

ARIZONA ROCKY MOUNTAIN SPOTTED FEVER HANDBOOK



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Prepared by Arizona Department of Health Services in collaboration with Arizona Indian Tribes, Indian Health Service and the Inter Tribal Council of Arizona, Inc.

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Objectives

Rocky Mountain spotted fever (RMSF) is an emerging public health threat in Arizona. The objectives of this handbook are to provide an epidemiological and historical background of RMSF in Arizona, present a sustainable framework for human case surveillance, and outline response strategies to minimize the disease threat. This handbook represents a compilation of RMSF best practices and recommendations that each tribal and local public health entity can utilize to develop their own protocols specific to their jurisdiction. Through this document, ADHS hopes to facilitate communication and collaboration between partners and stakeholders against RMSF in Arizona.

This handbook is divided into sections including epidemiology, history of RMSF in Arizona, clinical diagnosis and treatment, case investigations, outbreak response, and future projections. The sections of the handbook are designed to provide an understanding of the past and present burden of RMSF in Arizona and mechanisms by which the burden can be reduced. The surveillance and response activities outlined are to be carried out in collaboration with ADHS, IHS, tribal health departments, tribal programs and leadership, and local and other federal agencies. Additionally, this handbook may be utilized by the tribes as a planning document in the case of a RMSF outbreak and for federal funding advocacy for Arizona RMSF prevention and control.

Materials referred to in the text will be presented at the end of the document in the Appendix.

ABBREVIATION	DEFINITION
ADHS	Arizona Department of Health Services
ASPHL	Arizona State Public Health Laboratory
CDC	Centers for Disease Control and Prevention
IHS	Indian Health Service
ITCA	Inter Tribal Council of Arizona, Inc.
RMSF	Rocky Mountain spotted fever
MEDSIS	Medical Electronic Disease Surveillance Intelligence System

Epidemiology

BACKGROUND

Rocky Mountain spotted fever (RMSF) is a severe tick-borne rickettsial illness in the United States (1). RMSF is caused by *Rickettsia rickettsii*, is an intracellular bacterium and a member of the spotted fever group *Rickettsia* (SFGR). RMSF was first reported in the late 1890's and is endemic to North, Central and South America. The disease is potentially fatal, but can be treated effectively with doxycycline.

Human cases of RMSF have been described as early as the 1890's, with the disease being a nationally reportable disease in the United States since the 1940's. Cases reported in other parts of the United States occur most commonly from May to August, with the peak activity occurring in June and July. The highest incidence rate is observed in individuals 55 to 64 years of age. According to CDC, five states (North Carolina, Oklahoma, Arkansas, Tennessee, and Missouri) account for over 60% of RMSF cases, with the primary vector being the American dog tick (1).

VECTOR

RMSF is spread by the bite of an infected tick. The most common tick vectors for RMSF in the United States are the American dog tick (*Dermacentor variabilis*) and Rocky Mountain wood tick (*Dermacentor andersoni*). These tick species are widely distributed throughout the eastern and northwestern states, respectively.

In Arizona, the primary tick vector of RMSF is the brown dog tick (*Rhipicephalus sanguineus*), which is the most widely distributed tick in the United States. This tick was not known to carry *R. rickettsii* in the United States until 2003, when a locally-acquired case of RMSF was discovered in eastern Arizona. Environmental evaluations in the early 2000's revealed high burden of *R. sanguineus* in the peridomestic setting (in and around human dwellings). *R. rickettsii* was isolated and cultured from ticks collected in peridomestic settings (3, 8, 12).

Ticks require appropriate humidity, temperature, available hosts, and hiding locations for molting and egg laying for survival. Brown dog ticks thrive in hot climates, but are vulnerable to colder temperatures. They are a three-host tick, and primarily feed on dogs in all life stages. Humans and other species are considered incidental hosts. The brown dog tick can live indoors if there are dogs to feed on, and can hide in walls, carpets, cracks and crevices. Outdoors, these ticks are excellent at hiding under old boards, along the sides of houses, under porches, in wood piles, under trash piles, and in old mattresses and couches.

The life cycle of the brown dog tick can occur in as little as two months. One female tick can lay thousands of eggs. Interestingly, vertical or transovarial transmission is possible, meaning that a female *R. sanguineus* tick infected with *R. rickettsii* can lay infected eggs. Immature infected ticks can contribute to disease transmission, and in addition can be very difficult to spot (even if attached) because of their small size. The life cycle (see Figure 1) of the brown dog tick includes four stages: egg, larvae or "seed tick", nymph, and adult. Differences in size and color occur between each life stage. The cycle starts when a fully engorged adult female tick finds a sheltered place to lay her eggs. Eggs usually hatch within 1 to 4 weeks. The newly hatched larvae or "seed ticks", are light in color, have six legs, and are about the size of a pinhead. After feeding, the larva detaches, hides, and molts to the nymph stage

within several weeks. Nymphs and adults are brown and have eight legs. Immature brown dog ticks can survive for many months without feeding, and adults can survive more than a year. Nymphs feed and molt to become adults; the adult females can feed until up to 12mm in size and turn from brown to gray or olive. If dog or human hosts are readily available, the brown dog tick's entire life cycle can take place within 2-4 months. However, the tick spends more than 90% of its life cycle off-host, making both environmental and animal control strategies very important.

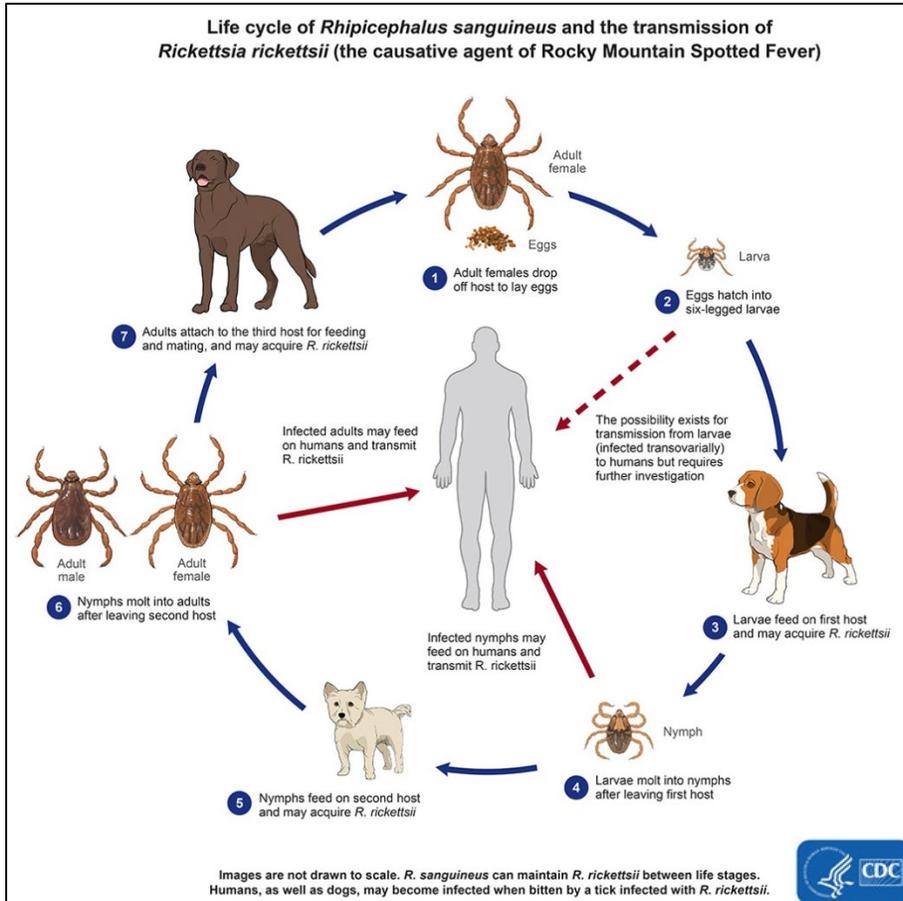


Figure 1: Life cycle of the brown dog tick (*Rhipicephalus sanguineus*)

The Role of Dogs in RMSF (4, 5, 11, 12, 13)

Dogs cannot directly spread RMSF, but they are the preferred host for brown dog ticks that carry RMSF. Free-roaming dogs play an important role in spreading ticks into nearby homes and yards. Although not scientifically documented, it is hypothesized that dogs that are spayed or neutered will be less likely to roam in search of a mate, and therefore, might be less likely to spread infected ticks around the community. Additionally, young puppies may be more subject to infection with *R. rickettsii* since they likely have had no previous exposure to RMSF and are considered to be immunologically naïve.

Dogs are also affected by RMSF and can develop a similar illness as humans. Recovered dogs are thought to be immune to reinfection with RMSF and have elevated antibodies (IgG) that can persist for months to years. The seropositivity of dogs for RMSF can serve as a warning system for RMSF emergence in new areas, as dogs are more likely to be infected before human cases occur. As a general guideline, in communities where canine seropositivity is $\leq 10\%$, reports of human cases are unlikely and risk of RMSF emergence is low.

However, in areas with canine seropositivity of $\geq 50\%$, human cases are often observed. The threshold for human cases is somewhere in between 10-50%, meaning that the risk of human cases is moderate. Knowledge of RMSF seroprevalence in dogs allows for a classification of areas into risk levels, which is vital for the development and implementation of public health prevention measures.

History of RMSF in Arizona

Figure 2 below represents a timeline of RMSF emergence and activities on Arizona tribal lands. The first locally-acquired case of RMSF in Arizona was identified in 2003 in an Arizona resident with no travel history, who resided in a tribal community (Reservation #1) in the eastern part of the state. In 2004-2005, Reservation #2, which shares a large border with Reservation #1, also identified a human RMSF case. Increasing numbers of RMSF cases continued to be reported from these two reservations each year, and response efforts were initiated by the tribal governments in coordination with other partners.

During 2009-2012, four other Arizona reservations reported their first human cases of RMSF. Concurrently, the epidemic of RMSF on Reservations #1 and #2 was growing.

- 2009: Reservation #3, south-central Arizona;
- 2011: Reservation #4, southern Arizona;
- 2012: Reservation #5 and Reservation #6, both located in northern Arizona.

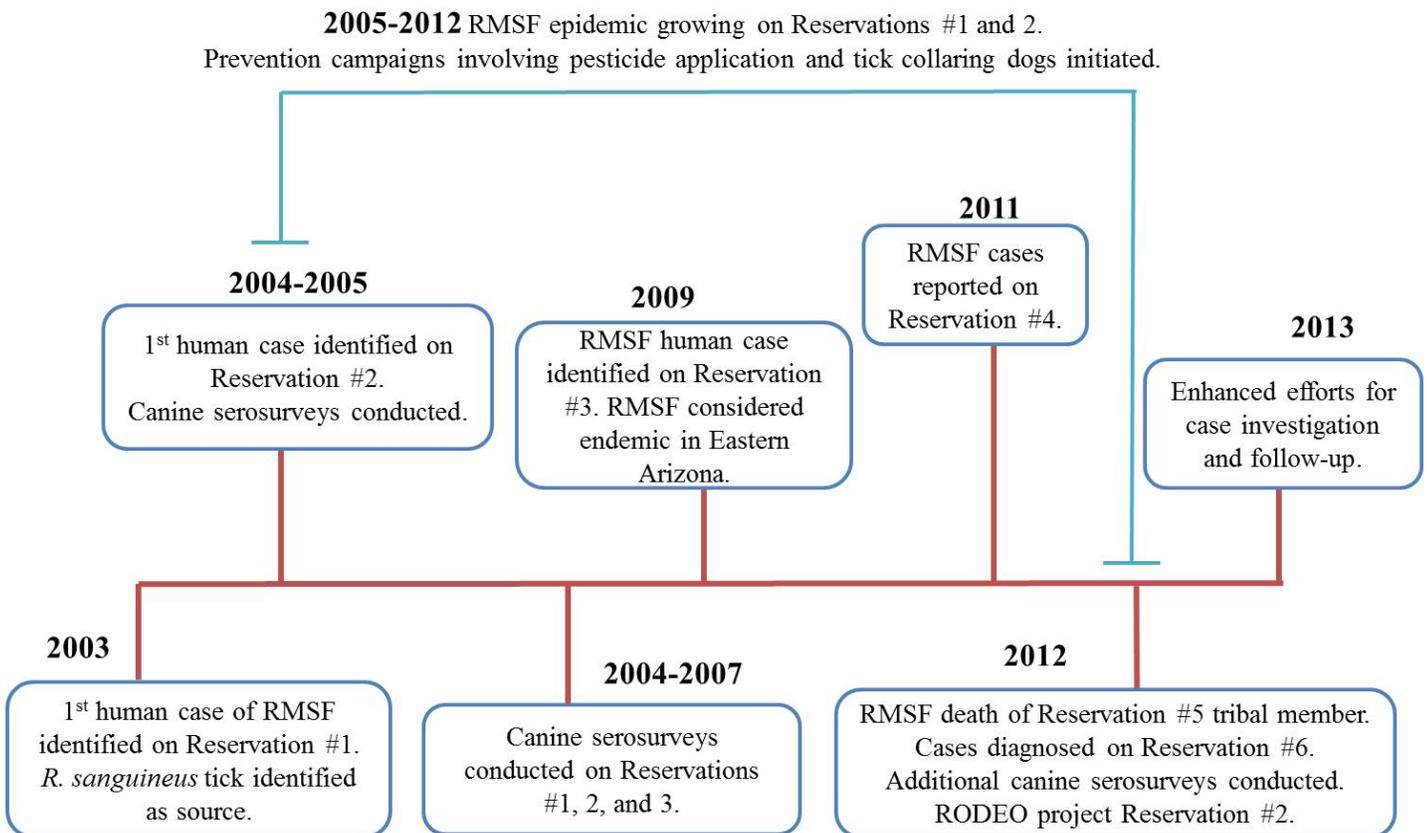


Figure 2: Timeline of RMSF emergence and activities on Arizona tribal lands

During 2004–2012, canine serosurveys were conducted on each of the affected reservations to predict the human risk level for RMSF (5, 11, 12). However, these are generalized risk categories and should be determined based on multiple indicators (e.g. dog seropositivity, human cases, and tick levels). Page 4 (“Role of dogs”) discusses the relationship between canine seropositivity and human risk. The six affected reservations (Figure 3) are considered to be RMSF-endemic regions in Arizona, and have been classified into low, moderate, or high risk areas. Figure 4 illustrates risk categories, which are based on investigations done in Arizona and are not validated elsewhere. As mentioned above, the risk categories are determined based on many factors, including canine serosurveys, presence of free-roaming dogs (around individual homes or around the community as a whole), and observed presence of ticks in yards, homes, and on dogs.

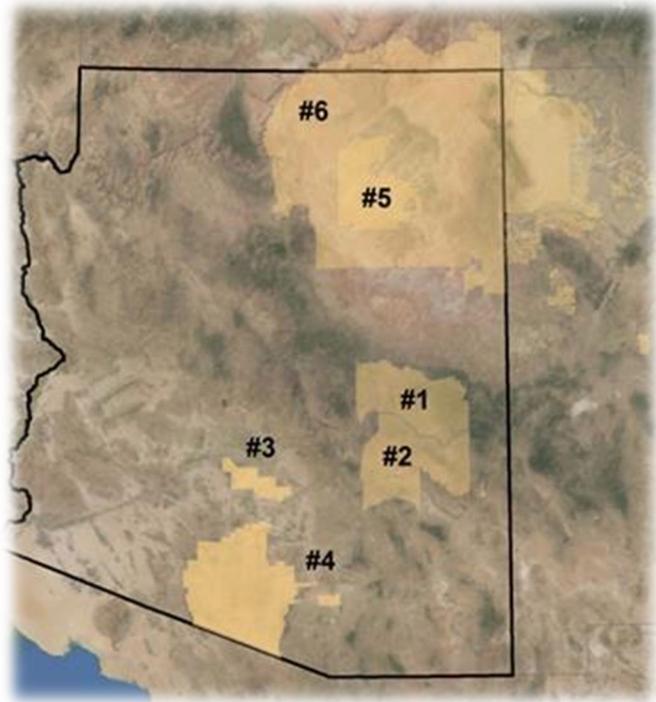


Figure 3: Map of six reservations Arizona implicated by RMSF

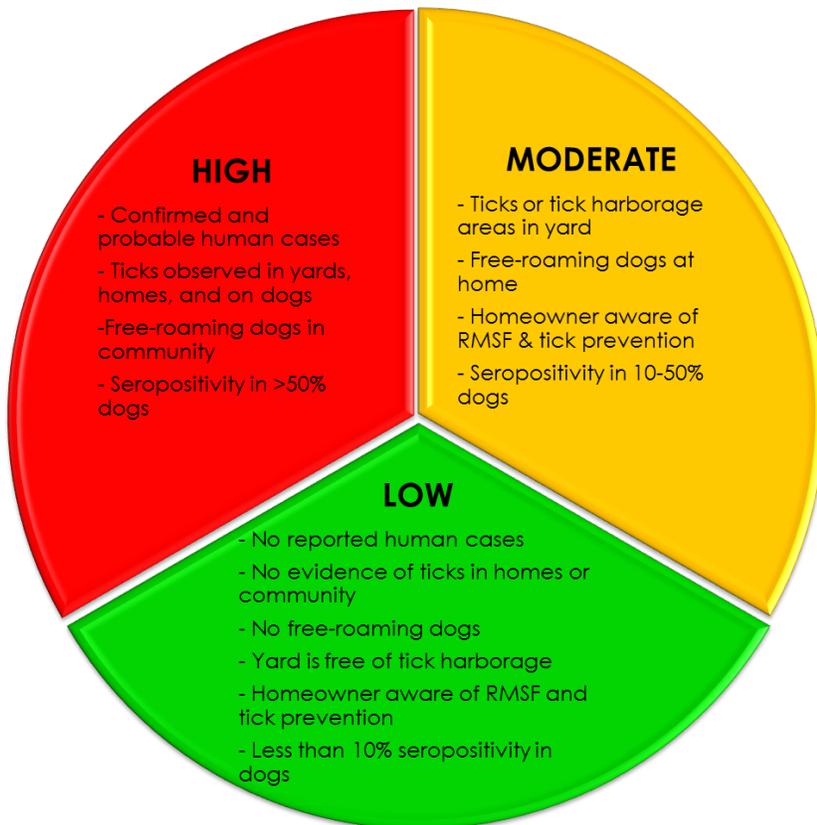


Figure 4: Human risk categories for RMSF endemic areas

CHARACTERISTICS OF RMSF IN AZ vs. U.S.

Although RMSF is widespread throughout the United States, several epidemiological and ecological features make RMSF unique in Arizona. Table 1 summarizes the key features of RMSF in Arizona in comparison with RMSF in other parts of the United States. This section will describe those differences in detail.

Table 1: Differences in RMSF Epidemiology, Arizona vs. United States (1, 3, 12)

	Arizona	United States
High volume of free-roaming dogs	Present	Absent
Tick vector	Brown dog tick	American dog tick Rocky mountain wood tick
Seasonality	Two peaks (May & August)	One peak (June/July)
Area Acquired	Near the home	Forest/wood settings
Age Distribution	Younger (<18 years)	Older (55-65+ years)
Case Fatality Rate	7%	<1%

FREE-ROAMING DOGS

The emergence, rapid spread, and continual circulation of RMSF on Arizona reservations can be associated with the high volume of free-roaming dogs. According to community-wide surveys, approximately 70-85% of the dog populations on reservations are free-roaming. As mentioned previously, dogs serve as the primary host for the brown dog tick and can spread ticks over a wider geographic area. Canine serosurveys conducted in 2005 and 2006 found that reservation dogs had a greater seroprevalence for RMSF than dogs living off reservations (4, 5, 11, 12, 13).

Free-roaming dogs can be defined as unrestrained dogs that are fed or harbored at home(s) in the community. There is often a lack of veterinary care and tick preventive for free-roaming dogs, leading to heavy tick infestations. These ticks can then be spread across communities as the dogs roam to different areas. The presence of high numbers of free-roaming dogs is a key factor influencing the epidemiology of RMSF and must be considered when developing RMSF prevention strategies.

NEW TICK VECTOR

The key feature that changes the epidemiology of RMSF in Arizona is the tick vector. After the first human case of RMSF was identified, an investigation led to the discovery of *Rickettsia rickettsii* in *R. sanguineus* ticks, both in the environment and on free-roaming dogs on tribal lands. These findings provided evidence of a new tick vector for RMSF in the United States, and confirmation of the source of exposure for the human case. Brown dog ticks are a peridomestic and hardy species, which are able to thrive in the dry Arizona environment.

SEASONALITY

Throughout the United States, tick-borne diseases correspond with the peak of tick activity. Peak activity for RMSF across the United States is usually around July. However, in Arizona, there are two peaks for RMSF activity — May and August. The two peaks for RMSF activity can be attributed to two rainy seasons in Arizona, which enables *R. sanguineus* ticks to complete

two full life cycles. These two peaks are generally observed on Reservation #1 and #2, though tick activity and transmission is year-round on most reservations. The risk of exposure to RMSF may be greatest during the periods with the most abundant tick populations, but the risk exists year-round as evidenced by identifying human cases every month of the calendar. Knowledge of RMSF seasonality allows for more targeted and effective environmental prevention approaches.

PRESENCE ON TRIBAL LANDS

To date, RMSF cases in Arizona have been identified exclusively on tribal lands. Human cases of RMSF were originally identified on only one reservation in 2003, but activity has since spread to 5 other reservations. Epidemiological investigations and case interviews also led to the discovery that RMSF was acquired most commonly around the home (peridomestically). As such, clusters of cases were often associated with a single community. In the rest of the United States, due to the differences in primary vectors, RMSF is not acquired near the homes, but commonly in forest or wooded areas. While RMSF has only been identified on tribal lands to date, given its continued geographic expansion in Arizona, it is very possible and maybe even likely to spread to non-tribal areas.

INCIDENCE RATE AND AGE DISTRIBUTION

In 2010-2011 the incidence rate of RMSF in Arizona was >200 times (1, 7) that of the national RMSF incidence rate among the affected populations. Some of the aforementioned features (e.g. free-roaming dogs, tick vector and peridomestic acquisition) may allow for a greater incidence rate in Arizona than in other areas of the U.S. Additionally, the incidence of RMSF in younger populations (<1–19 years) is significantly (1, 3, 7, 14, 15) higher in Arizona than in other parts of the U.S. In Arizona, ~45% of cases diagnosed are in children <20 years old (14, 15). In other parts of the United States, 45% of cases are diagnosed among adults 50 years and older. This is likely a result of the Arizona tick vector's association with dogs; because children are more likely to be exposed to ticks while outside playing with dogs, or playing near areas where dogs rest. Children might be less likely to notice a tick bite until the tick is attached and engorged with blood, although adults also frequently do not recall the tick bite. Children might also be at higher risk for fulminant disease or death because of physicians' hesitance to prescribe doxycycline as a result of its association with dental staining. However, studies on Reservation #2 among 335 children (16) found no evidence of dental staining at the prescribed dosages for RMSF treatment. Doxycycline is the most effective treatment for suspected RMSF; use of other drugs are associated with higher likelihood of death. Doxycycline is the recommended treatment of suspected RMSF by CDC and the American Academy of Pediatrics.

CHAIN OF PREVENTION

An array of prevention efforts has occurred throughout the decade since the initial emergence of RMSF in Arizona. These include the establishment of animal control programs, tick control (dog collaring, tick habitat removal, and pesticide-application), and educational efforts towards health care professionals and community members. However, a lack of consistent and sustainable access to financial resources, animal control programs, veterinary services, public health infrastructure, and integrated pest management techniques has enabled the tick vector to flourish, and reports of suspected human cases have continued on affected reservations. These limitations, in addition to the hardiness of the *R. sanguineus* tick

and a large population of free-roaming dogs, have posed significant challenges to the control and eradication of RMSF.

Response efforts target the "RMSF Chain of Prevention". There are four parts to this chain: 1) understanding the epidemiology and ecology of the cycle between the tick vector and primary dog host, 2) initiating empiric treatment, early detection and investigations of suspected RMSF human cases, 3) continuing environmental actions, such as pesticide application, placing tick collars on dogs, and removing solid waste from homes, and 4) conducting RMSF education for the community and health care providers. These parts function to stop the chain of RMSF transmission and prevent deaths and overall RMSF cases. Figure 5 illustrates the chain of prevention and control response efforts.

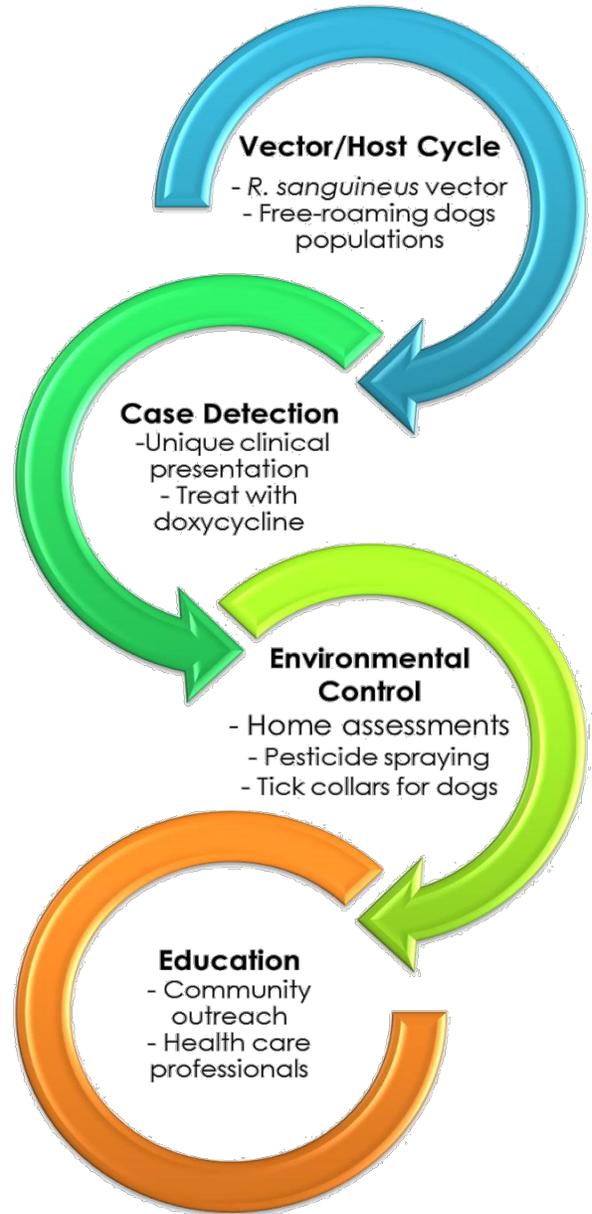


Figure 5: Chain of RMSF Prevention

Clinical Diagnosis & Treatment

Symptoms & Description of Illness

Signs and symptoms of RMSF usually occur 2-14 days after the bite of an infected tick. A tick bite is usually painless, and a person may not always remember being bitten; in Arizona, only 30% of cases reported a tick bite. RMSF usually presents with non-specific symptoms, (9, 10, 14, 15, 16) but can be a serious illness resulting in death within the first 8 days if not diagnosed and treated appropriately. Illness is often characterized by acute onset of fever, and may be accompanied by headache, malaise, muscle pain, nausea/vomiting, or neurologic signs. It is important to note that clinical characteristics of RMSF presents very differently in Arizona (14, 15), and many cases lack history of a fever. RMSF can therefore be challenging to diagnose because 1) the early symptoms are general, 2) the symptoms may resemble other illnesses, and 3) the presentation is extremely unique and diverse.

The majority of people with RMSF develop some type of rash during illness; however, the rash may not appear until 4-7 days following illness onset, several days after treatment should have already been started. Approximately 10% of RMSF cases do not develop a rash at all. The hallmark RMSF rash usually appears as small, flat, non-itchy, pink spots on the wrists, forearms, and ankles. This rash can then spread to the trunk of the body. About 35-60% of cases usually develop a red-purple spotted (petechial) rash around day 6 of illness. This type of rash often indicates advanced RMSF (1, 14, 15).

Laboratory findings indicative of RMSF include thrombocytopenia, anemia, leukopenia, and elevated liver enzymes. In the late stages of RMSF illness, a definitive rash usually develops, along with photophobia, confusion, ataxia, seizures, cough, dyspnea, arrhythmias, jaundice, and severe abdominal pain. This is due to the mechanism by which *Rickettsia rickettsii* attacks the cells that line the blood vessels. The damage to blood vessels can result in vasculitis, which can lead to bleeding or clotting in the brain or other vital organs. This damage can be life-threatening, and even recovered patients can suffer long-term health problems, such as amputations, hearing loss, and profound neurologic deficits (1, 14, 15).

Children with RMSF may experience nausea, vomiting, and loss of appetite. Compared to adults, children may be less likely to report a headache, but more likely to develop an early rash. Other frequently observed signs in children with RMSF are abdominal pain, altered mental status, and conjunctival infection. Occasionally, symptoms like cough, sore throat, and diarrhea may be seen and can lead to misdiagnosis. The most common differential diagnoses for RMSF, especially during initial presentation of symptoms, include viral illnesses, fever of undetermined cause, bacterial sepsis, upper or lower respiratory tract infections, or ear infections.

Diagnosis

RMSF should be suspected based on clinical signs and symptoms, and later confirmed using laboratory tests. Treatment should begin as soon as RMSF is suspected, as delay in administration of doxycycline can result in severe diagnosis and death. Treatment should **never** be delayed or withheld if laboratory results are pending or on the basis of an initial negative acute laboratory result. Review the clinical symptoms and the RMSF algorithm (Figure 6) to determine if a patient is a suspect RMSF case.

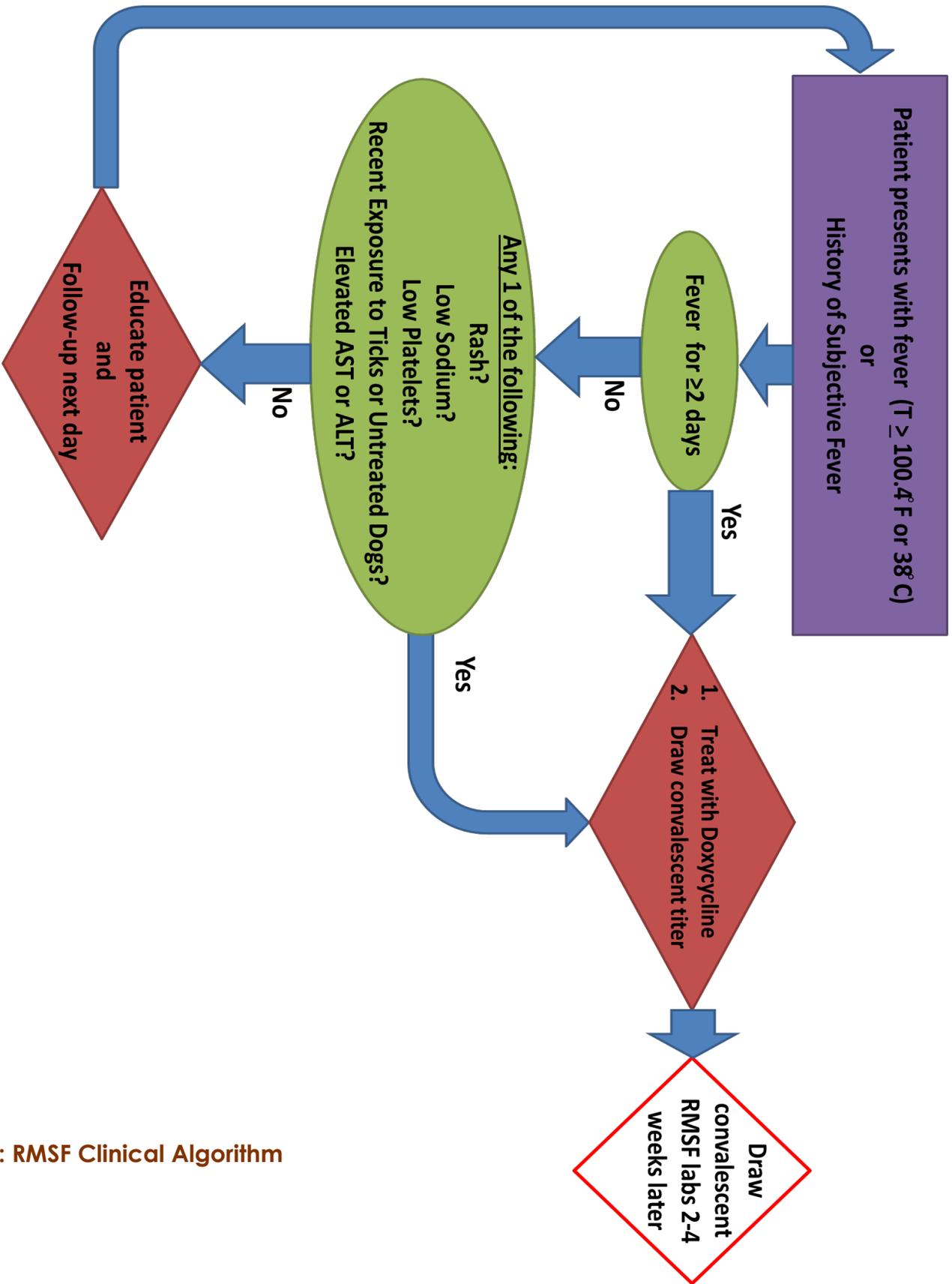


Figure 6: RMSF Clinical Algorithm

Treatment

Doxycycline is the first line treatment for adults and children, and should immediately be prescribed when RMSF is suspected. Chloramphenicol is considered an alternative when a contraindication to tetracyclines is present (e.g., allergy to doxycycline). In pregnancy, the possible adverse effects in the fetus from doxycycline use in the mother must be weighed against the potential fatal outcome of RMSF. The use of antibiotics other than doxycycline has been associated with a higher risk of fatality.

The standard treatment with doxycycline is 5-7 days with dosage as follows:

Adults: 100mg every 12 hours (i.e. twice a day)

Children < 45kg or 100 pounds: 2.2 mg/kg body weight every 12 hours (i.e. twice a day)

Treat for at least 3 days after the fever subsides and until evidence of clinical improvement.

Treatment is most effective if doxycycline is started within the first 5 days of symptoms (16). Treatment should be initiated as soon as a case is suspected. Never delay treatment to wait for lab results. If the patient is treated within the first five days of the illness fever generally subsides within 24-72 hours. In cases caught early, failure to respond to doxycycline suggests that the patient's condition might not be due to RMSF. In these circumstances consider a differential diagnosis. There have also been instances where cases die from RMSF without rickettsemia, because of the extensive vascular damage done before doxycycline administration. Resistance to doxycycline or relapses in symptoms after the completion of the recommended course of treatment has not been documented.

Some useful links for health care professionals include:

- <http://www.cdc.gov/rmsf/symptoms/index.html>
- <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5504a1.htm>
- <http://www.cdc.gov/rmsf/doxycycline/index.html>

RMSF Investigations

Algorithm

The RMSF clinical algorithm (see Figure 6, page 11) was developed to assist in identifying early cases and to avoid preventable deaths. The algorithm has been widely used to assist tribal health departments and physicians on tribal lands in the assessment of suspect cases. The algorithm was created to have broad criteria because of the non-specific presentation of RMSF cases. However, as robust environmental control, prevention, community education, and surveillance efforts continue, there may be a need for future discussions regarding less comprehensive use of the algorithm, specifically for low risk areas. Currently, many of the highly-affected tribal lands continue to use the algorithm to initiate clinical suspicion for RMSF and begin case investigations. It is important for clinicians to maintain a high level of suspicion for RMSF and low threshold for prescribing doxycycline for suspected cases.

Case Investigation Steps

RMSF is a nationally notifiable condition and suspect cases should be reported within 5 working days to the tribal or local health jurisdiction. For tribal lands, this could be a RMSF referral to a public health nurse from a doctor at the hospital. The Arizona Administrative Code (Title 9: Health Services) requires health care providers to report cases of RMSF to tribal health departments, local county public health or ADHS. [Communicable Disease Reporting Requirements](#) provides an overview of reporting requirements and may be a useful website to reference.

Tribal or local county public health agencies are responsible for conducting investigations into suspected RMSF cases. It is recommended that investigators use the rickettsial disease investigation form (Appendix 1), but similar questionnaires developed by local health departments can also be used.

The Arizona Department of Health Services uses an online database for reporting, investigating, and managing cases of communicable diseases such as RMSF. This system is called MEDSIS, which stands for Medical Electronic Disease Surveillance Intelligence System. MEDSIS is a secure, web-based, centralized, person-based disease surveillance system for Arizona. MEDSIS is a statewide system hosted and supported by ADHS for use by health care providers and institutions responsible for reporting communicable diseases, and for local health departments to conduct disease surveillance. MEDSIS allows cases to be reported in real-time and viewed by the respective local health department and ADHS.

The following steps for a RMSF investigation do not always have to be conducted in order, as long as important demographic, symptom, exposure, and laboratory information is collection.

- Consult with physician who reported the suspect case of RMSF. Gather information from the medical records or laboratory reports.
 - When did the symptoms start? What were the symptoms? Was an acute specimen drawn for RMSF? Was the patient hospitalized? Is there travel history? Is there tribal affiliation? Was doxycycline started?

- Contact the patient to query them about the above information that may be missing. Ask about risk factors, exposure history, dog ownership or contact, and any outdoor activities. Reinforce the need to stay on doxycycline for the entire course of treatment.
- Schedule a convalescent blood specimen draw 2-4 weeks after illness onset.
- RMSF is not transmitted person-to-person or by dogs, but if potential exposure to ticks occurred around the residence it is recommended to ask if others in the home have felt ill or have taken part in similar high-risk activities (e.g. played with dogs).
- Follow-up with the patient after the convalescent specimen is collected regarding completion of doxycycline course and that symptoms have resolved.
- Work with local animal control, environmental health, and veterinary clinic partners. Conduct home or community based environmental control strategies, including dog collaring and pesticide spraying if needed.
- Educate the patient and the community, with assistance from community health representatives, about tick prevention and how to keep their family and dogs safe.
- Review case investigation notes and complete reporting to ADHS using the online surveillance system. Close and classify case.

These are very general steps to investigating a suspected RMSF case, but it is essential that these steps are followed and MEDSIS is used as a tool to communicate case information to the state. Appendix 1 illustrates tips for RMSF case investigations that breaks the steps down into a flow chart and explains the key information needed for RMSF surveillance.

Case Classification

There are four case classifications available for RMSF in the state of Arizona: confirmed, probable, suspect, or not a case. Classification is determined based on clinical evidence and laboratory results. **Clinical evidence includes “any reported fever (subjective or measured) and one or more of the following: rash, eschar, headache, myalgia, anemia, thrombocytopenia, or any hepatic transaminase elevation”**. A history of a tick bite is not required.

In addition to symptoms and clinical information, cases are also classified based on laboratory diagnostics. When assessing laboratory criteria, serology is the best diagnostic option, and is most widely used for detecting antibodies against RMSF. Remember; always give doxycycline if RMSF is suspected!

To consider a case **confirmed** there needs to be laboratory evidence as follows:

- **Fourfold change in IgG** antibody titer reactive with *Rickettsia rickettsii* or other spotted fever group antigen by indirect immunofluorescence assay (**IFA**) between paired serum specimens (one taken in the **first two weeks** after illness onset and a second taken **two to ten weeks after acute specimen** collection); OR
 - Example: acute specimen is not detected (<1:64) and convalescent is 1:128
 - Note that A four-fold rise in titer should not be excluded (as confirmatory laboratory criteria) if the acute and convalescent specimens are collected within two weeks of one another.
- Detection of *R. rickettsii* or other spotted fever group DNA in a specimen by **PCR** assay, OR
- Demonstration of spotted fever group antigen in a biopsy or autopsy specimen by **IHC**, OR

- Isolation of *R. rickettsii* or other spotted fever group rickettsia from a clinical specimen in cell **culture**.

A note about PCR and IHC:

These testing methods are appropriate only for **cases of severe illness**, or from **post-mortem specimens** before doxycycline has been given.

- Biopsies of rash are appropriate when present, but again, rash may not be present until late in disease progression and should always be coupled with serology (negative PCR does not mean a non-case).
- PCR testing is currently only available at the Arizona State Public Health Lab (ASPHL) or at CDC, please contact ybzd@azdhs.gov for arranging testing.

To classify a case as **probable** there needs to be laboratory evidence as follows:

- Serologic evidence of elevated **IgG** antibody at a titer **≥1:128** reactive with spotted fever group *Rickettsiae* (SFGR) antigen by IFA in a sample taken within **60 days** of illness onset.
 - This includes paired serum specimens without evidence of fourfold rise in titer, but with at least one single titer $\geq 1:128$ in IgG-specific antibody titers reactive with SFGR antigen by IFA. The 60-day cut-off is especially important for probable cases with a single IgG titer to better capture real acute infection.

In summary, serology is the most common diagnostic tests for RMSF to look for increasing levels of RMSF-specific antibodies. This suggests recent infection. Early in any tick-borne rickettsial disease, most of the acute tests will be negative. It typically takes 7-10 days after the start of symptoms for the body to make enough antibodies to reach detectable levels.. Antibody levels may remain high for months following illness.

The above information explains in details the confirmatory and supportive laboratory criteria, **Table 2** below, more generally defines each case classification category.

Appendix 3 (page 38) displays these case classification as an **algorithm**.

Table 2: Case Definitions for RMSF (last updated Feb 2020).

CASE DEFINITION	DESCRIPTION
Confirmed	A person who meets the clinical description and has confirmatory laboratory evidence.
Probable	A person who meets the clinical description and has presumptive laboratory evidence.
Suspect	A person with confirmatory or presumptive laboratory evidence of infection with no clinical information available OR A person who meets the clinical description and has supportive laboratory evidence.
Not a case	A case with no clinical information and negative laboratory results.

Case Investigation Scenario

A. Clinical Course

A 5-year old child comes into a health care facility with high fever. The child has been sick for about two days. There does not seem to be a rash present or any severe body or muscle pain. The child sometimes plays outside with dogs, but the family cannot recall a tick bite. The child lives on tribal lands affected by Rocky Mountain spotted fever.

Due to fever and potential tick exposure, a blood specimen is drawn to test for acute titers to RMSF. Doxycycline is prescribed. Other labs (blood cell count and chemistry panel) are drawn as well. Other symptoms that may have developed and general lab results come back to the health care facility and are entered into the patient's medical record. The child is sent home with doxycycline and soon feels better. When the test results come back from the first test, the result is negative (usually written as "not detected").

B. Public Health Investigation & Environmental Health Assessment

- Public health nursing sets up an appointment in 2-4 weeks for the child to come back for a convalescent blood draw to detect RMSF titers.
 - Convalescent titer reminder should be utilized (figure 7 below)
 - May also need to remind patient about convalescent titer via phone or patient's preferred method
- Public health nursing conducts a case investigation and reviews the child's symptoms, potential exposures, general laboratory results, and differentials.
 - This involves collecting demographic information about the patient, determining when they started to feel sick and their symptoms, and recent activities leading to possible tick exposure.
 - Medical records should also be requested from the health care facility.
 - If the case fits the RMSF algorithm, public health nursing opens a case in MEDSIS (Medical Electronic Disease Surveillance Intelligence System).
 - Be sure to check for a pre-existing case to avoid duplication.
 - Cases need to be reported to the state within 5 working days from the time RMSF is suspected.
- Public health nursing consults with environmental health, including I.H.S. officers assigned to that region. Environmental health conducts a home assessment including presence of free-roaming dogs, tick load, and identification of potential tick habitats. Environmental health coordinates with tribal environmental health, animal control, and community health representatives to apply pesticides, collar dogs, and educate homeowners. I.H.S. is able to access patient medical records and enter notes on home assessment and actions taken.
- In MEDSIS, public health nursing completes the DSO (disease specific observations) with symptom information and date of illness onset. Medical records and laboratory results are attached to the record for ADHS' RMSF Epidemiologist to review. Additional information, as needed, is entered in the case as a note.
- Public health nursing follows-up with the case for the convalescent RMSF titer that was scheduled.
- The newly collected convalescent specimen and the acute specimen are sent to the state public health laboratory for paired sera testing.

- Paired testing determines if it was a true positive case or true negative case.
- Public health nursing updates the investigation status, classifies the case, and submits to ADHS in MEDSIS.
- ADHS's RMSF Epidemiologist reviews the case, and with symptom information and results from acute and convalescent sera, classifies and reviews the case.
- Cases are reported to the CDC.
- If larger scale, community-wide environmental health action and RMSF prevention is needed, assistance from ADHS, CDC, and ITCA can be requested from the tribe and I.H.S. (e.g. RMSF Prevention Campaigns).



Figure 7: RMSF convalescent specimen reminder card

C. Discussion

Follow-up for RMSF cases takes time and persistence. However, resources for case investigations are often limited, and it can be challenging to convince patients to return to the health care facility for a convalescent blood draw. In the short-term, this may seem like pressure is being placed on public health nursing resources. However, in the long-term, thorough case management and investigation is much more sustainable. It also results in a more complete picture of RMSF in Arizona.

For assistance in case investigation, please contact Hayley Yaglom at Hayley.Yaglom@azdhs.gov or 602-542-2521. For assistance with MEDSIS training, please contact the MEDSIS helpdesk at medsishelpdesk@siren.az.gov.

D. Importance of Case Investigations

- Without a case investigation and a convalescent specimen, public health, the health care facility, and the patient, never know if the illness was due to RMSF. Laboratory diagnostics can help determine if cases are true cases OR if they are not cases.
- Potential RMSF cases could be missed, which influences surveillance and the assessment of disease burden and needed resources. As a direct result of the lack of confirmatory clinical and laboratory information, ADHS's yearly statistics may underestimate the true picture of RMSF in Arizona.

- Tribes, counties, the State, and the CDC are unable to report whether the enhanced education and prevention for RMSF has made a difference in reducing case numbers.

E. Summary

Remember, that all case investigation information needs to be relayed to ADHS through MEDSIS and to utilize Appendix 2 for guidance. ALL suspect patients need to be contacted for symptoms, possible exposures, and to return for a convalescent blood specimen. A single acute titer is NEVER enough to confirm a true RMSF case. Furthermore, acute titers are almost always negative. The acute specimen is only important to act as a comparison to the convalescent specimen. When no convalescent specimen is collected the case cannot be confirmed. Often, for this reason, there are a large number of cases that must be left classified as probable or suspect. This is a large surveillance barrier for RMSF in Arizona. Public health can only utilize the information that meets the specified public health surveillance definitions. Generating more accurate case counts for RMSF in Arizona is advantageous for all jurisdictions by demonstrating the true burden of RMSF cases in Arizona and allowing for the more appropriate allocation of resources.

RMSF Response

The following section addresses five key aspects necessary for an effective RMSF response effort. The information included represents both currently implemented strategies, as well as suggestions for further measures. The five key components are:

- 1) Environmental Control & Surveillance
 - Development of programs for tick surveillance, risk assessment, and vector control
- 2) Animal Control & Veterinary Programs
 - Development of comprehensive animal control and wellness programs
- 3) Health Care
 - Addresses communication chain for suspect RMSF cases, clinical education, and transfer protocol.
- 4) Community Outreach & Education
 - Development of a community outreach program and standardized educational materials and messaging for RMSF prevention and control
- 5) Budget & Financing
 - Development of budget to support comprehensive RMSF control programs

Environmental Surveillance and Control

Overview

The life cycle, host preference, and behavioral patterns of the brown dog tick discussed earlier in this handbook provide the building blocks for RMSF environmental surveillance and control activities. Targeted environmental activities may include tick surveillance and control both in and around the home and on dogs. Strategies may differ slightly depending on the incidence and risk level of a particular location.

Pet owner responsibility is essential to ensure dogs are kept tick-free. Lack of tick control could be due to the cost of tick treatment, inability to catch the dog, the belief that tick treatment is not important, or lack of timely, consistent tick treatment. If possible, it is ideal to have a program in place to provide regular control of ticks on dogs and overall vector control in and around homes. Tick control services might include providing acaricidal products for free or at low-cost by going house-to-house, or by providing veterinary treatment at pet clinic events (e.g. rabies or spay/neuter clinics). Several topical treatments, oral medications, and tick collars are effective for controlling ticks on dogs. It is also important to reduce the populations of free-roaming dogs within communities by maintaining an active spay/neuter program and encouraging owners to fence-in owned dogs or use tethering lines.

Services at the home level should include outdoor and indoor tick control in households with large tick infestations. Remember, tick control is a community-wide issue deserving a community-wide response. Removing debris and solid waste is also key to tick control, as the presence of these materials can create a habitat that supports tick survival around the home. If resources are available, assistance programs to help homeowners remove debris and waste (especially large item pick up, such as couches and mattresses) can be successful at minimizing this as a risk factor.

Household Risk Assessment

Assessing environmental risk factors for RMSF is essential to determining and implementing appropriate and effective tick control measures. Three main areas are used to assess household risk: **human factors** (e.g. knowledge and awareness of RMSF), **dog factors** (e.g. observe dogs for ticks, including free roaming dogs), and the **living environment** (e.g. assess home and surroundings for tick harborage). A standardized questionnaire is available to capture this information. These factors also contribute to overall RMSF risk assessment for the affected tribal lands, as seen in Figure 4.

Surveillance Strategies

A. Canine Tick Load Assessment

Canine tick load can be one indicator of community-wide or area-specific tick issues. Assessment of canine tick load (figure 8) can often provide an estimation of the baseline tick burden for a community, and can serve as a monitoring tool and evaluation measure to determine the effectiveness of tick control activities. However, tick load specific to one area may have should be extrapolated with caution.

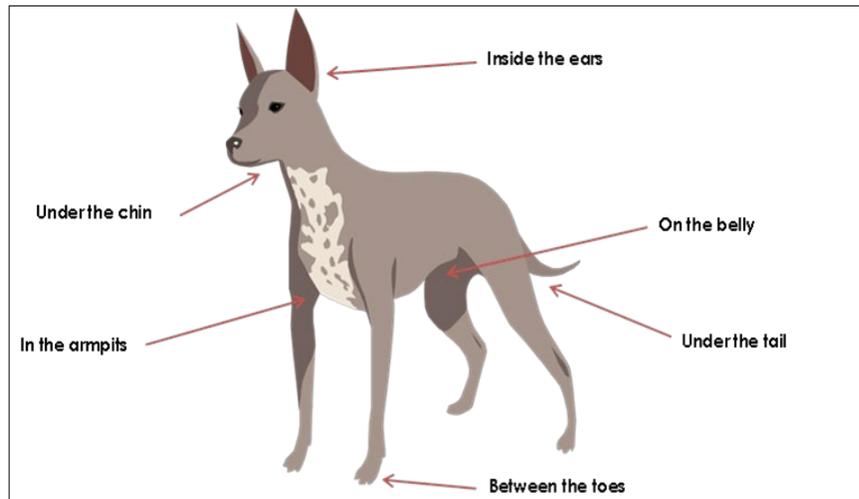


Figure 8: Areas to check a dog for ticks

For example, although one home may have an overwhelming number of ticks, a few homes away with multiple free-roaming dogs may have a low tick load. Surveillance of canine tick loads can be used to help determine what prevention efforts should be implemented, or can be used in combination with other factors to develop more comprehensive strategies.

The best method to assess the canine tick load is by observing all dogs throughout the community. When dog populations are too large for this, assessing dogs at a sample of homes also provides an estimate of canine tick load. How accurate this estimate is depends on how representative these dogs are of the entire population. It is important to consider seasonal differences and care status of the dog (e.g. presence of a tick collar, indoor/outdoor pet). These considerations will be beneficial for interpreting the information collected.

B. Environmental Tick Load Assessment

Environmental tick load is another surveillance strategy for RMSF risk assessment. There are three potential methods for environmental tick load analysis. These include:

- i. carbon dioxide tick traps, which involves using dry ice (carbon dioxide) to attract ticks,

- ii. flagging, which involves gathering ticks on a flannel cloth. Note: this method does not work well for *R. sanguineus* ticks nor is appropriate for the tribal land environments, and
- iii. direct environmental inspection/observations.

These strategies can provide an estimate of tick load in a particular area of interest. Appendix 4 provides some guidance on the resources and steps needed to conduct tick trapping. The limitations to conducting environmental tick load assessments include limited laboratory capacity for tick counts and identification of species, availability of resources (e.g. dry ice), and availability of local technical expertise to ensure proper trapping methods are followed. The best time to conduct these environmental assessments would be before tick season begins and during the peak tick activity periods in each of the locations of interest. This approach would provide a baseline environmental tick load, and would also allow for the assessment of environmental prevention efforts.

C. Canine Seroprevalence

Investigating seroprevalence of RMSF in dogs can be useful in determining the risk to humans in areas where RMSF presence has not yet been established. Dogs that are seropositive provide evidence of either recent or previous exposure to *Rickettsia rickettsii* from infected ticks. Therefore, canine seroprevalence may be the most empirical evidence that RMSF is circulating in the local tick populations. The serosurvey should be conducted with the assistance of a veterinarian or veterinary technicians, and requires laboratory analysis of the blood specimens. There are no rapid clinical test kits available. In the development phase, it is important to consider the baseline seroprevalence, the frequency of sampling, method of sampling, and evaluation/use of data. The most representative sampling method would entail recruiting dogs from random selection of homes throughout the community; however, this method is rarely feasible due to time and financial constraints. A second sampling method includes convenience sampling of dogs seen at rabies vaccination clinics, spay/neuter clinics, animal wellness events, or other community-based events in which dogs will be present. Other sampling options may be available depending on the community. The sampling method employed should be determined based on community-specific factors. Demographics about the dog, including age and care status (e.g. indoor/outdoor, tick collar present), should be collected.

Canine seroprevalence investigations provide beneficial information, but have several limitations. These limitations include limited funding and the need for laboratory capacity, and an experienced veterinarian. Once RMSF presence in a geographic area has been established, conducting further canine serosurveys may not be necessary as prevalence rates will likely stay the same or increase. Pre-post assessments may be valuable if you are measuring the efficacy of an RMSF control strategy (e.g. high volume spay/neuter efforts, pesticide applications, and collaring to prevent ticks). However, interpretation of seroprevalence results can be challenging given cross reactions with other spotted fever group *Rickettsiae*, as well as the fact that antibodies indicate past infection and not current infection rates, meaning that positive results indicate a dog has been exposed to a spotted fever group *Rickettsia* in its life time. Canine seroprevalence should be considered in conjunction with canine tick load assessment, as a dual RMSF surveillance strategy. Lastly, it is important to educate the community and owners that positive dogs are not a risk for spreading RMSF.

D. Prevalence of Rickettsial Infections in Ticks

Another strategy in determining community risk for RMSF is to test brown dog ticks for the *R. rickettsii* bacteria, which indicates the prevalence of infected ticks in an area. It is unlikely that this method will be implemented without additional collaboration with CDC or academic institutions, as this method requires collection of ticks for laboratory analysis for presence of the bacteria, which can only be done in specialized laboratories. This strategy may be utilized if RMSF emerges in a new location to determine if infected ticks are present around a particular home or community. It is not recommended as a routine method for environmental surveillance. Additionally, monitoring climate trends and weather conditions can assist in understanding changes in tick population-levels and predicting tick activity.

E. Tick Control Measures

Community-level integrated tick management and control strategies are the most effective public health response to reduce RMSF. Several community-based collaborative methods have been successfully implemented on affected tribal lands since the mid 2000's. The most successful efforts involve regular tick control measures on dogs and in the environment throughout the tick season. The following section describes each in detail.

a. Control of Ticks in the Environment

Brown dog ticks thrive in areas which are protected and retain moisture, including old furniture, mattresses, textiles, wood piles, and other types of solid waste. Reduction of tick habitats outdoors requires removal these tick harborage areas. Dog houses and outdoor solid waste piles, including tires, furniture, and bins should be routinely inspected for tick infestation. The best way to prevent indoor tick infestation is to maintain tick control on pets and good outdoor control. These control methods can be most effective when tailored to specific environmental conditions and community needs.

When choosing a pesticide, there are factors to consider, such as equipment cost, pesticide cost, active ingredients, application rate, potential residual compounds, and efficacy. Additionally, training and certification may be mandatory for pesticide use and application. Reapplication of pesticides is also an important component to environmental tick control, as pesticides can breakdown rapidly, and many need to be reapplied on a monthly basis. For more information, on appropriate repellants, see <http://cfpub.epa.gov/oppref/insect/>.

b. Control of Ticks on Dogs

Many dogs on tribal lands are not kept indoors and roam freely around the community. Without adequate and consistent tick prevention, dogs are likely to be exposed to ticks and bring those ticks back near their homes. The best method to prevent RMSF in dogs and further tick exposure to humans is to prevent ticks from feeding and attaching to dogs. Also, it is best to use products that kill ticks, not just repel them. Regardless of whether a dog has ticks on its body or whether ticks are present in the surrounding environment, tick control products should be used. Some tick collars, including Bayer Seresto™ collars, last about 8 months. In these collars, there is a sustained release technology that allows continuous protection with two active ingredients working synergistically. A topical or systemic tick-control treatment, such as spot-on treatments, or other collars types to prevent ticks are also recommended options. A spray treatment or dip may be necessary to kill ticks on dogs with

severe infestations. In areas with high tick activity and human cases of RMSF, regular applications of acaricidal treatments to yards and outdoor dog kennels can reduce the number of ticks in a dog's environment. Table 3 shows all the different tick control options for dogs, and includes product types and time frame of efficacy. When selecting a product, be sure to read the label carefully.

Ensuring the health of dogs in the community is another important way to prevent risk of illness to humans. In addition to tick prevention, maintenance of overall health and wellness is important. This can be accomplished through regular veterinary care services, including vaccination clinics. Spaying or neutering is another way to both help dogs live longer, healthier lives, as well as reduce the likelihood of roaming.

Table 3: Summary of tick collar options for dogs

Active chemical(s)	Brand names	Cost per collar	How long until active?	Length of activity	Mechanism	Safety information	Other notes
Amitraz or Amitraz-pyriproxyfen	Preventics	\$10-20	24-48 hrs	Up to 3 months	Detaches and kills ticks	Do not open until ready to use. Do not allow children to play with/handle product. Harmful if absorbed through the skin. Causes moderate skin and eye irritation. Wash hands with soap and water after handling.	Effective against the Brown dog tick, not effective treatment of fleas. Use caution when combining with flea treatment, possible human carcinogen
Imidacloprid and Flumethrin	Seresto	~\$75	Up to 48 hrs	Up to 8 months	Kills fleas and ticks	Do not open until ready to use. Do not let children play with this collar or to put them in their mouths. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and cold water after fitting the collar.	Effective against Brown dog tick, long lasting, water resistant
Propoxur/methoprene /phenothrin	Adams plus, Bio Spot, Seargent's, PowerBrand	\$5-15	Immediately	Up to 3 months	Kills adult fleas and ticks, controls flea development	Do not open until ready to use. Do not get dust in mouth. Harmful if absorbed through skin or swallowed. Wash hands thoroughly with soap and water after handling. Rinse immediately if on skin or clothing. Do not allow children to play with collars. Keep young children and pregnant women away from dogs for the first 24 hrs following collar application.	Effective against Brown dog tick, probable human carcinogen
	Zodiac	\$5		Up to 5 months			
Deltamethrin (pyrethroid family)	Scalibor	\$38	Up to 2-3 weeks	Up to 6 months	Kills fleas and ticks	Do not open until ready to use. Do not let children play with collar. Harmful if swallowed or absorbed through skin. Causes moderate eye irritation. Avoid contact with skin, clothes or eyes. Wash thoroughly with soap and water after handling.	Less effective on Brown dog tick, reports of resistance
Tetrachlorinfos	Hartz InControl, Hartz Ultraguard	\$5-10	Several days	Up to 7 months	Kills and repels fleas and ticks	Harmful if swallowed or absorbed through skin. Causes moderate eye irritation. Avoid contact with skin, clothes or eyes. Wash thoroughly with soap and water after handling, and before eating, drinking, chewing gum, or using tobacco.	Organophosphate, possible human carcinogen
Natural products: Citronella/phenylethyl	Fly-free zone	\$20	Has not been tested	"Replace when effectiveness diminishes"	Deterrent/repellent	Do not allow children to play with collar. Intended for external use only. Do not let dog chew on collar. Do not use other products with this collar. Do not use on sick or convalescing dogs.	Untested efficacy, not an EPA registered product, must remove for bathing

All pesticide products go through rigorous toxicity studies before being licensed for distribution. Even so, pesticides carry some risk to human and pet health, but these risks can be lessened by carefully following instructions and precautions listed on the box.

c. Summary

In summary, the most effective strategy to control ticks in a tribal community is through an integrated approach. Best practices are to apply pesticides monthly over the season when tick activity will peak and to ensure dogs are collared in the spring and fall to ensure protection throughout peak tick activity.

This includes the following:

- Use appropriate spot-on treatments, tick collars, sprays, or dips to control ticks on dogs. Remember to read the label.
- Apply appropriate pesticides to control ticks in yards. Follow the instructions carefully for the product chosen. Repeated applications may be necessary.
- Remove tick habitats on properties, including leaf litter and solid waste (e.g. old furniture, boards).

Animal Control

In the past, there has been a lack of established animal control programs which has potentially contributed to the rapid spread of RMSF across the affected tribal lands. Some affected tribes had animal control programs and veterinary services, but others did not. Since RMSF emergence, animal control programs have developed. In addition to the need for financial resources, this section presents some concerns and recommendations in regards to maintaining an animal control program.

Tribal councils will make decisions on whether animal control programs will focus on public health or ordinance enforcement. The key difference is proactive prevention versus reactive action. Stopping the transmission of RMSF and other diseases can be accomplished through education and community outreach efforts first and public health enforcement of laws and ordinances second. Enforcement may deal with animal related issues and perhaps give minimal emphasis to public health prevention. Combining both is the optimal approach.

Animal control programs should collaborate with tribal veterinarians and environment health representatives to accomplish prevention and control tasks at the tick and dog level. The animal control program should be tailored to the needs of the tribal jurisdiction and to promote sustainability, in addition to providing and focusing on RMSF prevention efforts. Some important functions of an animal control program are to impound stray animals, assist in coordination of spay/neuter, wellness, and vaccination programs, and potentially be a continual resource for owned dogs in the community. If tribes do not have an animal rescue facility for free-roaming dogs to be housed or dogs to be available for adoption, outside animal rescue and veterinary facilities may need to be contacted for assistance. There may be dogs that need veterinary care, whether routine or advanced, or may need to be euthanized. Building a network with these types of entities and local public health will be very beneficial to accomplishing tribal animal control goals.

If a tribe has plans to develop their own animal control program, remember to consider the necessary number of staff to run the facility, what services will be provided to the community and frequency of those services, budget and resources needed, and whether there will be a charge for services. Additionally, there may be existing tribal animal control laws and regulations that need to be enforced. Keep in mind that educating community members and dog owners is important before any ordinances are enforced.

In summary, animal control should be considered a public health issue rather than just a public safety issue. There is no perfect animal control program, and the needs of each tribe will be different. Some reservations have found that utilizing collars for tick control are the safest and most effective single approach to tick prevention on dogs. Spay/neuter capabilities are the best long-term control mechanism for keeping dog populations within desirable and manageable levels. While it is best to have a comprehensive animal control

program, any level of effort is beneficial to prevent RMSF in tribal communities and integral to saving lives.

Health Care

While health care may not be considered as a response strategy, best practices are vital to detecting cases, preventing deaths, and understanding the current burden of RMSF on tribal lands. This section will discuss the key areas where health care providers and public health nursing play a role, and the recommendations for maintaining their partnership. The transfer protocol will also be discussed. Case investigations and follow-up were discussed previously.

Health care providers are often the first people that a suspect RMSF patient will encounter. Clinicians have a unique opportunity to educate patients and their families about RMSF. It is therefore important that providers understand the clinical symptoms of RMSF, the RMSF clinical algorithm, and how to diagnose and treat RMSF. The goal is to reduce morbidity and prevent mortality caused by RMSF. The responsibility for training physicians can fall to tribal health departments, local public health, ADHS, or CDC. Establishment of protocols for diagnosing RMSF, laboratory testing, and reporting has been done by ADHS in conjunction with CDC expertise. As mentioned in the case investigation section, RMSF is a reportable disease, therefore laboratories and health care providers are mandated by the Arizona Administrative Code to notify local public health or ADHS.

In areas that have been declared as high risk, use of the RMSF clinical algorithm is highly recommended. There are automatic notifications to consider RMSF in some health care facilities when a person presents with fever. With the implementation of this algorithm came the requirement to train physicians, public health nurses, and other health care staff. It can be helpful to designate a RMSF infection preventionist or public health nurse to be the primary point of contact for public health. This individual may be able to work with other providers and tribal health department to develop patient-targeted education and an incentive program for outpatients to return for convalescent blood sampling. Health care providers are responsible for coordinating specimen collection and shipment to a laboratory for RMSF testing.

A chain of command for referral cases and point of contact for follow-up should be established. Public health nursing is often responsible for receiving referrals from physicians and conducting home visits with patients and completing case investigations and follow-up. Health care providers should be in regular communication with public health to obtain information about risk status, in order to procure the highest level of clinical care.

RMSF Transfer Protocol

The purpose of the RMSF transfer protocol is two-fold. First, it aims to promote continuation of patient care and treatment from a tribal health care facility to non-tribal health care facility. The second objective is to prevent gaps between jurisdictions in a scenario where a patient is transferred to a hospital outside tribal lands. Once a patient is transferred to a hospital outside tribal lands, responsibility temporarily falls into the local county public health's jurisdiction for investigation and follow-up. For example, a transfer of a tribal-affiliated patient to Phoenix Children's Hospital would fall into Maricopa's jurisdiction.

Some of the tribes utilize the state infectious disease online reporting system (MEDSIS), but not all the tribes have access or having varying levels of access. Without this protocol, there may

be no other way to get the case information back to the tribe. The RMSF transfer protocol was piloted in 2012, and is currently implemented collaboratively within two tribal and corresponding county jurisdictions. The goal is for all tribes reporting RMSF cases that are transferred out of tribal jurisdiction to implement this protocol. This will also facilitate enhanced multijurisdictional communication and collaboration.

Implementation of the protocol requires a few simple steps. The recommendation is to designate one or two points of contacts at each tribal jurisdiction that will be responsible for initiating the protocol. Refer to figure 9 for the flow of patient information. The **green arrows** indicate how the information **passed from** the tribal jurisdiction and the **red arrows** indicate the flow of information **back to** the tribal jurisdiction.

Step 1 → Tribal jurisdiction initiates protocol by notifying RMSF Epidemiologist at ADHS of suspect RMSF case that has been transferred. RMSF Epidemiologist needs the patient name, date of birth, date of symptom onset, tick exposure, symptoms and any laboratory results from the tribal health care facility, date of transfer and name of receiving facility the patient was transferred to. Any additional information is helpful, but not necessary, as long as the following questions are addressed.

- 1) Was the patient started on doxycycline at IHS or tribal health care facility?
- 2) Were RMSF labs drawn?

Step 2 → RMSF Epidemiologist gathers the above information from the tribal jurisdiction and contacts the epidemiology staff at the appropriate county public health department. RMSF Epidemiologist opens a MEDSIS case.

Step 3 → County public health will contact the hospital that the patient was transferred to and obtain follow-up information on condition and diagnosis. This includes determining if the patient was continued on doxycycline at the health facility in county jurisdiction and if RMSF was kept of the differentials list. County public health will also educate the physician as needed about RMSF.

Step 4 → Information will be provided back up the chain from county public health to the RMSF Epidemiologist at ADHS to the tribal jurisdiction. Additional case information obtained will be entered into the MEDSIS case. When the patient is discharged from the non-tribal health care facility, responsibility for additional patient follow-up (if necessary) falls back into the tribal jurisdiction.

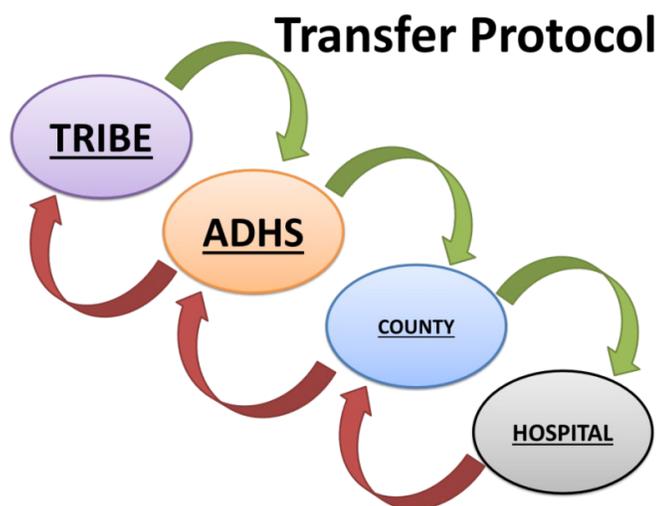


Figure 9: RMSF Transfer Protocol illustrating flow of patient case information

In high suspect cases, coordination of additional specimens for testing will be done by the RMSF Epidemiologist and appropriate corresponding jurisdiction. For this protocol to be successfully implemented, educational messaging is required, particularly to physicians and infection preventionists about RMSF in tribal areas if they are unfamiliar with the importance of using doxycycline to treat RMSF. Depending on the needs and audience, the role of educator can be filled by individuals from tribal jurisdictions, IHS, county public health, ADHS, and CDC. Lastly, the RMSF Epidemiologist will be responsible for maintaining a comprehensive record of all transfer cases across the state.

Community Outreach & Education

Without RMSF community education, acceptance of environmental and animal level control efforts may be limited. There are many ways to approach community outreach and education, including presentations at health fairs or schools, or panel discussions with different audiences. This section will provide some recommendations for RMSF health education programs and the importance of targeting different audiences.

Tribal health departments may want to consider dedicating specific staff to outreach and educational efforts, such as community health representatives or health educators. These individuals can play an important role in discussing the risk factors and symptoms of RMSF, how to check for and remove a tick, and how to reduce the risk of ticks around homes. Public health staff, animal control officers, tribal veterinarians and technicians, and environmental health representatives can also provide assistance to increase awareness and knowledge of RMSF and related prevention activities. Working with these partners can help identify existing animal control policies and ordinances, as well as the most appropriate and effective method to communicate prevention strategies to the community.

Development of a comprehensive toolkit to target specific audiences (e.g. general community, physicians, and veterinarians) may be beneficial for outreach efforts. A variety of educational materials, such as calendars, brochures, bookmarks, and posters have been developed by the tribes, ADHS, CDC, and ITCA. Bookmarks, tri-fold brochures, and health care provider pocket cards (Appendix VI) can be requested by jurisdictions from ADHS or CDC. Affected tribes have also shared educational materials and ideas with one another. Consider whether these have been useful or if there is a need to develop new materials. It is also important to consider whether materials need to be translated into other languages, specifically tribal languages. Many materials have been created electronically, which allows for easier sharing between partners and aligns with the goal of promoting consistent messaging statewide. Monthly RMSF health education workgroup and coalition calls also allow exchange of ideas and materials.

Remember that messaging for health care professionals about RMSF diagnosis and treatment is equally as important as messaging to the public. Presentations to physicians about RMSF and physician pocket cards are available to increase physician knowledge and

awareness about RMSF. Nurses and physicians should continually be informed about the threat of RMSF and educated on the use of the RMSF clinical algorithm. It is encouraged to reach out to health care providers at outpatient clinics and local hospitals in order to conduct presentations on RMSF, increase knowledge of staff, and improve patient care.

Community-wide outreach and education can be accomplished through presentations to large audiences, distribution of flyers, brochures or posters at health fairs, newspaper articles, social media messaging, and radio or television public service announcements. Individual efforts can be achieved through home site visits. During RMSF household risk assessments, the residents can be educated about tick habitats, solid waste removal, and how to properly care for any dogs they have. The importance of tick prevention and spaying/neutering dogs should also be emphasized. These one-on-one interventions are especially important at homes or neighborhoods where RMSF cases have been identified. Conducting school presentations are also recommended to teach children about RMSF and how to keep themselves safe and healthy, including what to do if they find a tick.

Financing & Budget

Developing a budget is an essential piece of the puzzle, and should reflect a long-term sustainable investment for RMSF prevention and control, rather than one-time emergency relief efforts. It is recommended that RMSF prevention budgets include animal control, tick control (on animals and in the environment), environmental surveillance, community outreach/education and clinical education. These categories have been addressed throughout this handbook and encompass comprehensive RMSF control efforts. The costs presented below represent rough estimates for planning purposes, and may vary depending on current resources and desired program elements. It is suggested that RMSF prevention programs address at least 5 years of prevention efforts in order to provide a sustainable impact. However, some activities may not need to be repeated annually. Some specific components are explained below and table 4 shows a sample budget for a 5-year RMSF prevention plan for a 3,000 household community.

Animal Control costs for a two staff office including personnel cost, animal control equipment and operating costs will be approximately \$110,000 per year. Annual operating costs of tick control programs for a 3,000 household community may include: \$70,000 for environmental control (including pesticide for 4 applications, storage, seasonal workers and equipment), \$200,000 for tick control on dogs (using long-lasting collars for estimated 6,000 dogs), and \$155,000 for waste removal. Additional costs could include vehicles, office space, and contract veterinary services. Environmental surveillance would involve a determination of the canine and environmental tick loads. The tick count on dogs will require significant staff time. The environmental tick load count in addition to staff time will cost \$75-100 for 10 CO₂ tick trap supplies.

Community Outreach/Education costs will involve development and printing of community brochures, children tools such as coloring book calendars, postage, etc. A budget of \$6,100 will cover 5,000 community brochures, 5,000 coloring book calendars, and necessary postage. Clinical Education involves the education of clinical staff on RMSF treatment which is an on-going practice of CDC, ADHS and IHS so there should be no costs to the tribes. Potential funding sources includes tribal programs (including general funds), government or private grants (businesses, philanthropic organizations), emergency funds (ADHS, IHS, CDC), and CDC community transformation grants.

Table 4: Sample budget for a 5-year RMSF prevention plan, example for a 3,000 household reservation/community

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Grant funded	Collar and environmental controls in 600 Household community	Collar campaign, environmental treatment by request only	Total grant contribution			
	-	Collar and environmental control reservation wide	-	-	-	
	RMSF Supervisor Spay/neuter Collar	Full time Spay/Neuter Seresto	Full time Spay/Neuter Seresto	Full time - Seresto	Part time - Amitraz	
Estimated cost	\$270,545	\$543,161	\$354,486	\$343,236	\$256,986	\$1,768,415
Tribe Funded	ACOs Spay/neuter	Staffing 2 ACOs	Staffing 2 ACOs	Staffing 2 ACOs	Staffing 2 ACOs	Total tribe contribution
	-	-	Spay/Neuter	Spay/Neuter	Spay/Neuter	
Estimated cost	\$105,000	\$105,000	\$130,000	\$130,000	\$130,000	\$600,000

The take-home message for budget development is that RMSF prevention should be a priority. A cost analysis conducted by CDC and I.H.S. (6) that costs (e.g. medical expenses and potential life lost) associated with illness and death caused by RMSF would be four-times greater than costs for community-wide RMSF prevention.

Summary

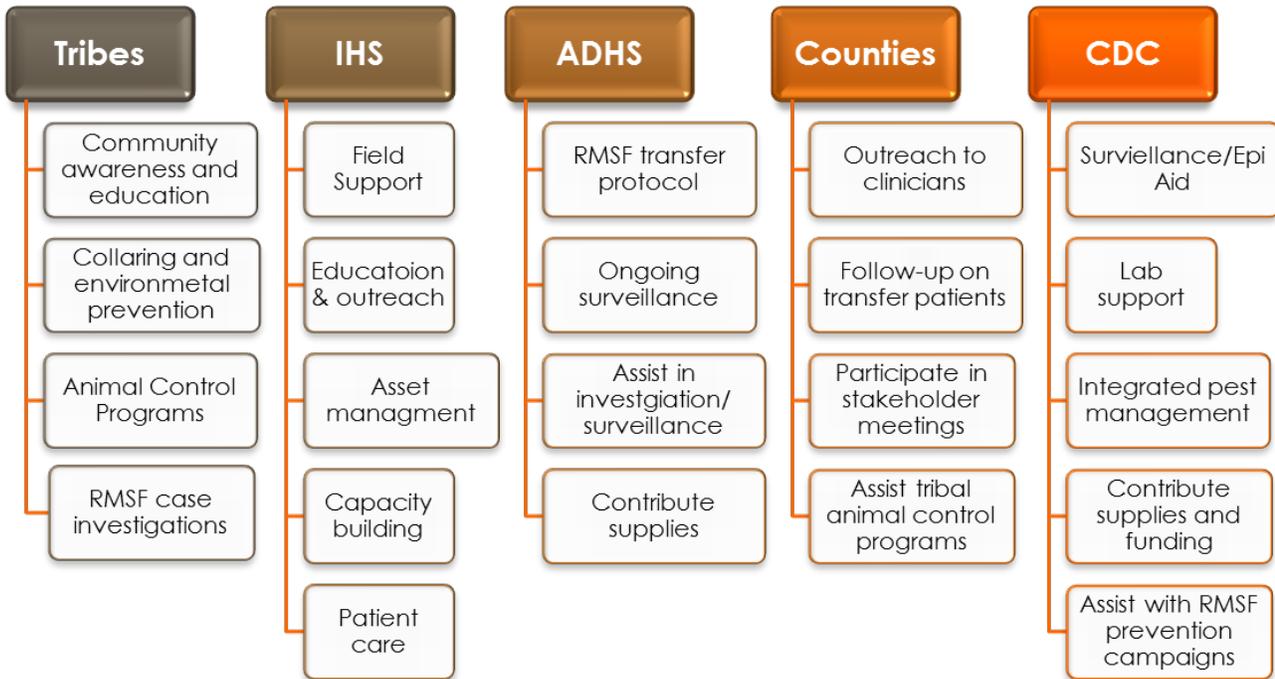
Development of a RMSF response plan requires comprehensive approaches to successfully implement surveillance, control and prevention efforts. These efforts also include collaboration and partnerships between multiple jurisdictions and stakeholders, such as tribal districts, CDC, ADHS, IHS, local county public health, ITCA, RAVS, National Animal Control Association, National Humane Society, Emergency Management, Community Housing, and Public Works. It may be necessary to evaluate and address targeted areas for RMSF response activities versus community-wide interventions if certain areas or districts of affected tribal lands fall into different risk categories.

Upon development of a response plan, be sure to do the following:

- 1) Discuss plan with stakeholders
- 2) Evaluate the type of equipment and resources needed
- 3) Inventory current supplies and place orders
- 4) Decide which RMSF education materials will be used
- 5) Disseminate RMSF information using flyers, PSA's, radio, and social media channels

Implementation of the plan involves continued and dedicated efforts, evaluation of surveillance investigations, and follow-up with areas where control strategies took place. RMSF control and prevention efforts cannot occur without collaborative partnerships. Everyone has a role, with tribal entities acting as the lead agencies (Figure 10).

Figure 10: Diagram summarizing some of the roles each partner can play. Note: ITCA (e.g. advocacy, funding, and assistance with prevention campaigns) and are not shown.



Future of RMSF in Arizona

Looking into the future, we can set some small attainable goals to help achieve the big picture objective.

- Continue coalition and response efforts on affected tribal lands
- Share experiences and outreach materials between tribes
- Enhance surveillance methods and case investigations on tribal lands
- Hold an annual statewide workshop/meeting to bring all partners together
- Hold bi-annual calls at the beginning and end of tick season with all partners
- Strengthen animal control and environmental control programs
- Expand educational opportunities for communities about RMSF and dog health
- Expand transfer protocols to include all tribal facilities
- Evaluate the need for continued use of the RMSF clinical algorithm
- Conduct canine serosurveys on affected tribal lands to assess risk levels
- Seek RMSF prevention funding

In the span of just over 10 years, RMSF has emerged in Arizona and spread to 6 different reservations, threatening the health of tribal communities. Despite significant efforts by the affected tribes, state, and federal partners, RMSF incidence rates steadily increased during 2003–2013. Many partners strongly state that RMSF designated funding has not only been inadequate, but sporadic. Our collaborative efforts, with the lead of ITCA, have reached beyond the local level to address policy, legislation, and advocacy work. These aspects will hopefully lead to future funding. In late 2014, the National Congress of American Indians passed a resolution to support RMSF prevention and control in Arizona. Appendix 5 shows the

full signed resolution. It is clear that a sufficiently funded and sustainable integrated approach is the key to eradicating RMSF in Arizona tribal lands.

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APPENDICES

APPENDIX I: CDC RMSF Case Investigation Form

APPENDIX II: Tips for RMSF Case Investigation

APPENDIX III: RMSF Case Classification Algorithm 2020

APPENDIX IV: Guidance on Tick Trapping

APPENDIX V: National Congress of American Indians 2014 Resolution

APPENDIX VI: Educational Resources

- Bookmarks
- Tri-fold brochures
- Physician pocket cards

Rocky Mountain spotted fever Action Plan Template in Arizona Tribal Lands

As of 1-23-2020

Purpose:

This document is intended to guide tribal public health leaders when developing RMSF action plans for their communities. This document may serve as a template for tribes to build their local response plans, and should be tailored to the needs, resources, and priorities of each community.

Background:

Rocky Mountain spotted fever (RMSF) is a potentially deadly bacterial infection spread by the bite of an infected tick. RMSF is not spread person to person. Early signs and symptoms of RMSF typically include fever, headache, and muscle pain. A rash may develop 2-4 days into the illness, along with worsening of signs such as stomach pain, confusion, and difficulty breathing. Without treatment RMSF progresses rapidly, and severe illness begins around day 5 of symptoms, when patients experience damage to organ systems, coma, sepsis, and eventually death. When recognized early, RMSF can be treated effectively with the antibiotic doxycycline. Treatment is most effective in the first 5 days of illness.

In Arizona, RMSF is spread by brown dog ticks (*Rhipicephalus sanguineus*). Heavy infestations of ticks in and around homes, fueled by free-roaming dogs, are risk factors for RMSF. Brown dog ticks primarily feed and breed on dogs, making dogs a key piece of RMSF prevention and a key way to track/predict RMSF risk.

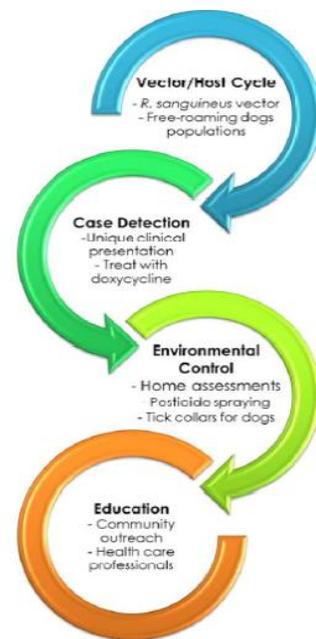
Since the first cases were identified, RMSF has been reported in six tribal communities. More than 450 cases, including 28 deaths, have been reported thru 2019. Cases of RMSF have been reported in every month of the year in Arizona, however most occur during warmer months March–October, when ticks are most active.

RMSF prevention includes:

- Vector control
- Animal control*
- Case detection
- Solid waste management*
- Education and outreach

Integrated prevention practices using elements such as these have been proven to significantly reduce tick burden and RMSF cases. RMSF risk is different throughout Arizona, therefore RMSF prevention should be scaled and adapted for each community.

*Note: Animal control and solid waste management are essential pieces of RMSF prevention but are not covered in detail in this response plan. Instead, such activities need to be continued year-round and should not vary depending on RMSF risk level. Activities towards reducing free-roaming dog populations thru dog ordinances, spay and neuter opportunities, and dog restraint policies reduce overall dog



populations and limit the ability for tick infested dogs to carry ticks to new locations. Solid waste management to reduce tick harborage sites in and around homes ensures the effectiveness of vector control and eliminates hiding places for ticks. Community clean-ups, large trash disposal days, and enforcement of solid waste ordinances should routinely be carried out in all locations to limit opportunities for ticks to thrive.

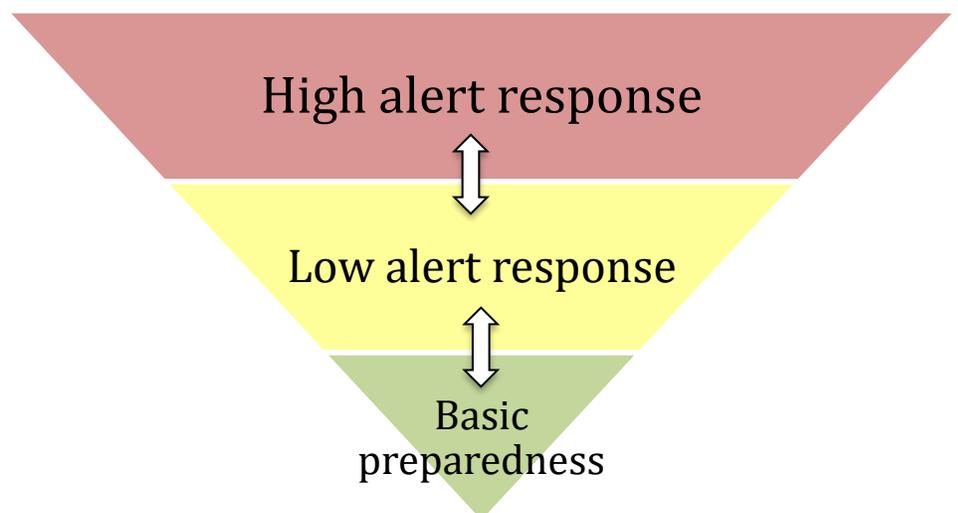
Definitions

- **Tick season:** (March–October) while ticks are active year-round in Arizona, more concentrated activity occurs in warmer months. This is the time of year when the majority of RMSF cases occur and more intensive vector control and surveillance activities are needed.
- **Off-season:** (November-February) times when ticks are less active and vector control activities can be stopped or slowed. Off-season is also a good time to evaluate RMSF prevention practices of the last year and plan for the next season.
- **Endemic communities:** areas which have reported one or more locally acquired cases of RMSF in the last 10 years. Endemic communities will be classified as either low alert or high alert depending on current RMSF activity (see tiered response below).
- **Non-endemic communities:** areas which have had no reports of locally acquired RMSF in the last 10 years. Non-endemic tribes should still maintain basic RMSF preparedness.
- **Surveillance:** tracking of key information on human cases or tick activity to compare over time. Surveillance data are used to define alert levels and can provide early warning information of priority areas for vector control.*

*Note: serologic testing of dogs for rickettsia is not necessary for endemic communities. Canine serosurveys may be considered when the first locally acquired case occurs within a new area, but are costly and do not provide actionable information for areas in which RMSF is established.

Tiered RMSF Response

The objective of a tiered, risk-based response is to implement public health interventions appropriate to the level of RMSF risk in a community. Effective tiered response depends upon an organizational preparedness, the collection and interpretation of surveillance data, and the flexibility to scale up intervention in response to changes in risk. A



tiered response further allows for tribes to scale down interventions when risk is reduced while still maintaining close monitoring of key RMSF indicators for early signals to human cases.

- **Basic preparedness:** activities which should be accomplished by all tribes in Arizona regardless of RMSF risk. Basic preparedness includes planning, education, and a mechanism to track and report cases.
- **Low alert:** ≤2 confirmed or probable cases in endemic community or the first confirmed case in non-endemic community in a single tick season. Low alert tribes should plan and execute some tick control activities, conduct home assessments in response to suspected cases, monitor tick activity, provide routine education/communication, and ensure healthcare providers in their area are educated on RMSF treatment and diagnosis.
- **High alert:** >2 confirmed or probable cases per tribal community or any RMSF death in a single tick season. High alert tribes should be conducting regular tick control activities, frequent surveillance of tick levels, conduct enhanced communication/education for healthcare providers and general audiences, and should regularly communicate with RMSF partners.

At minimum, tribes should assess their alert level (basic, low, or high) at the start of tick season based on last year's RMSF activity, but their category may increase at any time during the year in response to current risk.

The table below organizes recommended response steps based on RMSF response level: basic preparedness, low alert tribes, and high alert tribes. Response activities during and outside of tick season are detailed in the following targeted areas:

- Planning
- Communication
- Vector control
- Clinical response
- Surveillance

These steps are recommended by subject matter experts to improve preparedness and response actions. These are recommendations only; specific actions should be based on jurisdictional risks, resources, and identified preparedness gaps.

Tiered response activities

		Recommended activity or response				
Risk category	Timeline	Planning	Communication	Vector control	Clinical response	Surveillance
Basic preparedness	Off-season (November -February)	<ul style="list-style-type: none"> Review response plan annually and outline roles and responsibilities for each activity such as who is responsible for tracking tick activity on dogs, and who produces and circulates RMSF reports 	<ul style="list-style-type: none"> Place orders for standard RMSF communications materials from CDC or ADHS (trifolds, posters, flyers and bookmarks) 	<ul style="list-style-type: none"> Identify vector control resources available for your tribe (ex. tick control products sold locally, contract pest applicators in the area, if housing authority will provide pest management services). 	<ul style="list-style-type: none"> Have new clinical providers take RMSF training course to familiarize with RMSF in Arizona 	<ul style="list-style-type: none"> Identify point person for communicating RMSF case information to the state health department
	Tick season (March-October)		<ul style="list-style-type: none"> Distribute RMSF communications materials as you are able (ex. at health fairs, at the hospital or via CHR program) 	<ul style="list-style-type: none"> Consider making lists of vector control resources available to the public. 		<ul style="list-style-type: none"> Have a system for reporting cases of RMSF as soon as they are recognized to tribal council and tribal departments participating in RMSF response Consider tracking information of tick activity on dogs at selected events such as rabies campaigns, veterinary clinics or spay and neuter events

<p>Low alert (≤ 2) cases in endemic community or first case in non-endemic community)</p>	<p><i>Conduct all above activities listed for all tribes plus additional activities in the low alert section</i></p>					
<p>Off-season (November -February)</p>	<ul style="list-style-type: none"> ● Identify your Public Information Officer and routes of communication ● Train new staff or provide refresher trainings for staff on basic RMSF prevention, signs and symptoms and treatment ● Discuss cost, feasibility, and manpower for tick control activities 	<ul style="list-style-type: none"> ● Review current RMSF education tools including social media posts, school training, and written materials (posters, brochures, bookmarks, etc.) ● Make plan with timeline for each communication activity based on seasonality of cases and planned prevention activities 	<ul style="list-style-type: none"> ● Review list of approved pesticide products for environmental treatment ● Develop or review plan for acquiring needed tick control products (such as environmental pesticide or tick collars) including sources, approvals needed and timelines ● Ensure at least one certified pest applicator in community or identify a contractor to apply pesticide if needed -If the tribe is providing the pesticide application, maintain basic equipment (such as hand pumps, mixing equipment, and PPE for applicators) 	<ul style="list-style-type: none"> ● Develop or update RMSF referral procedures and review with CHRs and PHNs (or other key parties) ● Send refresher (by email, in-person training or memo) of RMSF signs and symptoms, current testing and treatment policies (specimen collection and early doxycycline administration), and tribe-specific risk data to healthcare providers ● Review transfer protocols for critical cases 	<ul style="list-style-type: none"> ● Refresh on process and ensure access to MEDSIS, with familiarity on process for reporting RMSF cases 	

	Tick season (March-October)		<ul style="list-style-type: none"> • Deploy regular communication of tick bite prevention, alert to seasonal activity, and reminder of signs and symptoms of RMSF using multiple communication platforms 	<ul style="list-style-type: none"> • Conduct home assessments following suspect case identification -If tick activity is observed, deploy environmental and dog-based treatment to homes within a ¼ mile of a suspect case -Return for repeat assessment 2 weeks following treatment to assure adequate knock down of tick activity, repeat treatment if necessary 	<ul style="list-style-type: none"> • Send provider alert when the first RMSF case is reported to remind providers about early doxycycline administration and proper testing procedures • Send monthly update of case burden to providers 	<ul style="list-style-type: none"> • Track human cases by neighborhood (district) with monthly reports • Increase monitoring of tick activity by neighborhood using dry ice traps or track tick activity on dogs at selected events (ex. spay & neuter events, veterinary clinic, or rabies clinics)
High alert (more than 2 cases per tribal community or any RMSF death)	<i>Conduct all above activities listed for all tribes, low alert tribes plus additional activities in the high alert section</i>					
	Off-season (November-February)	<ul style="list-style-type: none"> • Consider hiring temporary help for increased vector control during tick season • Apply for additional grants, as needed, to 	<ul style="list-style-type: none"> • Update RMSF communication products with local information about last year and upcoming RMSF prevention activities • Consider developing enhanced communications 	<ul style="list-style-type: none"> • Check and replace all damaged vector control equipment • Conduct refresher training for pest applicators to ensure safety and consistency 	<ul style="list-style-type: none"> • Conduct in-person refresher training for healthcare providers on the signs and symptoms of RMSF, current testing and treatment policies (specimen collection and early doxycycline 	<ul style="list-style-type: none"> • Identify at least 2 individuals (a primary and a backup) responsible for entering RMSF data into MEDSIS • Review and update RMSF data collection tools

		assist in carrying out RMSF prevention activities	products like videos or radio PSAs		administration), and report tribe-specific risk data to healthcare providers <ul style="list-style-type: none"> ● Review and update RMSF testing practices including rates of convalescent specimens 	
	Tick season (March-October)		<ul style="list-style-type: none"> ● Increase communication using multiple communication platforms (ex. social media, radio, pamphlets) ● Following any death: <ul style="list-style-type: none"> -Alert tribal council -Alert state & CDC -Emergency communication to the public via radio, flyer distribution or social media to alert them to RMSF death and encourage seeking medical attention early and tick checks 	<ul style="list-style-type: none"> ● Consider enhanced vector control using community-wide door-to-door provision of tick preventives for dogs and environmental treatment; may increase frequency (monthly) for high case burden ● Cycle pesticide products annually to reduce resistance opportunities ● Monitor pesticide effectiveness via spot checks on treated homes. Contact CDC if pesticide resistance is suspected. 	<ul style="list-style-type: none"> ● Send provider alert to increased case activity or death ● Consider use of treatment algorithm or increased encouragement of providers to treat suspected cases ● Encourage collection of whole blood for PCR testing in critical cases consistent with RMSF 	<ul style="list-style-type: none"> ● Consider tracking and reporting RMSF cases weekly for RMSF partners ● Track and report tick burden on dogs by neighborhood (district) through door-to-door campaigns ● Evaluate tick and human data monthly for clustering of cases by housing district

Annual Report:

At the end of each year, a summary of RMSF information should be compiled and provided to tribal council and programs involved in RMSF prevention. At minimum, the report should include annual number of RMSF cases, summary of RMSF prevention activities (such as cleanups, tick preventives provided and any assessment of tick activity). We encourage programs at any level to assess your surveillance and response plan at the end of the tick season and provide feedback to necessary partners to prepare for the next year.

Monitoring Pesticide Effectiveness and Resistance:

Yearly cycling of pesticide products and proper application helps reduce opportunities for pesticide resistance; however, limited options make rotating products challenging. Monitoring for pesticide resistance requires careful tracking of pesticide use compared to tick activity. Molecular testing for genetic mutations associated with acaricide resistance are available through some specialized laboratories, but are not recommended currently for routine pesticide monitoring. If you suspect pesticide resistance, based on ongoing tick activity despite numerous proper acaricidal applications (to dog or environment), alert a CDC representative for consultation about pesticide resistance testing. See resistance monitoring guide for further instructions.

Additional Resources

RMSF Indicator List

Home Risk Assessment Form

Brown Dog Tick Resistance Monitoring Guide

Rocky Mountain Spotted Fever Indicator List

Indicators for Human Health - **Bolded**, highlighted indicators are core indicators. Unhighlighted indicators are suggested/optional

Indicator	Report out:	Source(s)	Recommended Minimum Frequency of Collection/Reporting	Suggested Geographic Level
Total number of probable RMSF cases	Number	Hospital/State	Monthly	Tribe
Total number of confirmed RMSF cases				
Total number of RMSF deaths	Number	Hospital/State	Monthly	Tribe
Number of people treated for RMSF	Number	Hospital/State	Quarterly	Tribe
Number of acute RMSF tests	Number	Hospital/State	Quarterly	Tribe
Number of paired convalescent RMSF tests	Percent	Hospital/State	Quarterly	Tribe
Number of referrals/investigations	Number	Hospital	Quarterly	Tribe

Indicators for Tick Control on Dogs - **Bolded**, highlighted indicators are core indicators. Unhighlighted indicators are suggested/optional

Indicator	Report out:	Source(s)	Recommended Minimum Frequency of Collection/Reporting	Suggested Geographic Level
Dog population	Number	- Dog population surveys - Animal control officer reports - Vet clinic reports - Door to door campaigns - Police citations	Every 5 years	Tribe
Number of dogs treated	Number	- Dog population surveys - Animal control officer reports - Vet clinic records - Rabies clinic records - Door to door campaigns	Each campaign or 2 times a year	Tribe
Percent of dogs with ticks	Number of B+C dogs divided by number of A+B+C dogs	- Vet clinic records - Rabies clinic records - Door to door campaigns	Each campaign or 2 times a year	District/Village
Number of dogs spayed/neutered	Number	-Vet clinic records -Spay/Neuter clinic records	1 time a year	Tribe
Percent of dogs restrained	Percent	- Dog population surveys - Door to door campaigns	1 time a year	Tribe

Number of dogs euthanized	Number	- Animal control officer reports -Vet clinic records	1 time a year	Tribe
Number of dogs adopted	Number	- Animal control officer reports -Rescue group reports	1 time a year	Tribe

Indicators for Tick Control in the Environment - **Bolded**, highlighted indicators are core indicators. Unhighlighted indicators are suggested/optional

Indicator	Report out:	Source(s)	Recommended Minimum Frequency of Collection/Reporting	Suggested Geographic Level
Percent of households treated	Percent	- Pest management records - Door to door campaigns -Case follow-up referrals	Each campaign or 2 times per year	District/Village
Number of environmental cleanups performed	Number	- Tribal EPA records -Tribal waste management records	Each campaign	District/Village
Number of cleanup campaigns	Number	- Tribal EPA records -Tribal waste management records	Each campaign	District/Village
Number of households participating in cleanup campaign	Number	- Tribal EPA records -Tribal waste management records	Each campaign	District/Village
Number of homes reporting tick activity	Count of homes reporting tick activity	- Pest management records - Door to door campaigns -Case follow-up referrals	Each campaign or 2 times per year	District/Village

Indicators for Community Education – **Bold**, highlighted indicators are core indicators. Unhighlighted indicators are suggested/optional

Indicator	Report out:	Source(s)	Recommended Minimum Frequency of Collection/Reporting	Suggested Geographic Level
Number of radio communications	Number	-RMSF control program records -Radio station	1 time per year	Tribe
Number of social media posts	Number	-RMSF control program records -Social media accounts	1 time per year	Tribe
Number of community events	Number	-RMSF control program -CHR records -PHN records -EHS records	1 time per year	Tribe
Number of newspaper/newsletter articles/ads	Number	-RMSF control program -Newspaper/Newsletter	1 time per year	Tribe

Changes in knowledge, attitudes, and practices	Percent	-Surveys -Pre/Post tests during trainings and after	Every 2-5 years	Tribe
Number of people at community events or trainings	Number	-RMSF control program -CHR records -PHN records -EHS records	1 time per year	Tribe

Example Home Risk Assessment Tick Habitat and Rocky Mountain spotted fever Prevention

Date: _____ Family Name: _____

Community: _____ Neighborhood/Housing Area: _____

Housing number: _____ Address: _____

- | | | | |
|--|-------|-------|----|
| 1. Have ticks been seen around the outside of the home?
(Within the past 2 weeks) | Y | N | NA |
| 2. Have ticks been seen inside the home?
(Within the past 2 weeks) | Y | N | NA |
| 3. Was pesticide applied to the outside of the Home?
If yes, what type of pesticide is being used? _____
How often is pesticide applied? _____ | Y | N | NA |
| 4. Was pesticide applied to the inside of the home?
If yes, what type of pesticide is being used? _____
How often is pesticide applied? _____ | Y | N | NA |
| 5. Any dogs owned by family?
Dog history (health status, dog travel) | Y | N | NA |
| 6. Any free roaming dogs? | Y | N | NA |
| 7. Dogs in the neighborhood? | Y | N | NA |
| 8. Have ticks been seen on dog(s)? | Y | N | NA |
| 9. Have ticks been seen where the dog sleeps? | Y | N | NA |
| 10. Does the dog(s) have a tick collar? | Y#___ | N#___ | NA |
| 11. Are the dog(s) treated with a tick medicine?
If yes, what type? _____ | Y#___ | N#___ | NA |
| 12. Are pets allowed in the house? | Y | N | NA |
| 13. Has anyone in the family or visitors had a tick bite recently? | Y | N | NA |
| 14. Has there been family/visitor illness that resulted in fever or rash? | Y | N | NA |
| 15. Was a doctor seen as a result of illness or a tick bite? | Y | N | NA |

Check factors observed and recommendations for homeowner's action:

- Routine presence of stray dog(s) outdoors _____
- Pets kept indoors _____
- Yard not fenced _____
- Open cracks in siding _____
- Open cracks in foundation _____
- Dog house located next to the house _____
- Trash/debris around the house _____
- Area under house is open to dog(s) _____
- Mattress or upholstered furniture kept outside _____
- Outdoor sleeping area _____
- Firewood or other items stored near the house _____
- Firewood or other items stored directly on the ground _____
- Uncut grass/weeds/bushes near the house _____
- Untrimmed trees in yard _____
- Old non-operating vehicles near the house _____
- Water leaks or standing water near the house _____
- Improper pesticide application _____

- Recent activity in past 10 days (i.e. hiking, playing outdoors, etc.)_____
- Other (describe) _____

Monitoring pesticide resistance of brown dog ticks in tribal lands

As of 1-23-2020

BACKGROUND:

Brown dog ticks (*Rhipicephalus sanguineus*) are the primary vectors of *Rickettsia rickettsii*, the bacteria which causes RMSF, in Arizona and northern Mexico. There are four life stages of brown dog tick (egg, larva, nymph and adult), all of which can carry *R. rickettsii*. Brown dog ticks primarily feed on dogs, but may also bite small livestock, rabbits, and people. Ticks may remain active year-round due to warmer climate and close proximity to domestic settings. Brown dog ticks feed and mate on host but spend 95% of their time off-host. Integrated prevention practices using regular environmental pesticide application, long-lasting tick control products on dogs, community education and increased opportunities for spay and neuter have been associated with a significant reduction in human cases of RMSF.



Figure 1: *Rhipicephalus sanguineus* life states (from left to right: larva, nymph, flat adult male, flat adult female, fed adult female, fed adult female ready to lay eggs)

INTENDED AUDIENCE:

Tribal health programs, environmental health officers, and vector management professionals in areas with Rocky Mountain spotted fever (RMSF) spread by brown dog ticks.

OBJECTIVE:

Prevention of RMSF in high and moderate risk areas currently involves integrated pest management practices, including host-targeted and environmental pesticides. The primary objective of this document is to provide practical guidance on the monitoring of pesticide effectiveness and resistance in brown dog ticks.

Why monitor pesticide effectiveness and resistance?

Pesticides are used routinely to control the imminent threat of RMSF. Correct use of pesticides is important to prevent pesticide resistance and decreased pesticide susceptibility.¹ Monitoring the effectiveness of tick control efforts ensures the best, most successful products are used.

¹ To reduce pesticide resistance opportunities, CDC recommends routine cycling of environmental and host-targeted products every 12-18 months, preferably to a different class of pesticide. It is also important to make sure that products are

Pesticide susceptibility

Pesticide susceptibility simply means how well a chemical treatment is working to kill ticks. There are many factors that can affect pesticide susceptibility: concentration of the chemical, efficacy of the application (user error or obstructed application due to harborage), and genetic changes. The best methods to test pesticide susceptibility are complicated, typically requiring newly hatched larvae which have not been exposed to pesticides directly. These methods are not currently feasible for Arizona prevention practices.

Tracking effectiveness of pesticides

We can, however, track if individual treatments are or are not effective. We encourage tribes to record instances where products (animal and environmental) were applied and yet, 2 weeks later, ticks are still active either on a dog or in the home environment. This information can come from a telephone follow-up asking selected homes if they are still seeing tick activity, or by going back 2 weeks later to check in person (preferred). Maintain this information in your records. If after 2 treatments tick activity is still observed, consider using a different environmental chemical or tick control product on this animal the next time. Contact CDC if pesticide resistance is suspected.

RESISTANCE TESTING

Pesticide resistance refers most commonly to genetic changes that make a tick unaffected, or less affected by a pesticide. PCR tests can be used to identify gene mutations previously associated with pesticide resistance. The most common PCR assay looks for a mutation to a sodium channel receptor (Na⁺) which has been connected with pyrethroid resistance. We currently recommend resistance testing be done by tribes routinely applying pesticide to large portions of the community; largely high alert areas (communities with more than 2 cases per tribal community or any RMSF death).

Where to send ticks for testing

Commercial and state laboratories do not currently offer resistance testing for ticks. This test may be available at some academic institutions or at the CDC. If you wish to send tick samples in for resistance testing at CDC please contact Dr. William Nicholson wan6@cdc.gov. With approval, ticks can be sent to:

Attn: Disease Ecology Laboratory
Rickettsial Zoonoses Branch (Unit 217)
c/o Mail stop G-12
S.T.A.T.-D.A.S.H Receiving Laboratory
Centers for Disease Control and Prevention
1600 Clifton Road, NE
Atlanta, GA 30333

Methods of collection

Option #1 Convenience sampling from dogs

Dogs are the primary host for *Rh. sanguineus* and serve as an important sentinel (early warning system) for tick activity and human RMSF. Observing ticks on dogs is an easy and cost-efficient way of tracking relative tick

applied according to label instructions because under-dosing of pesticide, or improper application can reduce the efficacy of products and promote development of resistance in ticks.

burden in a community environment where free-roaming dogs may be common. Heavily infested dogs in the immediate area are a risk factor for human RMSF cases.

Ticks collected from dogs represent a convenience sample and therefore may not be a good representation of what is happening throughout a reservation community. However, they are easy sampling sources. Testing ticks collected from dogs for pesticide resistance can give you a good idea on the presence/absence of pesticide resistance, but cannot tell you how frequently this is occurring.

When to collect

We currently recommend collecting tick samples for testing once per year, in the spring, prior to the first prevention campaign.

Types of information to collect

- Geographic information (at minimum neighborhood, could also use GPS coordinates or description of location)
- Reservation community
- Type of sampling (removed from dog)
- Dog identifier (name, ID number, or description)
- Seresto collar (yes/no)
- Other tick control product: (list and date of last application)
- Date of collection
- Number of ticks collected

Sample size

Ideally, you should collect 5-10 ticks per dog from 10 dogs per neighborhood (a total of 50-100 ticks per neighborhood/housing district). Samples can be pooled by dog and results will be provided back by dog. Try to collect flatter ticks from dogs.

Storage

Place ticks into vials of 90-95% alcohol with other ticks collected from the same dog.

Option #2 Systematic tick collection using CO₂ traps

Systematic sampling of flat (host-seeking) ticks provides information that is more representative of a geographic area and can be used to tell how often (relative frequency) pesticide resistance is occurring across a community. However, it requires more time and resources. Host-seeking ticks are collected using a CO₂ emitting, dry ice trap (see appendix for recommended protocol).

When to sample

Systematic sampling should be conducted at least once a year, typically in the spring or summer. Sampling should be done at the same time of day (morning or midday preferred), in similar weather conditions, using the same methods for each location.

Types of information to collect

- Geographic information (at minimum neighborhood, could also use GPS coordinates or description of location)
- Reservation community
- Type of sampling (dry ice trapping)
- Are there dogs on property? (yes/no)
- Was environmental pesticide applied within the last 30 days (yes/no), if so, what chemical?
- Date of collection
- Number of ticks collected

Sample size

For a 200 household community, select 5 households or areas separated from one another within a neighborhood or housing district. Up to 3 dry ice traps will be set at each of the 5 households. No more than 20 ticks should be sent for testing per household.

Storage

Place ticks into vials of 90-95% alcohol with other ticks collected from the same household.

TESTING TICKS FOR PATHOGENS

Testing of ticks for bacteria can provide information about the presence/absence of rickettsial pathogens in a given area. Positive ticks indicate the presence of a rickettsial pathogen in a given area, **negative ticks do not necessarily mean the pathogen is not present in your area** and may just mean that that particular tick was not carrying bacteria. It is not currently known what density of infected *Rh. sanguineus* are needed in order to support human disease transmission. Studies have shown that even in areas with epidemic levels of human RMSF, only a small proportion of ticks (<1%) are carrying *R. rickettsii*².

As with resistance testing, fed ticks can be collected from dogs as a convenience sample, or unfed ticks can be collected from dry ice trapping. PCR tests are available through public and private laboratories. Be sure that your laboratory is using validated (proven) tests. Please talk to CDC about which laboratories use validated tests.

- Pan rickettsia assay: tests for any rickettsial bacteria (even those that are not known to cause human disease) using primers PanR8³
- RICK assay: specific for *Rickettsia rickettsii*, the bacteria that causes RMSF, using primers RRi6⁴
- 16S: utilizes a target shared across many bacteria

LIMITATIONS

Pathogen and resistance testing do not currently provide a real-time response about disease risk or resistance profiles. Results may take weeks or months. Interpretation of results should always take into context the limitations of how samples were collected. We do not currently understand what proportion of resistant ticks may make a treatment ineffective, and we do not know what proportion of infected ticks place people at risk.

² Foley, J., Tinoco-Gracia, L., Rodriguez-Lomelí, M., Estrada-Guzmán, J., Fierro, M., et al. (2019). Unbiased Assessment of Abundance of *Rhipicephalus sanguineus sensu lato* Ticks, Canine Exposure to Spotted Fever Group Rickettsia, and Risk Factors in Mexicali, México. *101*(1), 22-32. doi:<https://doi.org/10.4269/ajtmh.18-0878>

³ Kato, C. Y., Chung, I. H., Robinson, L. K., Austin, A. L., Dasch, G. A., & Massung, R. F. (2013). Assessment of real-time PCR assay for detection of *Rickettsia* spp. and *Rickettsia rickettsii* in banked clinical samples. *Journal of clinical microbiology*, *51*(1), 314-317.

Tick Trapping Guide

Equipment

- List of home sites/trapping locations
- Trapping log (to record pertinent information like trap location)
- GPS (optional)
- White flannel cloth (~ 3 square feet)
- CO₂ containers (plastic containers with holes or insulated paint container)
- Dry ice
- Plastic re-sealable zipper bags (size = 1 gallon)
- Pen/pencil
- Labels
- Sealable Vials
- 90-95% alcohol

How to Set Trap

1. Set up to 3 traps per home site
2. Set traps around perimeter of house (within ~10' from base of house), in shady spots where dogs lay (e.g. under porches, stairs, ramadas, car ports, trees), or near locations ticks can be found (e.g. water source like leaking hose bib); note if trap in sun for more than 30-60 minutes, ticks will leave trap
3. Spread cloth on ground
4. Secure cloth so it does not blow away (e.g. rocks)
5. Safely place dry ice in container with holes
6. Set container with dry ice in center of cloth
7. Record the date, trap #, location, and "start" time in the log
8. Leave the trap set for at least 3-4 hours

How to Collect Trap

1. Record the "end" time in the log
2. Remove container with dry ice from cloth

Either:

- Fold cloth carefully to ensure ticks do not fall off (corners – to the center)
- Place cloth in plastic re-sealable zipper storage bag (1 cloth per bag)
- Label bag with date, trap#, location
- Place all bags in freezer overnight to freeze ticks

Or:

- Carefully pick ticks off flannel cloth with fine tipped tweezers and place into 90-95% alcohol in sealable vials
- Place vials in zip plastic re-sealable zipper storage bag (1 cloth per bag)
- Label bag with date, trap#, location

Contact laboratory for testing and arrange shipping

Pesticide classifications and active ingredients registered with US EPA

Pesticide class	Active ingredient	Uses
Pyrethroid	Permethrin	Human, animal and environmental
Pyrethroid	Deltamethrin	Animal and environmental
Pyrethroid	Flumethrin	Animal
Pyrethroid	Bifenthrin	Environmental
Pyrethroid	Beta-cyfluthrin	Environmental
Amidine	Amitraz	Animal and environmental
Phenylpyrazole	Fipronil	Animal and environmental
Isoxazole	Fluralaner/Afoxolaner	Animal
Carbamate	Propoxur	Animal and environmental
Carbamate	Carbaryl	Environmental

NOTE: each state and tribal community is responsible for reviewing and approving pesticides for use in their area.

Sample tick collection forms

HOMESITE TICK TRAPPING RECORD

Assessed by: _____ Date: _____

Community: _____

Description of home: _____

Location of trap: _____

Was environmental pesticide applied within the last 30 days: Y N

If so, what chemical: _____

Date of last application: _____

Dog Presence: Y N Wood pile: Y N

Fence: Y N Refuse/Trash: Y N

Tick Assessment (2-4 hour period):

Describe location of trap:

Time started: _____ am pm

Time ended: _____ am pm

- Tick Index: [] No ticks (0)
 [] 0-10 ticks (1)
 [] 11-100 ticks (2)
 [] > 100 ticks (3)

Total number of ticks: _____

Comments:

TICK COLLECTION FROM DOGS

Assessed by: _____ **Date:** _____

Community: _____

Description of dog (ID, name or description):

Was a tick control product (collar, top spot, oral) used in the last 30 days? Y N

If so, what product?: _____

Date of last application: _____

Total number of ticks: _____

Comments:

Resources:

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