Spread of H5N1 on Dairy Farms

Seema Lakdawala

Co-Director, Emory Center for Transmission of Airborne Pathogens

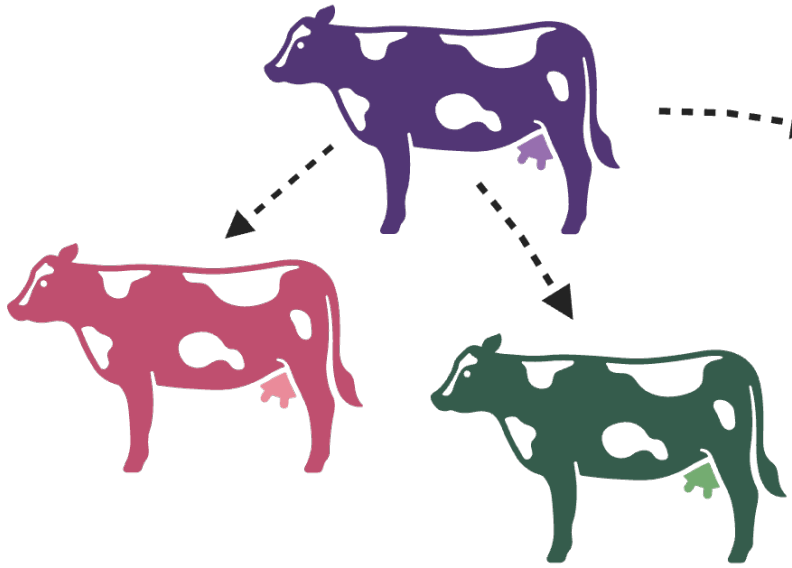
EMORY UNIVERSITY SCHOOL OF MEDICINE

CTAP

Disclosures

I receive funds from the NIH and Flu Lab.

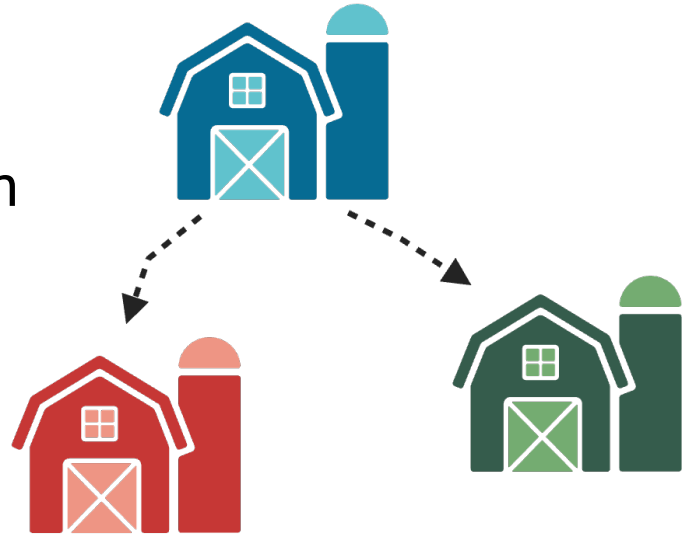
Spread of H5N1 on Dairy Farms



Cow-to-cow transmission

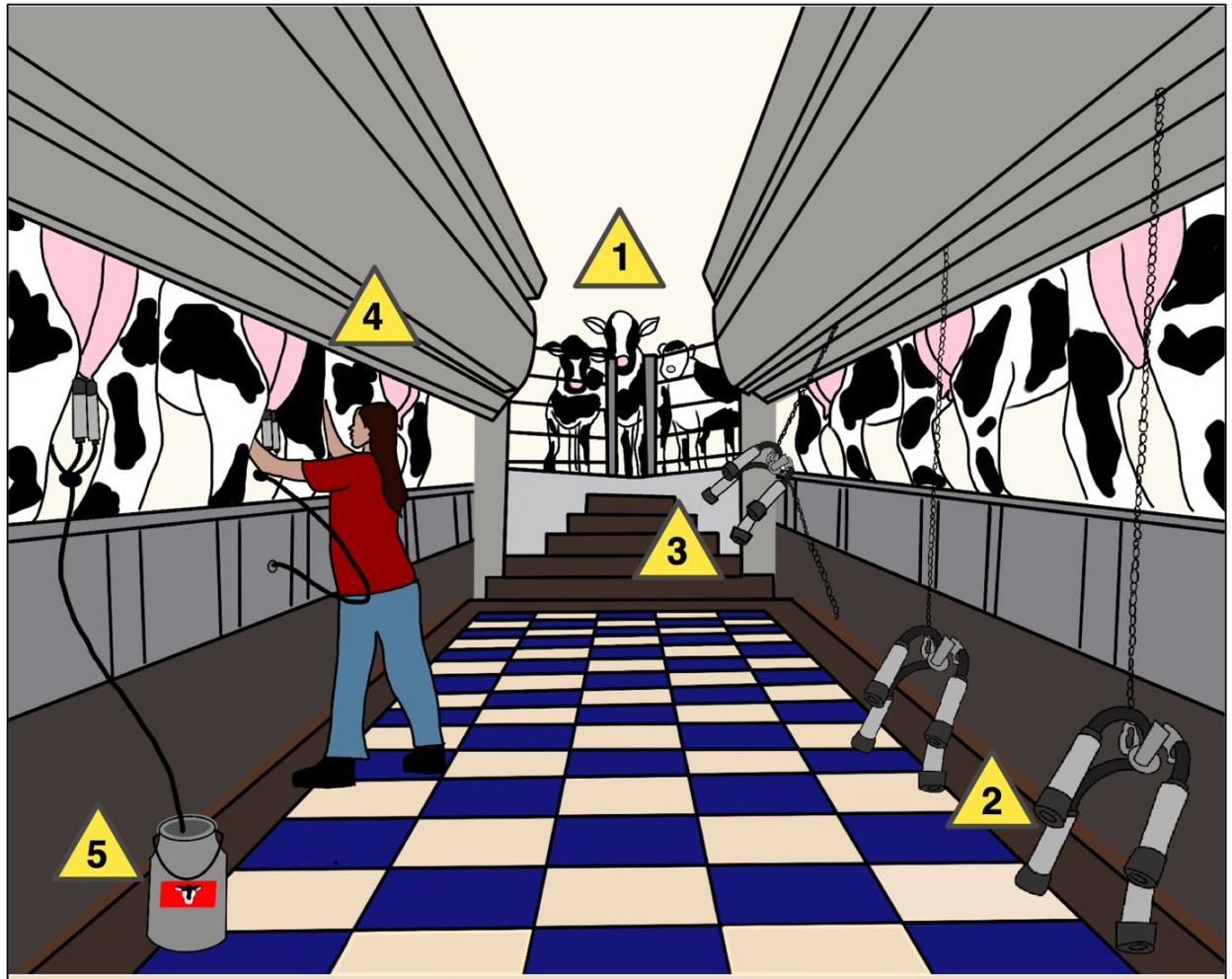
Cow-to-human transmission

Important to know where the virus is to decipher possible transmission modes

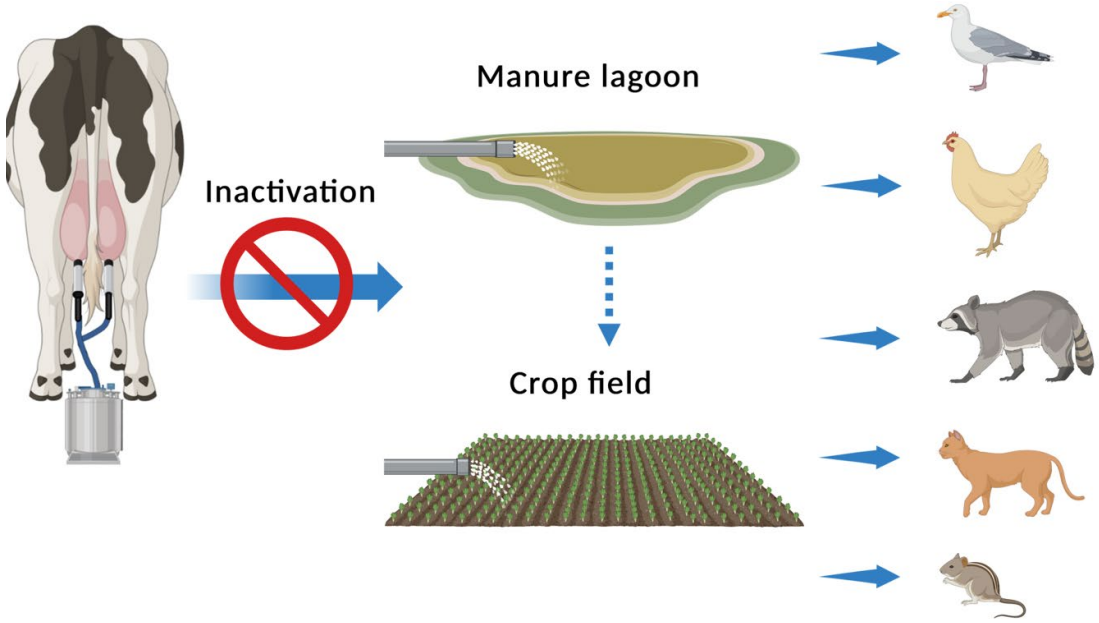


Farm-to-farm transmission

Dairy Parlors and Manure Lagoons



1. Crowding in holding pen; no tracking of which cows use which equipment
2. Milking equipment not cleaned between animals
3. Splatter and aerosolization of milk, e.g. from release of milking units and forestripping
4. Workers at eye level and at close range to cows; often lack of PPE
5. Collection of milk from sick cows and how to handle disposal



Likely transmission mechanisms

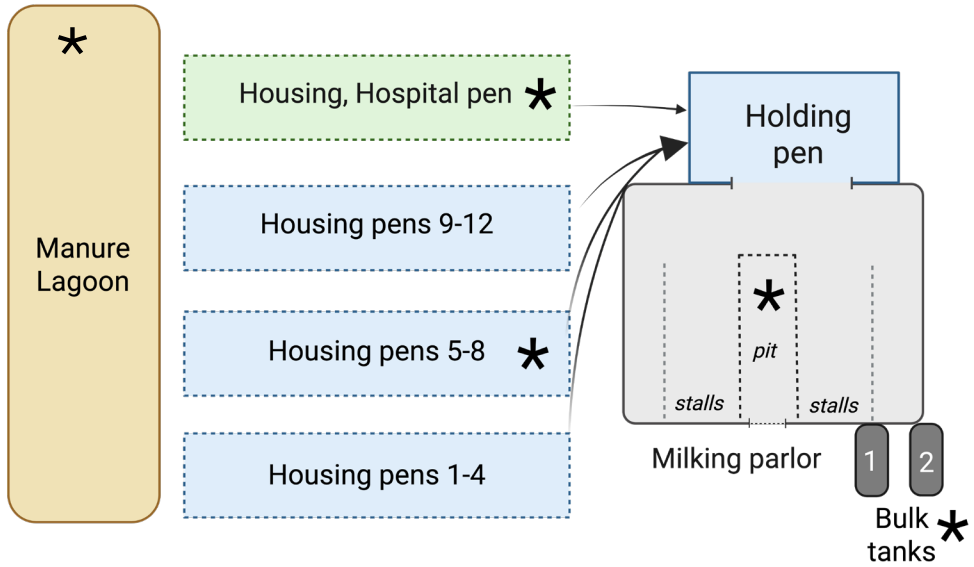
Contaminated surfaces

Aerosols

Campbell et al mBio 2025

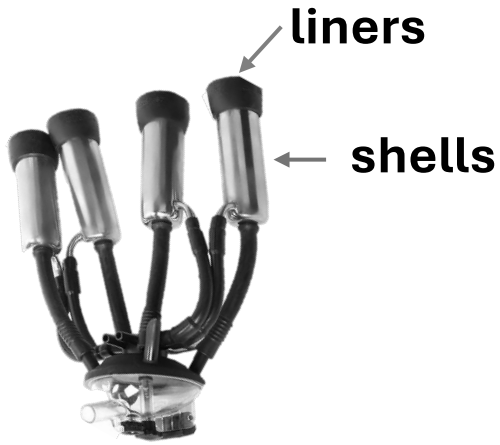
Assessment of H5N1 on Dairy Farms in CA During Active Outbreaks

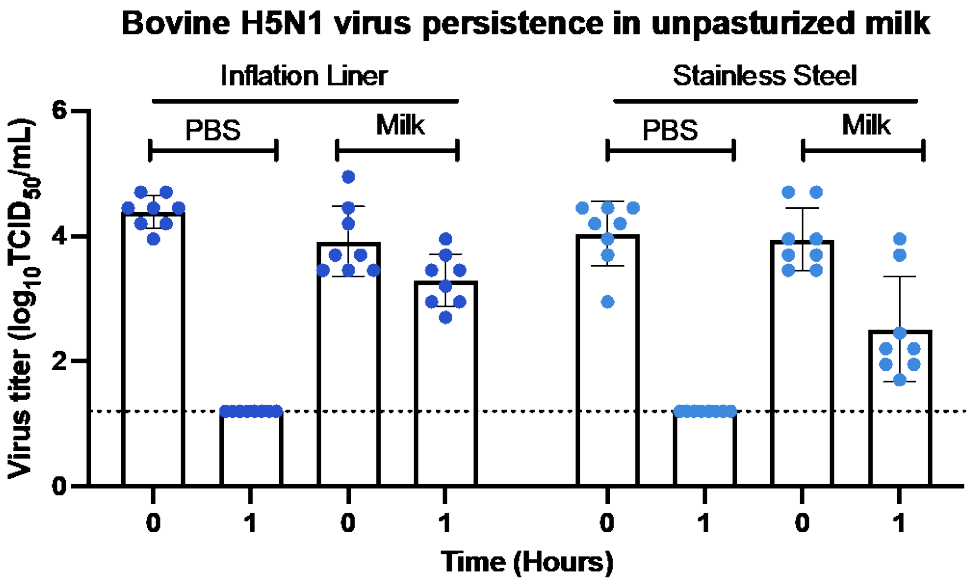
* Locations of sampling efforts

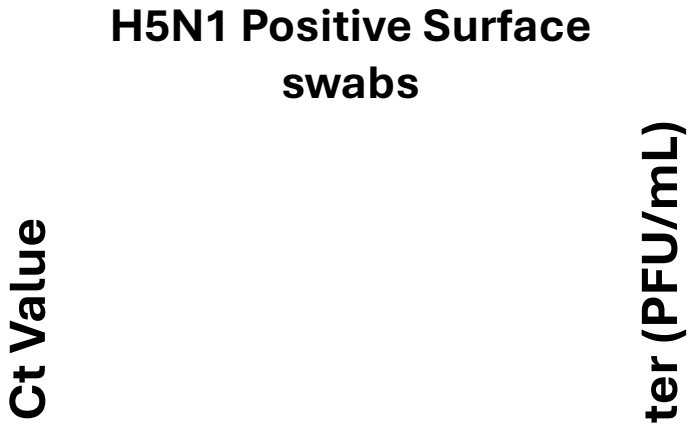


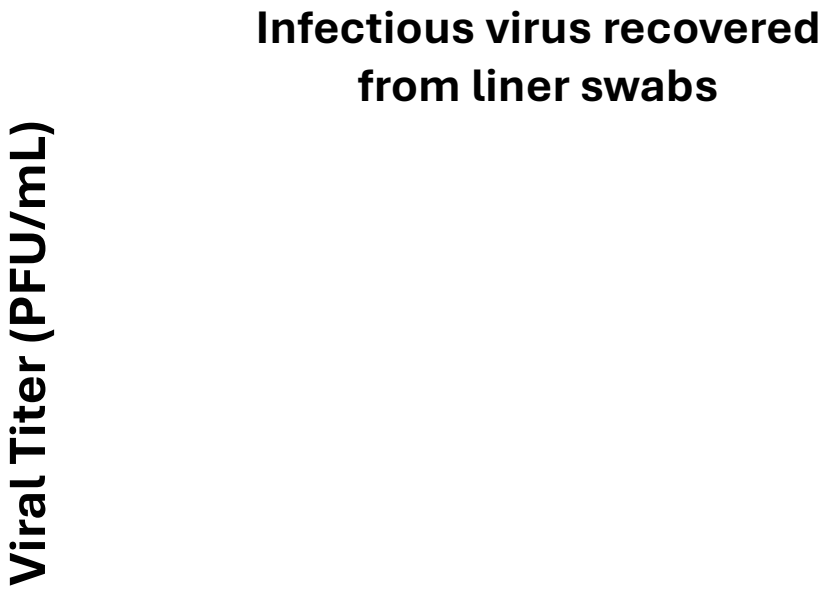
Collaboration: Jason Lombard (CSU), Blaine Melody (Lander Vet Clinic); Milk Producers Council (Kevin Abernathy and Betsy Hunter-Binns), CA dairy Research Foundation (Denise Mullinax), CA Dept of Food and Agriculture (Edie Marshall), Marlene Wolfe and Abby Paulos (Emory University)

Infectious H5N1 Virus on Milking Equipment









Milk can increase the persistence of infectious H5N1 on milking surfaces

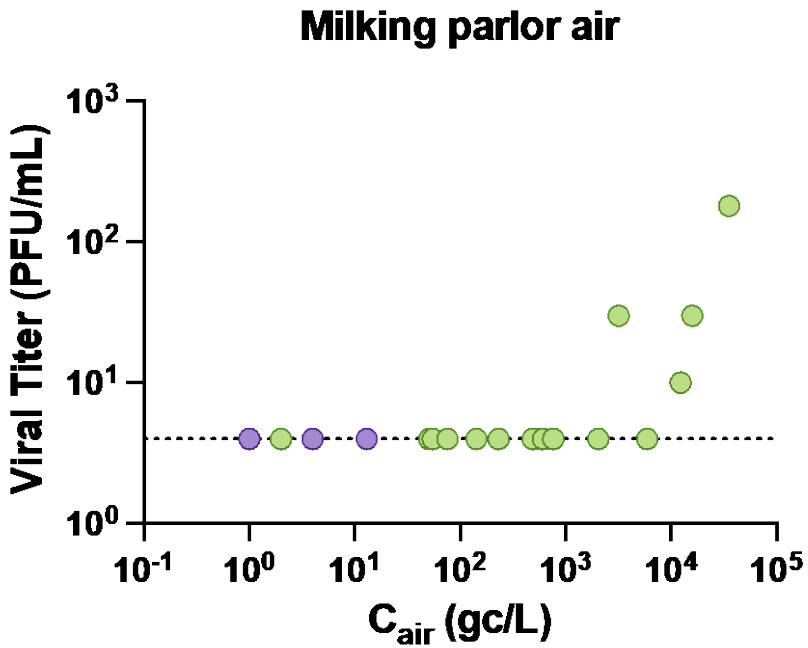
Le Sage et al EID 2024
Campbell et al bioRxiV 2025

Detection of Infectious Virus in Milking Parlor Air

Using MD8 Sartorius Air Sampler 50 LPM

Milking Parlor

Exhaled Breath



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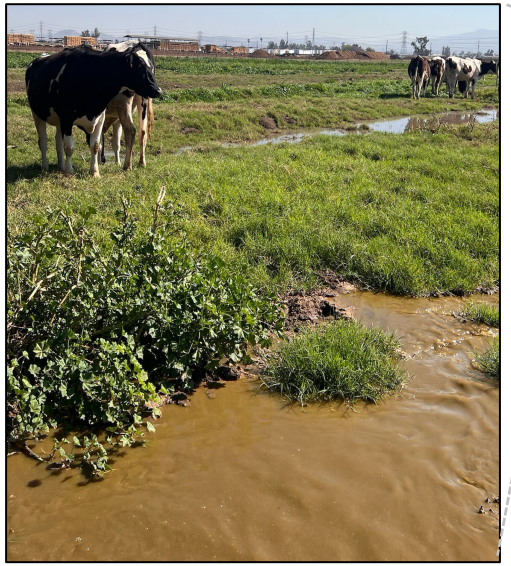
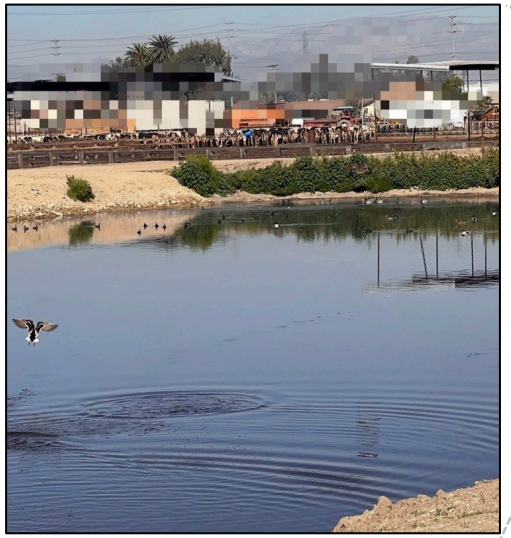
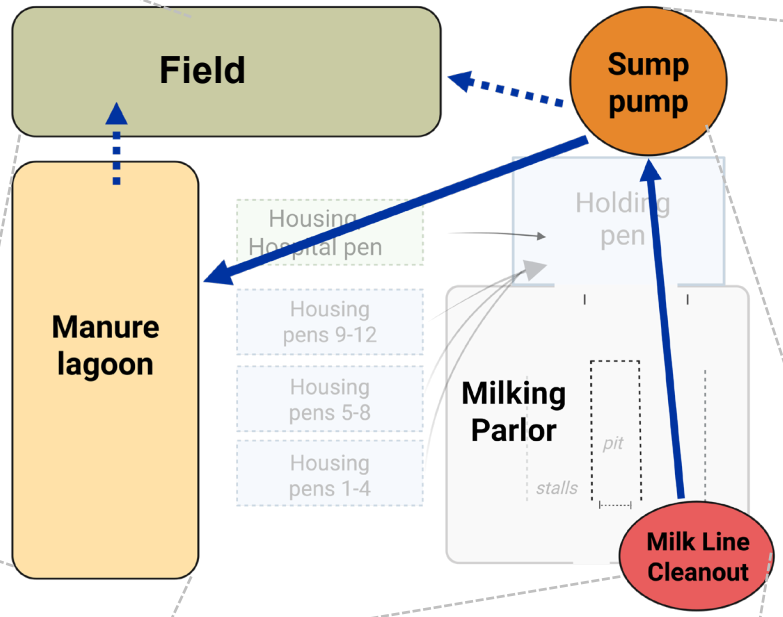
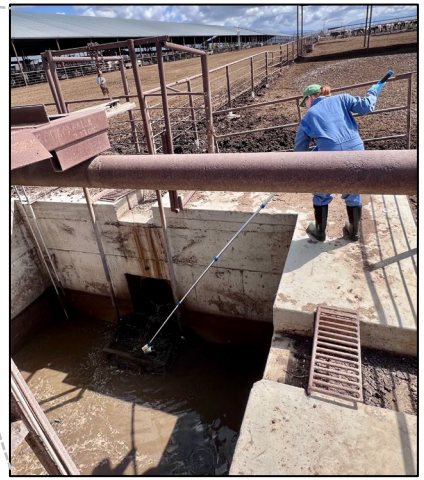
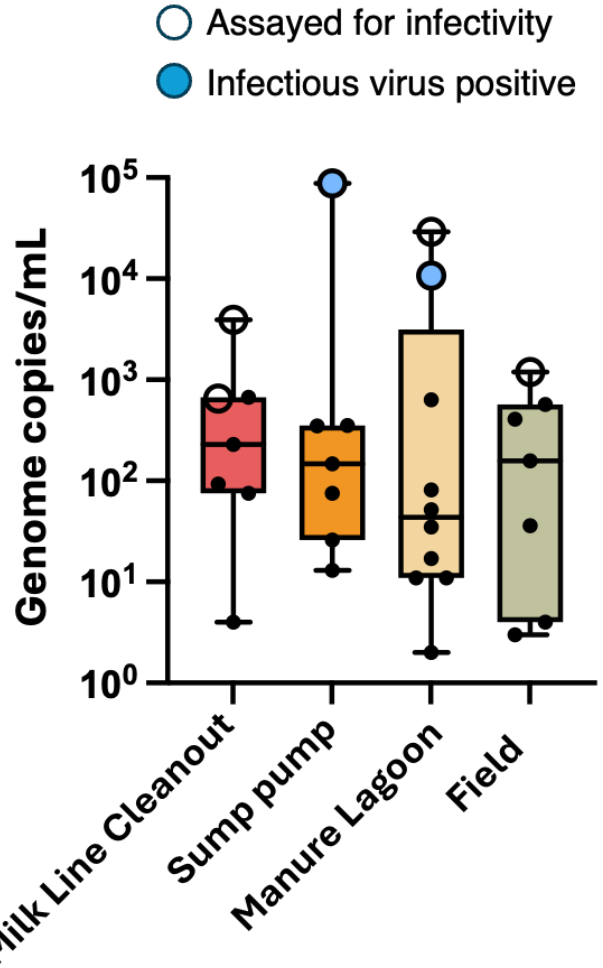
Infectious H5N1 Virus in Farm Waste Streams











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Abby Paulos and Marlene Wolfe

Inactivation of H5N1 in Waste Milk Achieved with Common Acids

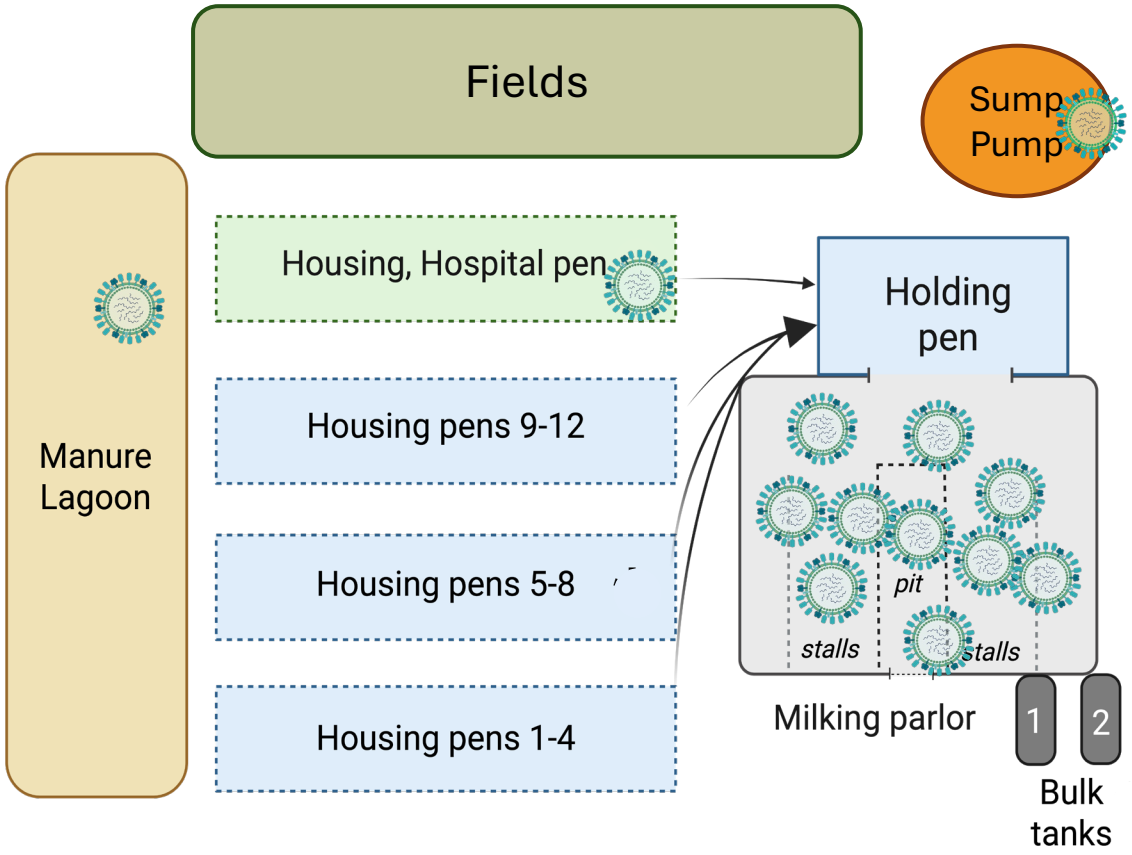
Inactivation of H5N1 in Raw Milk

Untreated (pH=6.7)	10% Lemon Juice (pH=4.4)	1.5% Vinegar (pH=3.9)	3% Vinegar (pH=3.6)

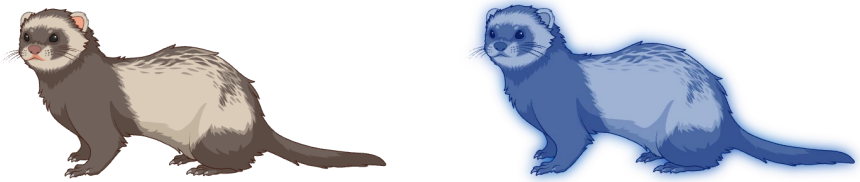
Alteration of Milk pH to <4.0 can reduce the infectivity of the virus in waste milk within 1 hour

Lakdawala unpublished data

Abundance of H5N1 Virus In Milking Parlor

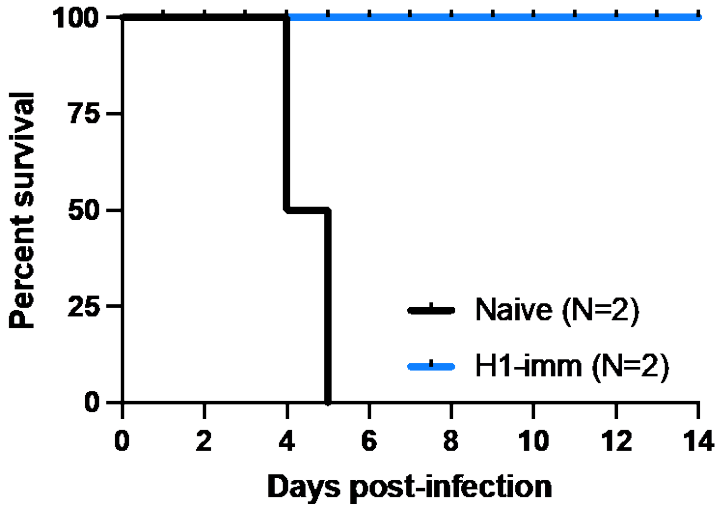


Why has the viral infection in dairy workers been primarily mild?



No immunity H1N1 immune

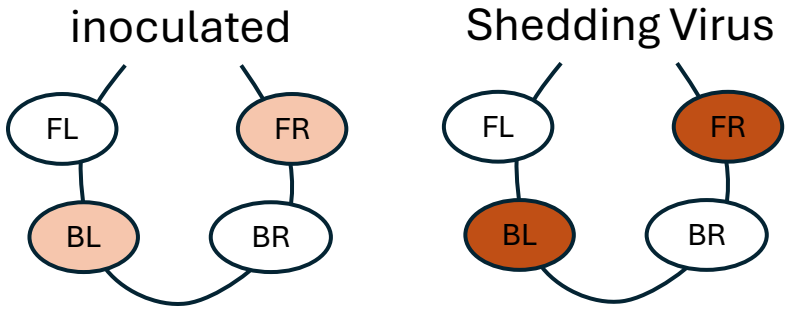
+ H5N1 virus



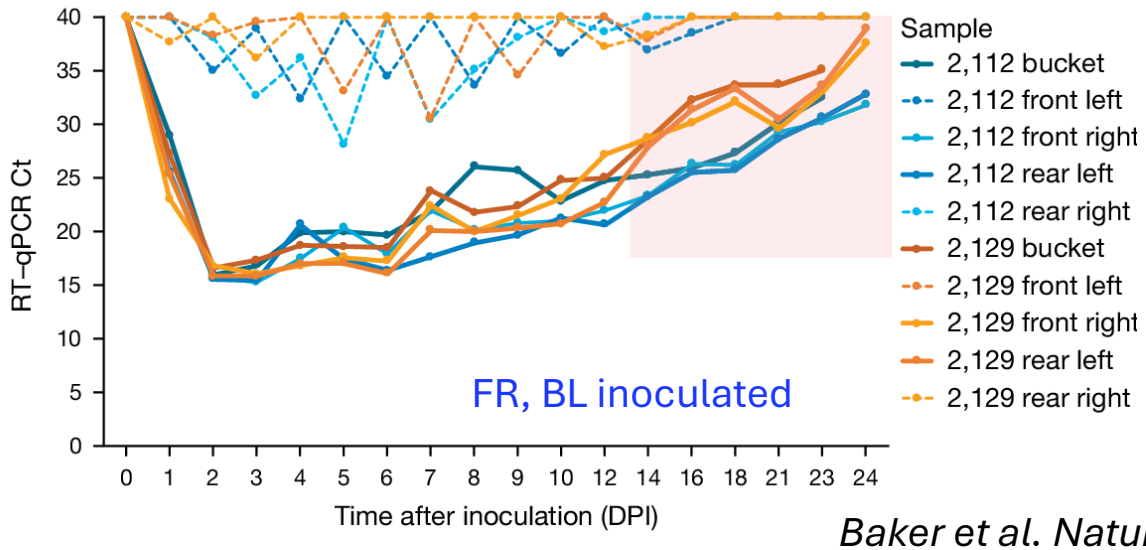
Le Sage et al EID 2025

Udderly Amazing Cows: Distinct Routes of Inoculation will alter the Anatomical Site of Viral Replication

Experimental Intramammary Infection

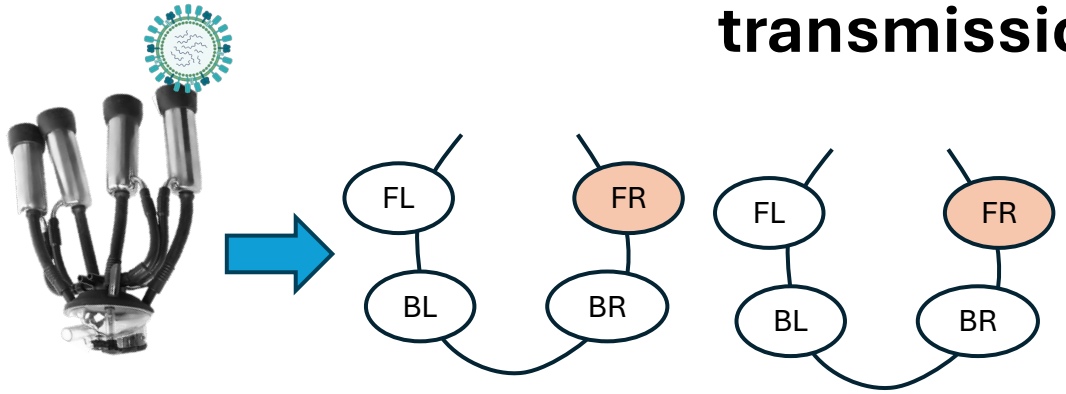


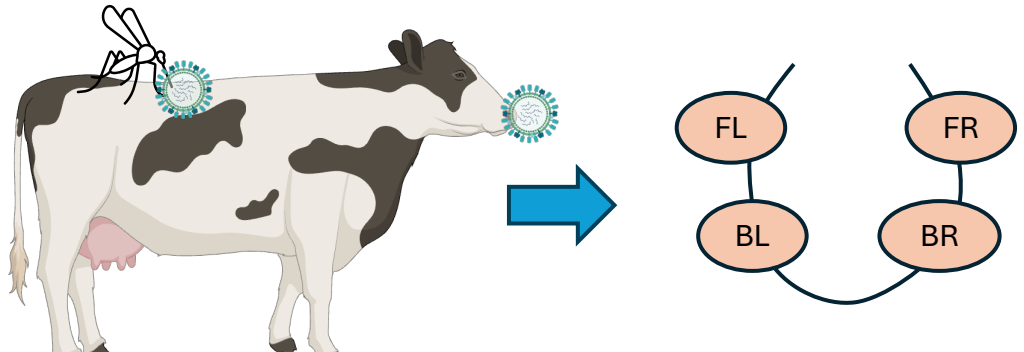
Virus does not move between quarters!



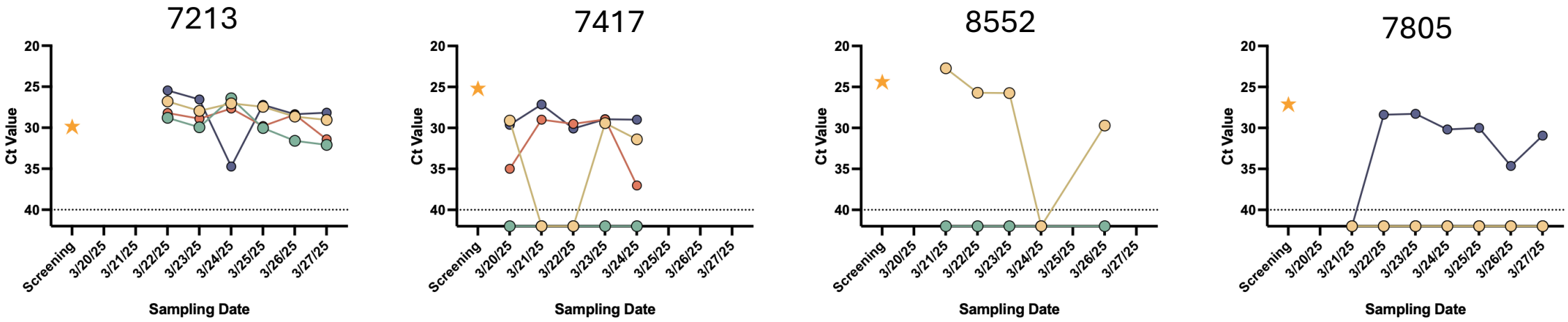
Baker et al. Nature. 2025

Can quarter level information inform H5N1 transmission routes?

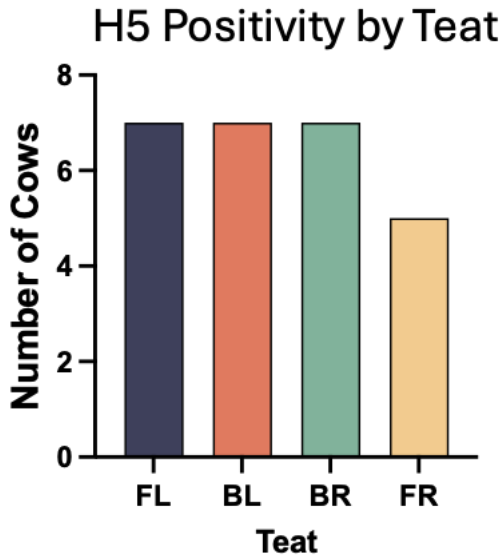




H5N1 Quarter Positivity is Heterogeneous



H5N1 Positivity



Mastitis No clinical signs

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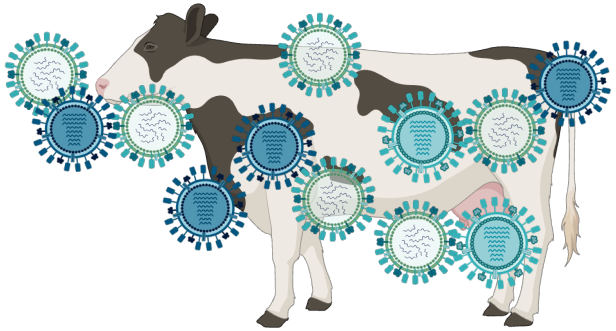
Take home messages..

- Milking parlor has a high density of virus in the air and on surfaces.
- Subclinical cows can be infected with H5N1 virus.
- PPE use and virus inactivation in waste milk and on surfaces should be employed to reduce exposure risk.
- Immunity to seasonal H1N1 viruses from prior infections (but not vaccination) likely reduces severity of H5N1 disease.

Multiple modes of transmission exist on farms and will require multiple interventions.



THE FLU-TASTIC TEAM!

Lakdawala Lab
Matthew Pauley
AJ Campbell
Ashish Mishra
Michelle Vu
Nirmal Kumar
Meredith Shephard
G Humber
Kayla Brizuela
Grace Quirk
Kaitlyn Bushfield
Julie Nguyen
Tobi Lawal

U. of Pittsburgh
Valerie Le Sage

Former members
Eric Nturibi
Amar Bhagwat
Karen Kormuth
Richard Manivanh
Annika Avery
Jennifer Jones
Janie French
Cami Brown
Nicole Rockey
Krishna Patel
Bailee Werner
Mckenzie Mullis

Thanks to all the Dairy Producers and Farm Workers!

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Milk Producers Council
Kevin Abernathy
Betsy Hunter-Binns

CDFA
Edie Marshall

U. of Michigan
Adam Lauring
Emily E. Bendall
William J. Fitzimmons

U. of Colorado
Jenna Guthmiller

Virginia Tech
Linsey Marr

University of Pittsburgh
Paul Duprex

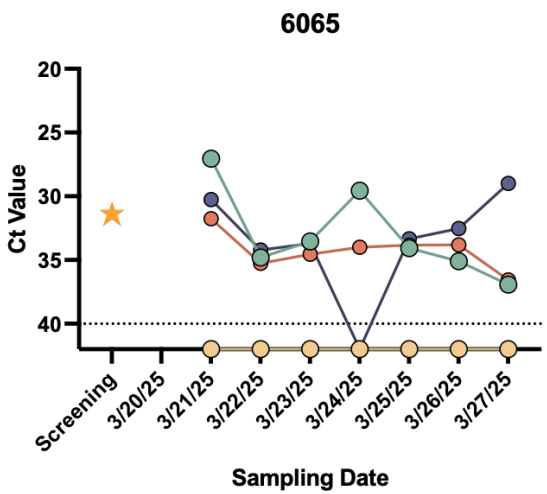
Emory University
Marlene Wolfe
Abby Paulos
Orlando Sablon

Colorado State
Jason Lombard
Chloe Stenkamp-Strahm

Lander Veterinary Diagnostic Clinic
Blain Melody

U. Of Pennsylvania
Louis Moncla
Scott Hensley
Jeffrey Santos

Schematics Created with BioRender.com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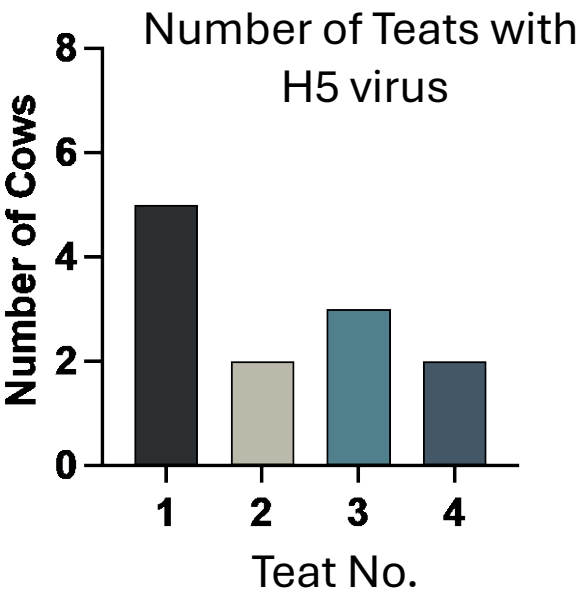
Sampling Date

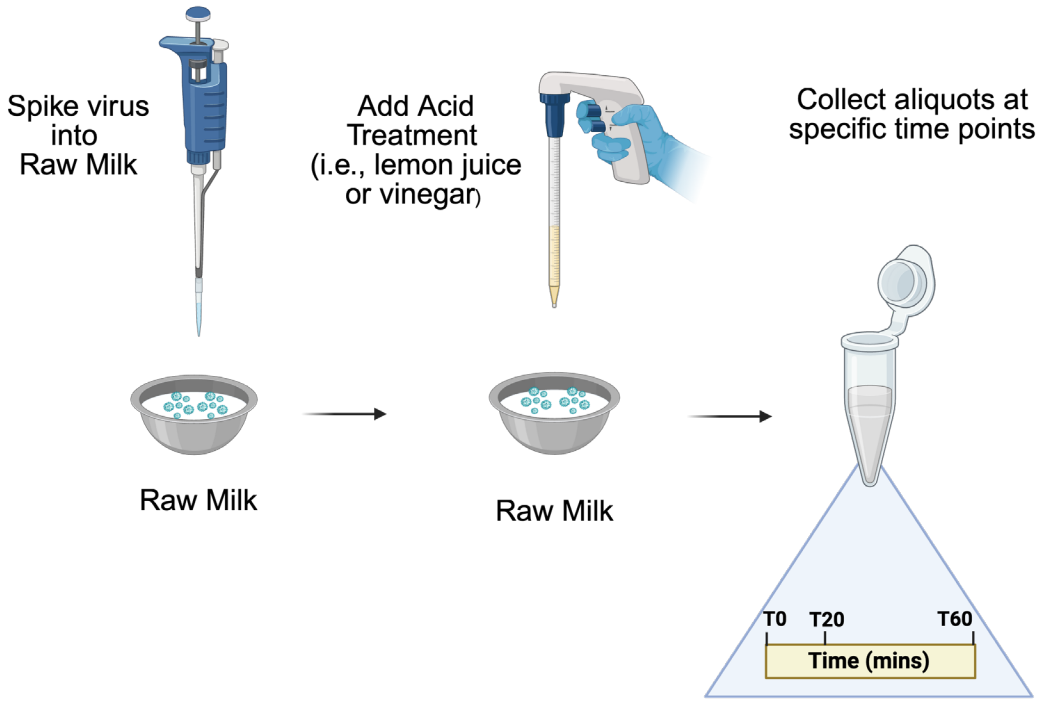
H5N1 Quarter Positivity is Heterogeneous in Nature

Mastitis



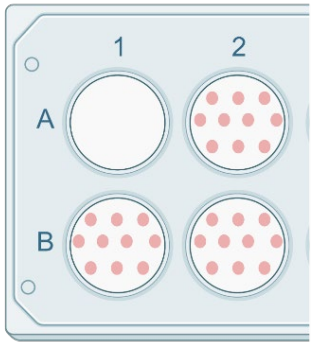
H5 Positivity by Teat

Low pH solutions could be used to inactivate sick milk prior to the waste stream

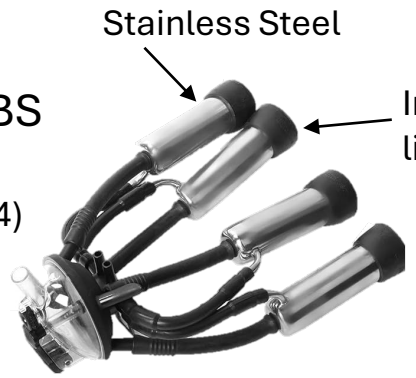


Milk Protects H5N1 from Decay on Milking Equipment

Dilute stock of H5N1
1 part: 9 parts raw milk or PBS
Titer: ~10^4.5
(A/dairycattle/Texas/24008749001/2024)

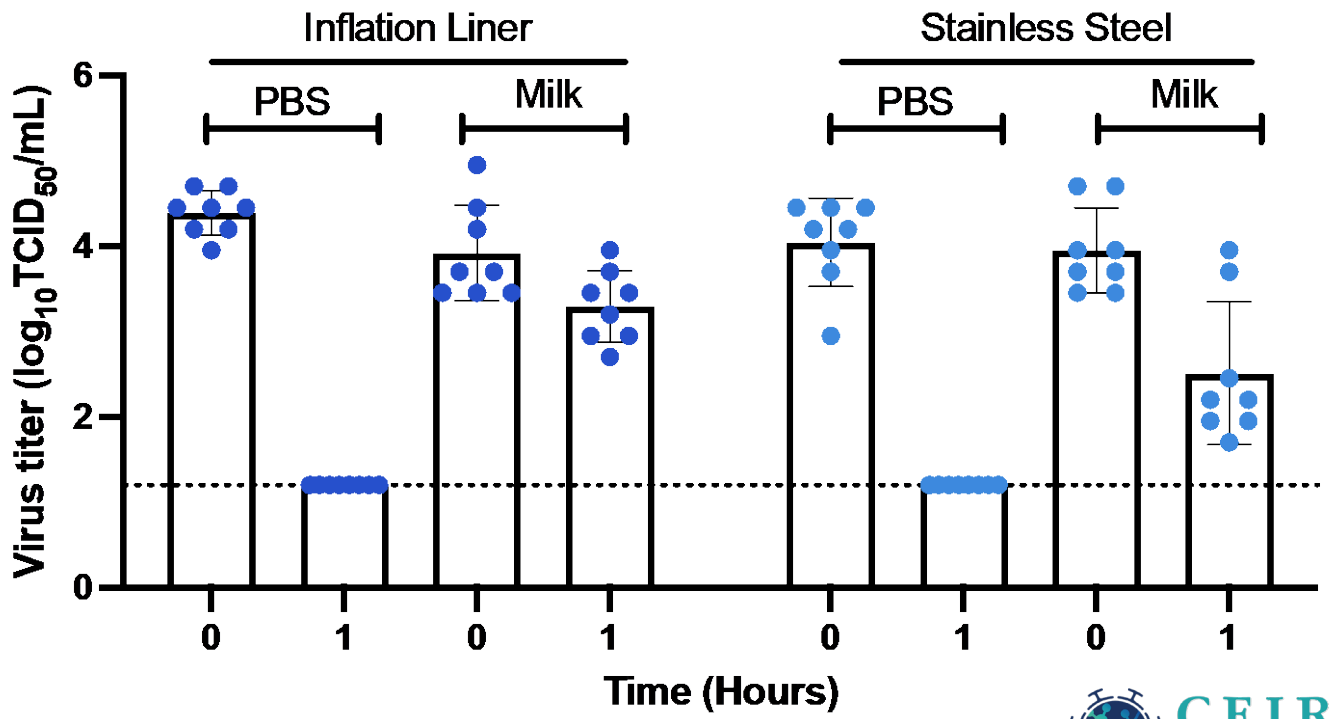


10 1 uL droplets onto various surfaces
70% RH



Cut into square coupons for stability assay

- Collect time 0 in 500uL of VTM– immediate recovery of droplets
- Collect time 1 hr post aging in 500uL of VTM



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Method to Detect of H5N1 Virus in Air

MD8 Airport

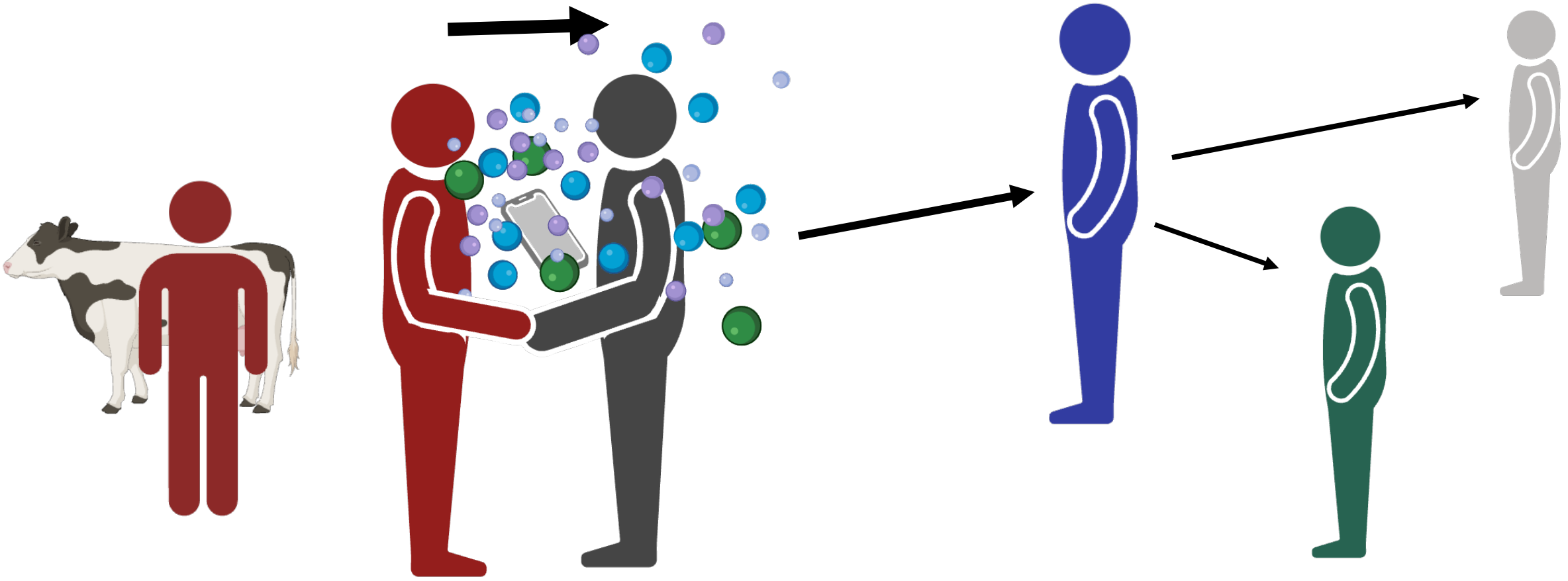
Air flow rate **50 LPM**
Aerosols collected onto gelatin filter

Following the milking process

Sampling exhaled breath of rows of cows

Gelatin filter allows for assessment of infectious virus in the

Sustained Human to Human Transmission



Sporadic spillovers occur.

But no sustained human to human transmission yet..