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Current situation with anthrax in Russian Federation

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ABSTRACT

Anthrax is a zoonotic disease classified as a highly hazardous infection.

Until the mid-20th century, the capabilities of regulatory services were insufficient to prevent the emergence of new infection hotspots. Each year, mass livestock die-offs and human cases of this disease were recorded.

Public unawareness of the disease's causes and the lack of proper disposal methods for deceased animals led to widespread soil contamination with anthrax spores across extensive territories of Russia, particularly in southern regions. The disposal of infected cattle and other animals involved the creation of burial sites. In practice, however, these often turned into "murrain fields," where animal remains lay exposed. Only in the 1950s was there a shift toward ash-based burial methods for cattle.

The current state of monitoring for anthrax-affected sites and burial grounds, coupled with decreased oversight by veterinary services, does not exclude the possibility of animal and human anthrax cases. However, these cases are predominantly sporadic, appearing as outbreaks.

In Russia, anthrax-prone areas are monitored at multiple levels. Collected information is compiled into reference materials, facilitating differentiated planning of preventive measures based on regional characteristics.

The existing registry of anthrax-affected sites in Russia no longer meets current demands. Modern electronic databases and geographic information systems contribute to identifying common patterns of anthrax territorial distribution in Russia and understanding the persistence of activity in affected locations. These tools enable efficient data collection, analysis, and synthesis to prevent deterioration of the epizootiological and epidemiological situation.

Keywords: anthrax; anthrax burial sites; registry; anthrax-affected locations; geographic information systems.

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Текущая обстановка по сибирской язве на территории Российской Федерации

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АННОТАЦИЯ

Сибирская язва — заболевание, входящее в группу зоонозов и относящееся к особо опасным инфекциям.

Возможности контролирующих служб до середины прошлого века не позволяли предотвратить возникновение свежих очагов инфекции. Ежегодно регистрировали массовый падёж сельскохозяйственных животных и случаи заболевания людей от данной патологии.

Незнание причин заболевания у населения и отсутствие возможностей для захоронения павших животных привели к заражению спорами сибирской язвы почвы обширных территорий Российской Федерации, особенно в южных регионах. При утилизации падшего крупного рогатого скота и прочих животных предусматривалось формирование скотомогильников, но чаще в реальности получались «моровые поля», где на открытой поверхности находились останки умершего скота. Только в 50-е годы был осуществлён переход к зольным захоронениям крупного рогатого скота.

Современное состояние учёта стационарно неблагополучных пунктов и сибиреязвенных захоронений в сочетании со снижением контроля со стороны ветеринарных служб не исключает заболеваемости сибирской язвой животных и людей, но при этом она носит в основном спорадический характер в виде вспышек сибирской язвы.

В Российской Федерации существует несколько уровней надзора за неблагополучными по сибирской язве территориями. Собранная информация обобщается в виде справочных материалов, что облегчает проведение дифференцированного планирования профилактических мероприятий с учётом региональных особенностей.

Кадастр стационарно неблагополучных пунктов по сибирской язве в Российской Федерации перестал соответствовать существующим потребностям. Установлению общих закономерностей территориального распространения сибирской язвы в Российской Федерации и причин сохранения активности стационарно неблагополучных пунктов способствуют современные электронные базы данных геоинформационных систем. Это позволяет обеспечить сбор, анализ и обобщение информации в целях предотвращения ухудшения эпизоолого-эпидемиологической ситуации.

Ключевые слова: сибирская язва; сибиреязвенные захоронения; кадастр; стационарно неблагополучные пункты; геоинформационные системы.

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INTRODUCTION

Anthrax is a zoonotic disease classified as a highly hazardous infection. The pathogen is a Gram-positive bacillus that exists in a vegetative form in an infected animal's body and as spores in soil.

In humans, infection occurs primarily through contact, affecting the skin and oral mucous membranes and resulting in specific types of carbuncles, bullae, and erysipeloid lesions. In some cases, the disease manifests as generalized forms—gastrointestinal or pulmonary anthrax. Fatal outcomes in all forms are caused by infectious-toxic shock.

The incubation period averages 2–4 days (up to 14 days). After recovery, immunity is unstable, and reinfection is possible.

Anthrax most commonly affects cattle, less frequently small ruminants, as well as horses and camels. Infection occurs via the alimentary route during grazing on contaminated land or via bites from bloodsucking insects, i.e., through vector-borne transmission.

In humans, sources of infection include sick animals and animal products. The main transmission routes are contact, alimentary, and vector-borne.

In the general population, anthrax incidence is sporadic. Occasionally, group outbreaks are observed. Cases occur predominantly in the summer and autumn, due to the seasonal features of anthrax.

Occupational anthrax is classified into three types: industrial, contact, and agricultural. Most cases occur in males [1, 2].

REGISTRY OF SANITARY HAZARD POINTS AND ANTHRAX BURIAL SITES IN THE RUSSIAN FEDERATION

The primary route of infection for animals is ingestion of anthrax spores from soil foci located at sites where diseased or forcibly slaughtered livestock have been buried.

It should be noted that until the mid-20th century, simple burial methods were practiced, and only since 1953 has an ash-based method with preliminary incineration been used. The situation is aggravated by the presence of "murrain fields," i.e., territories without clear boundaries where mass animal die-offs related to anthrax epizootics were observed in the past.

In recent decades, certain progress has been achieved in controlling anthrax within Russia; however, outbreaks among animals and humans continue to be reported annually. This is facilitated by the expansion of agricultural activities and various natural and climatic factors, such as floods and droughts.

To prevent contact with soil foci at burial sites, a registry of permanently hazardous points and anthrax burial sites across Russia (2005) was established. This registry compiled all available information at that time and introduced standardized terminology for epidemiologists describing anthrax foci [3].

Anthrax epizootic focus is a location of the source or transmission factor of the infection agent within boundaries where transmission to susceptible animals or humans is possible (e.g., pasture, watering place, livestock facility, animal product processing enterprise, etc.).

Anthrax epidemic focus is an epizootic focus where human cases of the infection have occurred.

Soil foci are animal burial grounds, biothermal pits, and other sites of carcass disposal of animals deceased from anthrax.

Anthrax-affected location (AAL) is a settlement, livestock farm, pasture, or geographic locality where an epizootic or epidemic focus has been identified regardless of how long ago it emerged.

Depending on the time of emergence, periods, and intervals of activity, AALs are classified as new or old. Old ones are further subdivided into manifest (active), continuously active (interval of manifestations 1–4 years); recurrent (no more than once every 5 years); and non-manifest (no activity for more than 10 years).

CURRENT SITUATION OF ANTHRAX BURIAL SITES IN THE RUSSIAN FEDERATION

Characteristics of Anthrax Burial Sites

Class 1 hazard. Area up to 1000 meters in diameter with a solid fence at least 2 meters high. Along the perimeter, there is a trench up to 1.4 meters deep and 1.5 meters wide with an external embankment of excavated soil [4].

According to the Registry, there are approximately 35,000 AALs and about 14,000 anthrax burial sites (ABSs) in Russia. It has also been established that necessary characteristics are often missing: type and frequency of burials, number and species of animals, current condition, and geographic coordinates [5, 6].

Dissatisfaction with the existing situation has led to the adoption of a set of measures aimed at improving the situation through the creation of an interagency plan for anti-epizootic activities in Russia.

To improve the current anthrax situation, a package of preventive measures was outlined and reflected in the decree of the Chief State Sanitary Doctor of the Russian Federation.

The primary focus within the scientific research project "Improvement of Comprehensive Epidemiological Monitoring and Prevention of Anthrax in the Russian Federation" was the creation of a unified electronic database of AALs and ABSs based on geographic information system (GIS) technologies. Additionally, regions were categorized according to the degree of epidemiological risk.

GEOGRAPHIC INFORMATION TECHNOLOGIES IN ANTHRAX EPIDEMIOLOGICAL SURVEILLANCE

A systematic approach to identifying epidemiological and epizootic patterns to enhance the effectiveness of anthrax prevention measures involves the application of currently relevant technologies.

Monitoring hazardous sites as indicators is important for establishing the anthrax enzootic area. An AAL represents a high-risk zone for anthrax epizootics. To prevent deterioration of the situation, current information from all available sources is analyzed. The collected data require continuous synthesis of informational resources. A multidisciplinary approach based on GIS technology ensures analysis of the current significant epidemiological situation, considering the geography and characteristics of existing foci to forecast the changes of the situation over time.

In accordance with these requirements, information on AALs and ABSs was collected in the regions and incorporated into the Russian anthrax registry using GIS technologies.

The collected data were summarized and analyzed by specialized institutions of Rospotrebnadzor (research institutes) with integration of geoinformation databases of AALs and ABSs into the GIS data.

Subsequently, Russian territories were ranked using modern statistical data processing methods to identify possible deterioration of the epizootic-epidemiological situation in specific regions regarding anthrax.

ANTHRAX REGISTRY AND GEOINFORMATION TECHNOLOGIES

To determine the distribution of anthrax within specific territories, search activities are conducted to identify all types of AALs. The compiled information at all levels is summarized as analytical materials, which is necessary for a discrete approach in forming preventive measures considering the characteristics of particular regions.

The use of GIS technologies significantly facilitates statistical processing of existing data on anthrax enzootic areas for summarizing and forecasting epizootic-epidemiological development scenarios.

During the formation of the AAL and ABS registry based on GIS 7, data on AALs and ABSs were collected and regional databases were created, which were then consolidated at the anthrax monitoring center. Afterwards, specialized Rospotrebnadzor institutions summarized and analyzed the data, integrating geoinformation databases of AALs and ABSs into GIS.

Multifactorial analysis ranked districts and regions of Russia by risk of epizootic-epidemiological complications related to anthrax. This enabled the formulation of a set of preventive measures based on scientific principles, important for planning construction and land use to prevent exacerbation of the epizootic-epidemiological anthrax situation in specific Russian subjects.

Currently, active reevaluation and correction of existing data are underway, which is reflected in regional registries (particularly in the North Caucasus [NCFD] and Southern [SFD] Federal Districts) [7].

OVERALL ANTHRAX SITUATION IN THE RUSSIAN FEDERATION, 2004–2023

From 2004 to 2023, the total incidence of anthrax among humans amounted to 182 cases, with no indication of a decline in the annual number of reported cases. The incidence demonstrated a wave-like pattern, with distinct “spikes” corresponding to large epizootics [8]. A clear correlation between human and livestock incidence is illustrated in Fig. 1.

Confirmed anthrax episodes among the population were registered in 24 administrative regions during the study period. Cases of disease manifestation have been recorded almost annually in southern regions of Russia (the Republic of Dagestan, North Ossetia, Volgograd Region, Stavropol Territory), as well as in Altai Region, and the Orenburg, Omsk, and Tambov Regions. The outbreak nature of the disease is noted, predominantly affecting rural populations, which is explained by their involvement in livestock farming [9, 10].

Investigation of cases revealed that the main causes were forced slaughter of livestock with carcass processing and sale without veterinary inspection, and, less frequently, care of sick animals. This pattern was especially evident during the 2010 outbreaks in the Republic of Dagestan and Krasnodar Region [11].

A notable case occurred in 2016 in the Yamalo-Nenets Autonomous District, where 36 people and over 2500 reindeer were infected. The investigation showed that following the cessation of animal vaccination in 2007, the territory was classified as anthrax-free. Due to an anomalously hot summer and permafrost thawing, anthrax spores migrated to the soil surface, infecting livestock during grazing within the range of unaccounted ABSs (animal burial grounds and “murrain fields”). Consumption of raw meat resulted in a significant number of rare oropharyngeal anthrax cases [12].

In 2023, 7 anthrax outbreaks with 19 human cases were reported in 5 subjects across 3 federal districts (Volga, Siberian, Central) in Russia. In nearly all instances, forced slaughter of animals occurred in the absence of vaccination and veterinary control [13].

Thus, the occurrence of sudden anthrax epizootics among animals and human cases indicates a high likelihood of contaminated soil areas caused by AALs and unaccounted ABSs.

According to Rospotrebnadzor recommendations, in 2023, 10,275 people (10,119 adults and 156 children) were vaccinated against anthrax in 70 Russian subjects, achieving 111.95% of the planned target (9178 persons). Revaccination

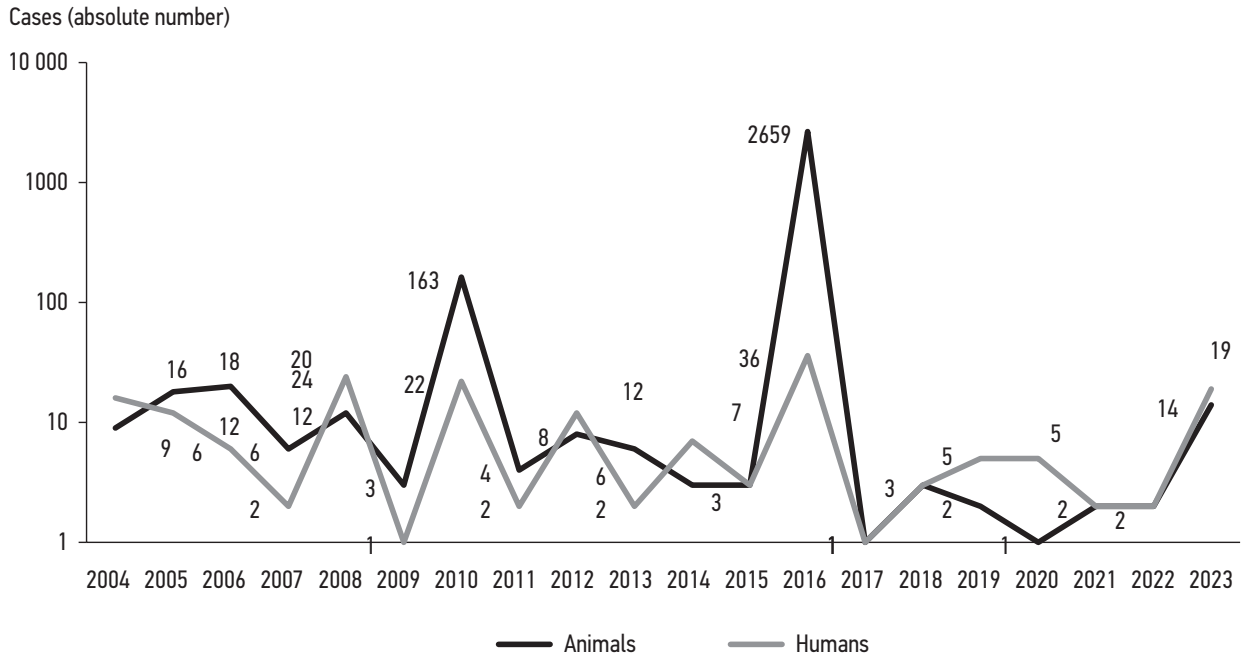

Fig. 1. Anthrax incidence trends in animals and humans in Russia, 2004–2023.

was conducted in 69 subjects, immunizing 32,696 individuals (32,571 adults and 125 children). The revaccination plan was fulfilled by 94.03% [14].

According to the Ministry of Agriculture, the epidemiological situation of anthrax in the agricultural animal population in Russia in 2023 was deemed unfavorable. The changes in this unfavorable situation since 2004 are shown in Fig. 2 [8].

Currently, there is a need to identify previously unaccounted and "lost" burial sites. The application of computer technologies and modern engineering systems, such as GIS, allows highly accurate mapping for the detection of unknown and "lost" anthrax hazardous sites.

We propose to examine this situation using modern technologies based on the example of the Astrakhan Region and neighboring areas.

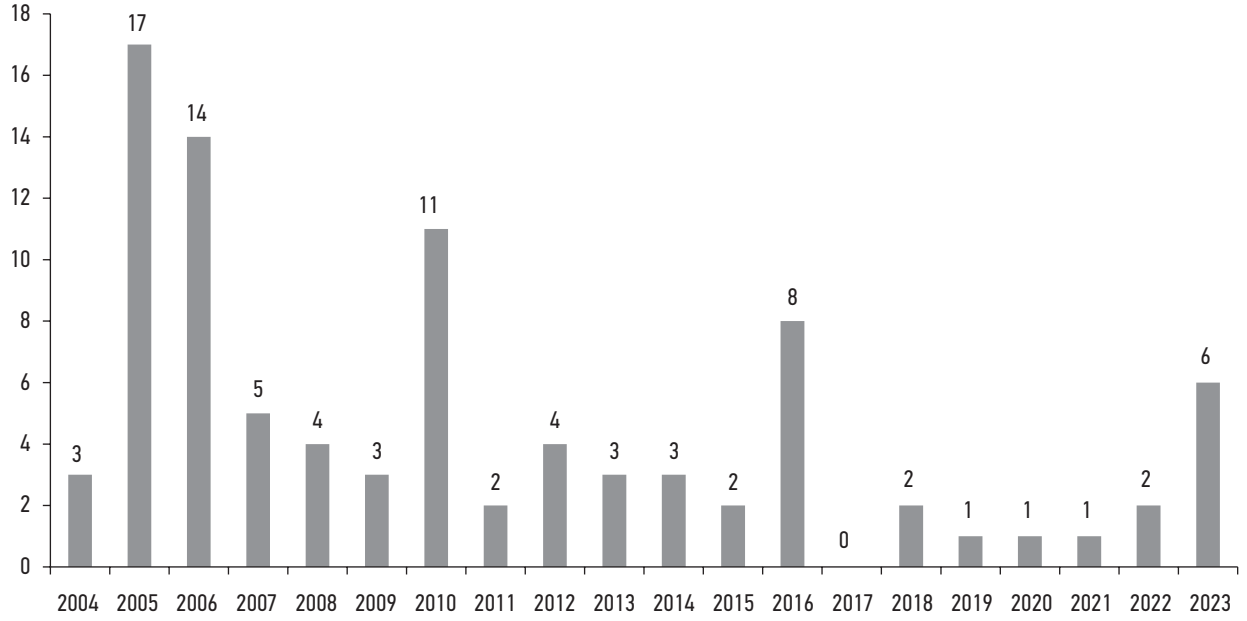

Fig. 2. Anthrax incidence trends in Russia, 2004–2023.

ANTHRAX SITUATION IN THE SOUTHERN REGIONS OF THE RUSSIAN FEDERATION WITH THE USE OF GEOGRAPHIC INFORMATION TECHNOLOGIES

Anthrax Situation in the North Caucasian and Southern Federal Districts

The southern part of Russia (SFD and NCFD) has traditionally been characterized by high anthrax incidence in both livestock and humans. This is due to intensive livestock farming and a combination of soil and climatic conditions favorable for the persistence of the etiological agent of anthrax in the environment. Since 2016, a set of measures has been implemented in these federal districts, as well as across Russia, to improve the anthrax situation. The collected data have been analyzed, including through the use of GIS technologies, and used to update the electronic databases of AALs (Table 1) [15].

The SFD and NCFD account for 3.61% of the total area of Russia, yet concentrate 12% of all AALs. In the SFD, over 80% of AALs are located in Krasnodar, Rostov, and Volgograd Regions. According to Rospotrebnadzor, over 900 unregistered "murrain fields" have been identified in Volgograd Region alone. High AAL density and proportional distribution are notable. In the neighboring NCFD, the Republic of Dagestan, Stavropol Territory, and the Chechen Republic (81% of AALs) are the most problematic ones. In total, 3845 AALs and 350 ABSs have been recorded [15].

Between 2004 and 2023, 81 human cases of anthrax and 210 cases in farm animals were reported (Fig. 3). The main source of infection for humans was unvaccinated cattle, as well as small ruminants and pigs. Epidemiological investigations revealed that all infections were associated with violations of basic sanitary standards and inadequate oversight by regulatory authorities. Human contact with infected animals (either through animal care or processing of animal products) resulted in contact transmission of the causative agent. All reported patients had the cutaneous form of anthrax. Secondary sepsis and anthrax meningitis led

Table 1. Data on anthrax-affected locations in Southern Russia

Territory	Total number	Number per 1000 km²	Proportion, %	Periods of activity, years	Total duration of activity, years
Southern Federal District					
RR	797	7.89	34.71	1803–2014	113
VR	727	6.44	48.66	1900–2016	76
KT	555	7.35	31.44	1923–2011	65
RK	211	7.82	19.81	1922–1995	53
AR	125	2.55	28.80	1934–2008	43
RK	99	1.32	37.22	1956–2011	46
RA	75	9.63	32.19	1947–1998	37
SFD	2589	6.14	33.26	–	–
North Caucasian Federal District					
RD	516	10.26	31.64	1882–2022	81
ST	361	5.46	47.56	1879–2022	89
CR	142	8.78	39.01	1939–2010	62
RSO–A	89	11.14	40.45	1878–2009	74
KBR	81	6.50	45.0	1946–1999	47
KChR	46	3.22	31.08	1923–1999	45
RI	21	6.72	17.21	1956–2005	33
NCFD	1256	7.44	35.99	–	–
Total	3845	6.79	34.63	1803–2023	–

Note. RR, Rostov Region; VR, Volgograd Region; KT, Krasnodar Territory; RK, Republic of Kalmykia; AR, Astrakhan Region; RA, Republic of Adygea; SFD, Southern Federal District; RD, Republic of Dagestan; ST, Stavropol Territory; CR, Chechen Republic; RSO–A, Republic of North Ossetia–Alania; KBR, Kabardino-Balkar Republic; KChR, Karachay-Cherkess Republic; RI, Republic of Ingushetia; NCFD, North Caucasian Federal District.

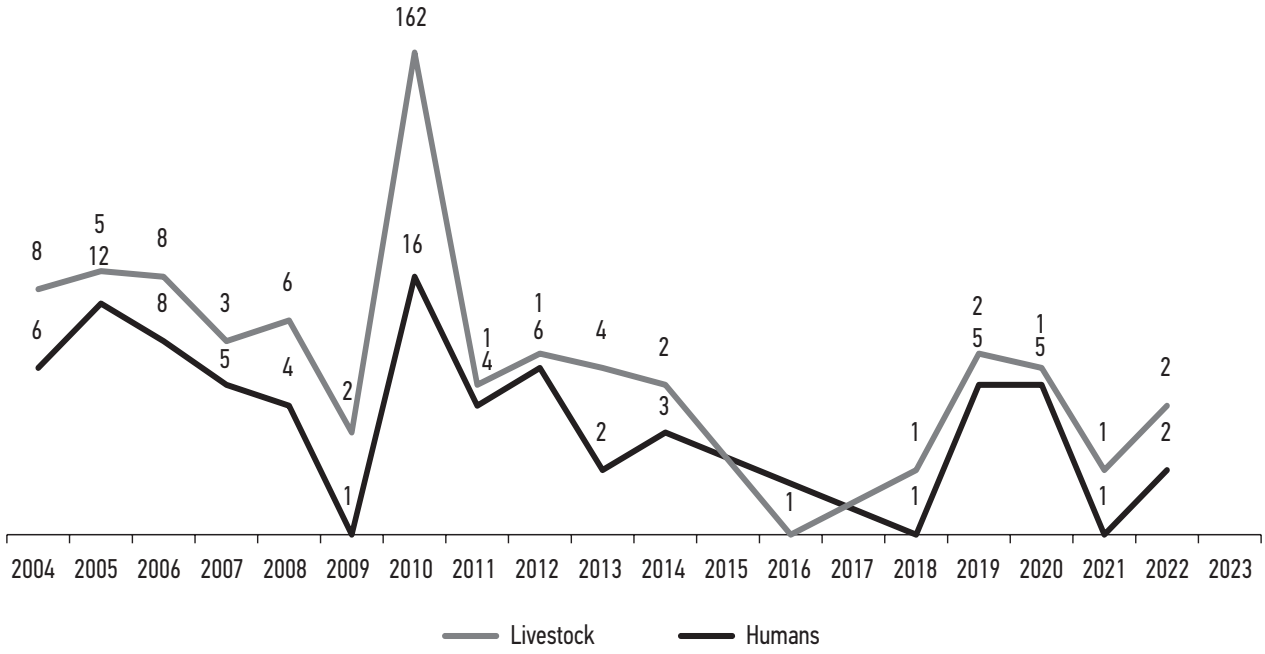

Fig. 3. Anthrax incidence trends in humans and livestock in Southern Russia, 2004–2023.

to 4 fatal outcomes (Republic of North Ossetia–Alania: 2 cases in 2006 and 1 in 2007; Republic of Kalmykia: 1 case in 2004), representing 50% of all anthrax-related deaths [15].

Analysis of anthrax outbreaks revealed that in several cases, no link could be established between the infection and AALs or ABSs registered in official databases. This suggests the existence of previously unidentified areas where livestock were infected, highlighting the need for their identification.

Anthrax Situation in the Astrakhan Region

Currently known AALs are predominantly located in the interfluve of the Volga and Akhtuba rivers and adjacent areas. The climate, landscape, and soil characteristics promote prolonged persistence of anthrax spores.

In recent decades, efforts have been made to develop electronic databases using ArcGIS 10 technology to determine the geographic coordinates of both existing and newly identified AALs. Based on these data, reference materials have been compiled to provide an overview of general features and to clarify the locations of hazardous sites.

According to available information, the majority of the 125 AALs (up to 60%) originated in the 1940s, primarily in the northern districts of the Astrakhan Region (Chernoyarsky, Akhtubinsky) and in areas adjacent to the delta (Volodarsky, Kamyzyaksky). To date, of the 166 known ABSs, only 15 have been reliably verified and investigated, all of which failed to meet basic sanitary requirements. The lack of data on the remaining sites remains a concern due to the potential risk of infection for both humans and livestock. The most "well-known" ABSs include: Petropavlovka village of Narimanovsky District, Seitovka village of Krasnoyarsky District, Dianovka village of Volodarsky District (1993 outbreak: 1 case in cattle, 1 human case), and Ushakovka village of Chernoyarsky District (2008 outbreak: 4 human cases).

No human cases of anthrax have been reported in the region over the past 15 years. The last confirmed outbreak occurred in 2008 in the Ushakovka village, where a new ABS was identified. Four individuals became infected following the forced slaughter of small ruminants (a goat and four sheep) without veterinary oversight. The meat was partially distributed to other regions (Kaluga Region). Manifestation of the cutaneous form of anthrax developed on day 10 in individuals who had traveled to visit friends or relatives in the Volgograd Region. Treatment was provided at Regional Infectious Diseases Hospital No. 1. Two additional individuals were managed in the infectious diseases ward of the Chernoyarsk Central District Hospital. In total, 34 people were examined as contacts, and over 500 head of livestock were vaccinated.

Currently, five districts are classified as anthrax-endemic: Chernoyarsky, Volodarsky, Akhtubinsky, Kamyzyaksky, and Yenotayevsky [16, 17].

Active vaccination of domestic and farm livestock, conducted since the mid-20th century, has significantly reduced the number of anthrax outbreaks. In 2023, vaccination coverage was as follows: 83.2% of cattle, 53.8% of small livestock, 41.1% of horses, 58.3% of camels, and 48% of pigs. As shown in Fig. 4, the relative proportion of vaccinated farm animals has remained stable from 2014 to 2023, despite scheduled slaughter and natural herd attrition. No cases of anthrax in animals were reported during this period [18].

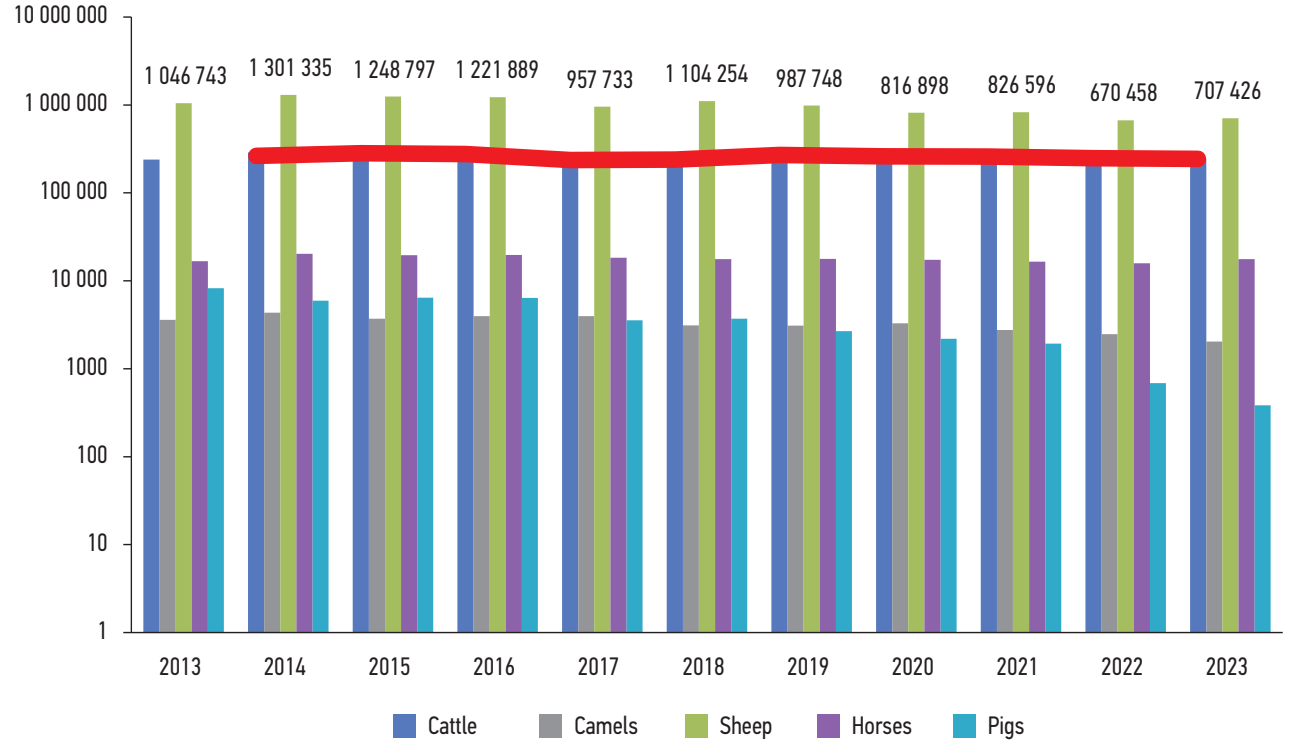

Fig. 4. Vaccination trends of livestock against anthrax in the Astrakhan Region, 2013–2024.

CONCLUSION

Anthrax remains a significant zoonosis in Russia, with near-ubiquitous distribution across the SFD, NCFD, and border areas.

The epizootic and epidemiological situation of anthrax in southern Russia continues to be unstable, characterized by periodic manifestations ranging from sporadic cases to large-scale epizootics and group outbreaks in humans.

Within the Astrakhan Region, four districts exhibit elevated to high anthrax risk levels, with the highest risk observed in the Chernoyarsky District.

The presence of a substantial number of soil reservoirs, primarily old and unregistered ABSs, contributes to the unfavorable situation amid incomplete implementation of preventive measures and violations of veterinary-sanitary regulations.

Stabilization of the anthrax situation in the region can only be achieved through consistent execution of a comprehensive prevention program and the implementation of anti-epidemic measures via interagency collaboration.

Identification of anthrax-affected locations requires the application of advanced search methods and geographic referencing using GIS technologies combined with statistical analysis of collected data. This approach will enable refinement of registry data and facilitate comprehensive assessment and dynamic monitoring of potential risk factors.

ADDITIONAL INFORMATION

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