The Heat Is On: Killing Blacklegged Ticks in Residential Washers and Dryers to Prevent Tickborne Diseases

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Background

According to the Centers for Disease Control and Prevention (CDC) > 300,000 Americans contract Lyme disease each year, and the incidence of Lyme disease and other tick-borne diseases has steadily increased over the past two decades. Reducing exposure to ticks is important to prevent Lyme disease and other tick-borne diseases. Although the risk of tick bites can be reduced by application of repellents and conducting tick checks, these are often not practiced by individuals due to safety concerns, time constraints, and other factors[1]. Therefore, it is important to identify additional effective, easily implemented methods to reduce tick bites.

CDC recommends drying clothes on high heat for one hour as a means of killing residual ticks on clothing after spending time outdoors. This recommendation, however, is based on a single study which investigated tick survival under various washing conditions, followed by a single predetermined one-hour drying time[2]. The objective of this study was to determine the minimum amount of time necessary to kill ticks in residential clothing dryers.

Methods

We conducted a comprehensive series of trials investigating the effects of time, temperature, humidity, clothing type (thin and thick), and model of washer and dryer on killing adult & nymphal blacklegged ticks. Five ticks each were secured inside muslin bags during washing and drying (Figure 1.)

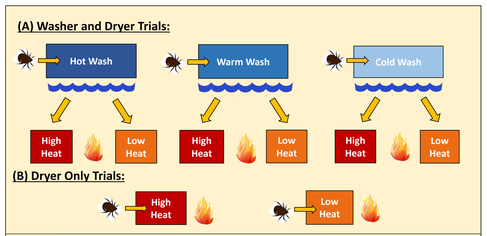

Figure 1: (A) Ticks were washed in either hot, warm, or cold water with cotton towels then dried on either high or low heat. **(B)** For the second arm of the study, ticks were placed directly in the dryer with dry cotton towels and dried on either high or low heat.

During each round of testing, 10-20 ticks were placed in petri dishes in the laundry area to serve as controls and assessed for survival at 24 hours.

Water temperature was measured during the beginning of both the wash and rinse cycles using the Cooper-Atkins SRH77A Thermo-Hygrometer. We also measured temperature and humidity levels inside the dryer prior to removing ticks at each of the predetermined drying times. Three different washer and dryer models were used for testing*.

To date, we have conducted four rounds of testing with a total of 1,080 ticks (600 nymphs and 480 adults).

We used laboratory reared colonies of uninfected *Ixodes scapularis* ticks from the Oklahoma State University Tick Rearing Facility.

*Washers-GE, Fisher & Paykel, Kenmore; Dryers- GE, Admiral, Maytag

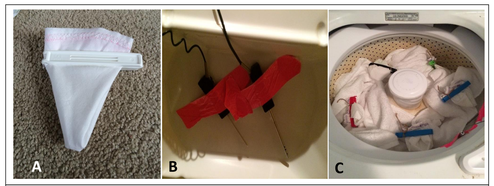

Figure 2: (A) Muslin bag used to confine ticks during washing & drying **(B)** Temperature and humidity probes attached inside dryer **(C)** Towels with muslin bags in the washer

Results

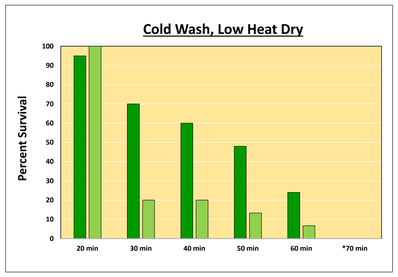

Figure 3: Nymphs (light green) and adults (dark green) washed in cold water then dried on low heat. All nymphs and adults were dead at 70 min. Nymphs= 60 ticks total, Adults= 60 ticks total, *includes 65 min (adults)

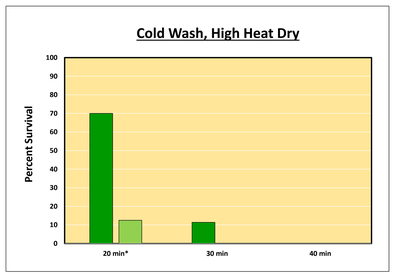

Figure 4: Nymphs (light green) and adults (dark green) washed in cold water then dried high heat. All nymphs were dead at 30 min and all adults were dead at 40 min. Nymphs= 45 ticks total, Adults= 50 ticks total, *includes 22:30

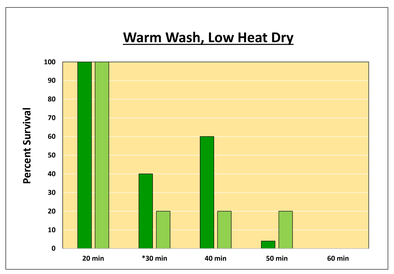

Figure 5: Nymphs (light green) and adults (dark green) washed in warm water then dried on low heat. All nymphs and adults were dead at 60 min. Nymphs= 60 ticks total, Adults= 55 ticks total, *includes 33 min (adults)

Table 1: Temperature and Relative Humidity Ranges

Washer Model	Temperature Range in °F		
	Hot Wash	Warm Wash	Cold Wash
GE	105-107	80-84	59-64
Kenmore	129-130	91-93	63-66
Fisher & Paykel	111-130	106-115	75-80

Dryer Model	Temperature Range in °F		Relative Humidity Range	
	High Heat	Low Heat	High Heat	Low Heat
GE	138-184	110-160	4-25%	7-29%
Admiral	127-186	112-168	3-15%	4-24%
Maytag	150-171	112-146	5-11%	5-17%

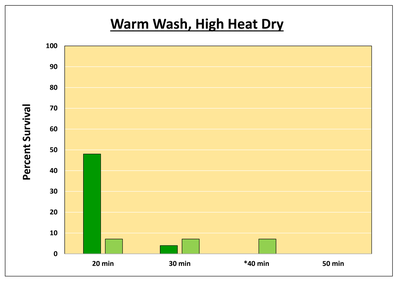

Figure 6: Nymphs (light green) and adults (dark green) washed in warm water then dried on high heat. All nymphs were dead at 50 min and all adults were dead at 40 min. Nymphs= 60 ticks total, Adults= 50 ticks total, *included 40.5 min (nymphs) 41 min (adults)

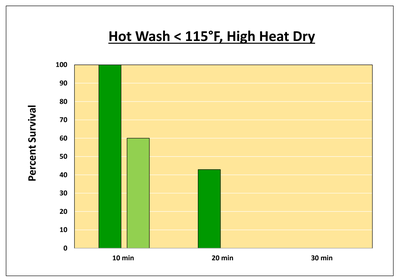

Figure 7: Nymphs (light green) and adults (dark green) washed in hot water < 115°F then dried on high heat. All nymphs were dead at 20 min and all adults were dead at 30 min. Nymphs= 100 ticks total, Adults= 14 ticks total

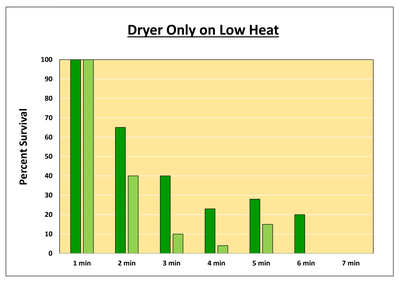

Figure 8: Nymphs (light green) and adults (dark green) directly placed in the dryer on low heat. All nymphs and adults were dead at 7 min. Nymphs= 60 ticks total, Adults= 60 ticks total

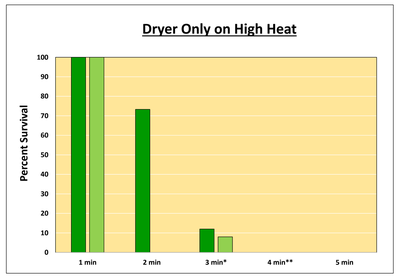

Figure 9: Nymphs (light green) and adults (dark green) directly placed in the dryer on high heat. All nymphs were dead at 4 min and all adults were dead at 5 min. Nymphs= 65, Adults= 50 ticks total, *includes 3:26 min (nymphs) **includes 4:26 min (nymphs)

We found that there was no statistically significant effect of wash temperature on subsequent survival **in <u>low or high</u>** heat dry cycle.

Table 2: Summary of the Minimum Time Needed To Kill Ticks In the Dryer

After Cold Wash	
Low Heat	70 min
High Heat	40 min
After Warm Wash	
Low Heat	60 min
High Heat	50 min
After Hot Wash Less than 115°F	
High Heat	30 min
No Wash	
Low Heat	7 min
High Heat	5 min

Additionally, we found that **<u>if both nymphal and adult ticks were washed in hot water greater than 115°F, all ticks died during washing (Table 3).</u>**

Table 3: Tick Survival in Hot Washes at Varies Temperatures

Hot Wash Temperature	Percent Survival After Wash
107°F	100%
111°F	55%
115°F	0%
130°F	0%

<u>Additional Variables Tested:</u>
Although statistical analysis is still in process, <u>thickness of clothes</u> and use of <u>detergent or dryer sheets</u> did not appear to alter tick survival during washing and drying.

Conclusions

In summary, all ticks survived both cold and warm washes. However, tick survival varied considerably depending on the temperature of the wash cycles. **<u>Water temperatures > 115°F resulted in complete mortality of all ticks during washing.</u>**

For those ticks that survived a wash cycle, it took an additional 30-70 min in the dryer, depending on the temperature of the dryer, to kill all the ticks after washing.

<u>Most significantly, we found that all adult and nymphal ticks were killed when dried with dry towels for 5 min on high heat or 7 min on low heat.</u> Our results seem to indicate that blacklegged ticks are relatively tolerant of moist heat in the dryer but not desiccation (i.e. dry heat).

There are some limitations to our study. The muslin bags which contained the test ticks may have protected the ticks somewhat from heat and dryness. In addition, stopping and restarting the dryer at pre-determined time points may have released heat and decreased temperature. Therefore, the drying times we found necessary to kill ticks are likely conservative and could be even shorter. Lastly, we only used lab-raised *I. scapularis* ticks but survival of wild-caught ticks and different species of ticks may vary.

Through this study we have identified an effective and easy method to kill residual ticks on clothing, potentially reducing the risk of tickborne diseases.

<u>Possible New Recommendations for Killing Ticks on Clothing:</u>

1) **After spending time outdoors, place clothing directly in dryer and run for 5 minutes on high heat or 7 minutes on low heat.**
2) **If clothes are heavily soiled and require washing first, if possible wash on hot cycle with water temperature greater than 115°F.**
3) **If it is not possible to wash with a temperature greater than 115°F, clothes should be dried for 70 minutes on low heat or 50 minutes on high heat to kill blacklegged ticks after washing.**

<u>References:</u>

1. Due C, Fox W, Medlock JM, Pietzsch M, Logan JG. Tick bite prevention and tick removal. BMJ 9;347:f7123. 2013
2. Carroll JF. A Cautionary Note: Survival of Nymphs of Two Species of Ticks (Acari: Ixodidae) Among Clothes Laundered in an Automatic Washer. Journal of Medical Entomology 40(5):732-736. 2003