χ^2	P-value	χ^2	P-value	χ^2	P-value	χ^2	P-value	χ^2	p-value	χ^2	p-value
Study site	47,08	0,001*	6,01	0,422	46,06	0,001*	19,19	0,004*	25,71	0,012*	51,50	< 0,001*
Level of education	1,73	0,421	1,57	0,457	0,64	0,727	6,63	0,036*	5,25	0,263	4,05	0,399
Nationality	2,37	0,53	4,18	0,041*	1,24	0,13	7,09	0,008*	5,23	0,073	0,76	0,684

*: significatif, χ^2 = chi carr é

4. Discussion

The results of this study show that the use of antimicrobials on cattle farms in Korhogo is influenced by low levels of education (28.84%). This could be due to some farmers not attending school due to financial constraints, as well as the predominantly rural nature of livestock farming areas, where access to schools is limited. In this area, livestock farming is a traditional activity, with young people learning the trade by working with the herd rather than attending school. This often comes at the expense of modern schooling, which has only been introduced more recently. This figure is lower than that reported by Orounladji *et al.* [14], who found that 34.5% of livestock farmers had received some form of education.

Furthermore, our results showed that around 24% of farmers seek professional advice. This could be due to the high cost of care and the remote location of farms. This leads farmers to favour self-medication in order to preserve their income. Our results are lower than those reported by Yao [15], who found that 39.5% of farmers in a survey on the use of antibiotics in cattle farming in the Abidjan district (Ivory Coast) sought professional advice. In Abidjan, farmers benefit from a high concentration of veterinary practices and technicians nearby.

On the other hand, farms in Korhogo are often isolated in rural areas, making access to professionals much more difficult and costly due to travel expenses.

Regarding antimicrobials, the survey of cattle farmers revealed a reliance on tetracyclines, accounting for 39.91% of cases. This high level of dependence could be linked to the affordability and availability of tetracycline molecules in the

Korhogo region. Our results are higher than those reported by Zeru *et al.* [16], in Ethiopia, who found a proportion of 30% in a survey of the sale and use of antimicrobials in cattle farming. The development of the informal sales channel and the widespread availability of medicines on local markets in Korhogo facilitate unlimited access to tetracyclines without a prescription, unlike in other areas where the pharmaceutical channel is better controlled. In addition, our work has revealed a non-compliance rate of 68.48% among farmers. This can be attributed to the fact that most farmers do not know how to read the instructions and prefer to treat their livestock themselves. Consequently, they administer insufficient quantities of antibiotics, which could hinder full recovery and encourage the survival of resistant bacteria. These results are higher than those reported by Soma *et al.* [17], on antibiotic use practices in livestock farming in sub-Saharan Africa, where a proportion of 40% was observed, and higher than those reported by Tufa *et al.* [18], who observed a rate of 55%. These figures suggest a high risk of resistant bacteria emerging and spreading, particularly due to the uncontrolled sale of drugs and their use without a veterinary prescription. Regarding pest control, the survey revealed that 76% of respondents used diminazene to treat trypanosomiasis. The high usage rate of diminazene can be attributed to the significant presence of tsetse flies in the Korhogo department, which is situated in a savannah region. Trypanosomiasis is one of the most common diseases affecting livestock. The results reported here are higher than those of Okello *et al.* [19], who found diminazene was used at a rate of around 54% to combat trypanosomiasis. Similarly, the study showed that albendazole was used at a rate of 55.14% on cattle farms in Korhogo. This high usage rate can be attributed to the prevalent presence of intestinal parasites among Korhogo's livestock, a condition exacerbated by outdoor grazing. These results are consistent with those reported by Tufa *et al.* [18], who observed an albendazole usage rate of 58%. These differences reflect the severity of parasitic diseases in the study area and the extent to which livestock farmers rely on empirical treatments. The survey revealed that 37.83% of people had access to informal markets and street vendors. The latter travel directly to isolated villages and camps, thereby facilitating the unregulated supply of medicines. These results are higher than those reported by Azabo *et al.* [20], in a study on the use of antimicrobials in cattle production in Tanzania, where rates ranged from 25 to 30%.

With regard to chi-squared tests, the study revealed a correlation between the study site and compliance with prescriptions and frequency of administration ($p = 0.001$). Depending on whether a farmer is located near an urban centre or in a remote rural area, their access to veterinary advice can differ significantly. The further away they are, the less likely they are to comply with official prescriptions. These observations corroborate those of Tufa *et al.* [18], who examined the knowledge, attitudes and behaviours (KAB) of Ethiopian livestock farmers with regard to the use of

antimicrobials. Furthermore, the study showed that nationality influences treatment duration ($p = 0.041$). Indeed, livestock farmers from countries or regions with a long pastoral tradition have acquired different empirical knowledge to that of local livestock farmers. This knowledge influences how they administer medication and how long they treat the animal for. These observations are consistent with those of Yao *et al.* [21], who analysed cattle farming practices on rural farms in northern Côte d'Ivoire.

5. Conclusion

The Korhogo department is characterised by a strong dependence on informal channels, frequent self-medication and low use of veterinary services. The predominant use of tetracyclines and antiparasitics, combined with non-compliance regarding dosage, frequency and duration of treatment, poses a significant risk of antimicrobial resistance emerging and spreading. These practices are negatively influenced by the geographical context, the level of education, and the mobility of livestock farmers. These results highlight the urgent need to strengthen local veterinary supervision, regulate access to veterinary medicines and encourage the more responsible use of antimicrobials, in order to protect animal and consumer health sustainably. The study also revealed that livestock farmers have a relatively low level of education and consult with veterinary professionals infrequently. Tetracyclines and diminazene were the most commonly used antimicrobial molecules, with high levels of use in terms of dosage, frequency of administration and duration of treatment, particularly in cattle. This situation, exacerbated by cultural and mobility constraints related to the background of livestock farmers, could lead to antimicrobial resistance emerging. Therefore, it is urgent to strengthen local veterinary supervision and regulate the drug market in northern Côte d'Ivoire to ensure public and animal health. The following concrete actions are strongly recommended to effectively reduce the risk of antimicrobial and antiparasitic resistance: strengthening local veterinary supervision; promoting simplified education and awareness among livestock farmers; regulating and securing the drug supply chain; and adapting care protocols to mobility constraints.

Abbreviations

PIB	Gross Domestic Product
LANADA	National Laboratory for Agriculture Development Support

Author Contributions

Modeste N'dri Koffi: Conceptualization, Methodology, Investigation, Writing – original draft

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Validation, Writing – review & editing

Séraphin Affou Wognin: Data curation, Methodology, Project administration, Resources, Validation

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this article.

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