Diagnosis and Management of Canine Influenza and Pneumovirus Outbreaks

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Explosive Epidemics

- H3N2 canine influenza virus (H3N2 CIV) and canine pneumovirus (CnPnV) have emerged as frequent causes of respiratory disease outbreaks
- Cause explosive epidemics of coughing dogs in shelters
  - Highly contagious
  - Most dogs are susceptible due to no pre-existing immunity
  - Short incubation period and longer shedding period contribute to rapid increases in sick dogs
  - Preclinical and subclinical virus shedding ensures exposure of more dogs

Rapid Transmission

- Direct contact with oronasal secretions
- Sneezing generates droplets that can travel 5 ft
- Coughing generates aerosols that can travel 20 ft
- Fomites (incl. people)

Virus Properties

Property	H3N2 CIV	CnPnV
Incubation period	<7 days	<7 days
Shedding period	14-21 days	<14 days
Preclinical/subclinical shedding	Yes	Yes
Duration of illness	~2 weeks	~2 weeks

Diagnosis

Triggers for Diagnostic Testing

- Number of coughing dogs spikes above baseline
- Explosive spread through the population in 2-4 weeks
- Progression to pneumonia and death
- Prolonged illness
- Failure of the usual containment protocols
- Staff report their dogs at home are coughing
- Complaints from adopters, rescues, and community veterinarians

Diagnostic Test

- Nasal/oropharyngeal swabs
  - 8 to 10 acute cases
  - Look for a pattern
  - Improves reliability
- Start with CIRD PCR panel to identify H3N2 CIV or CnPnV
- Subsequent testing by H3N2 CIV PCR or CnPnV PCR

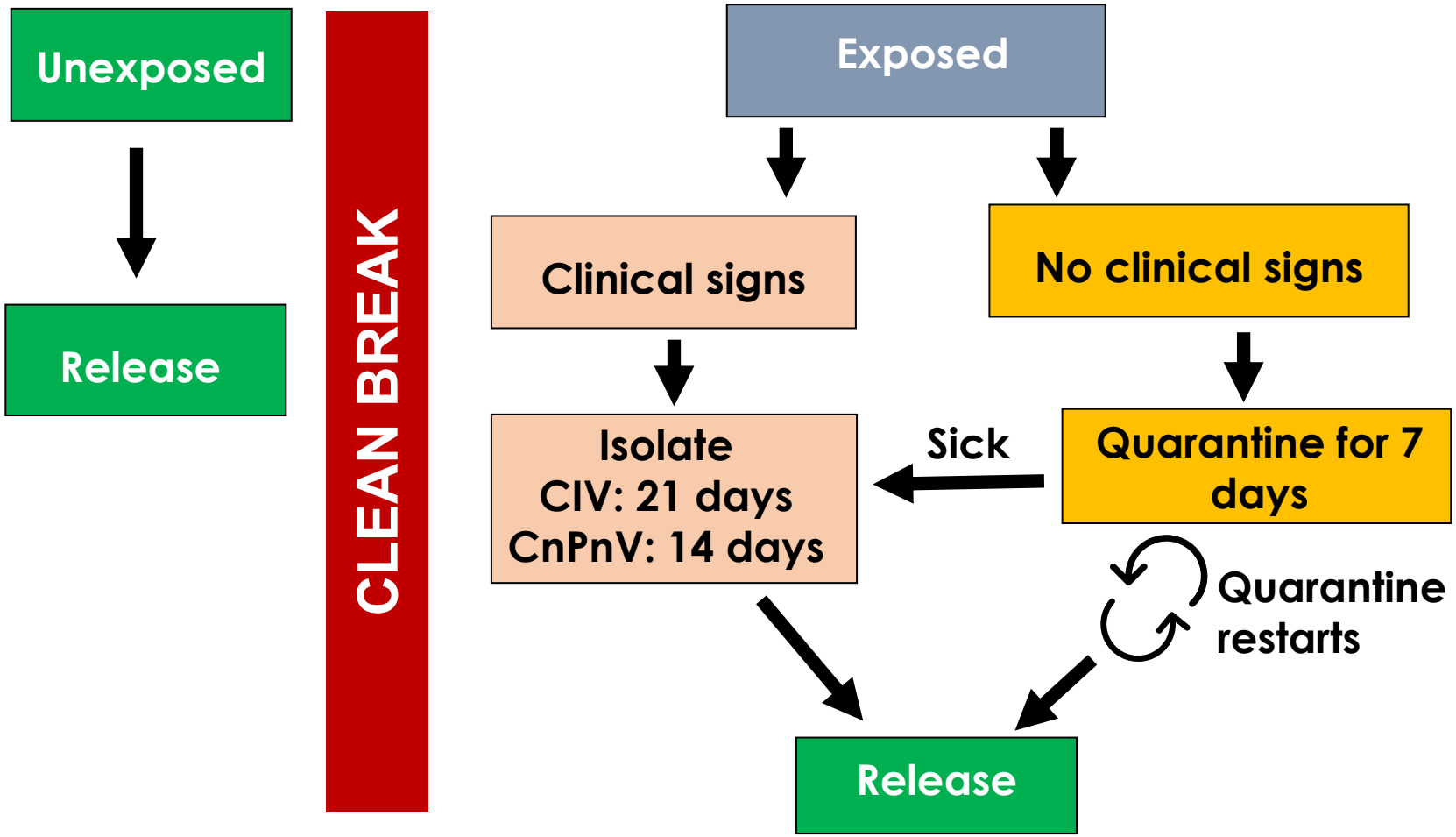
Diagnostic Labs

Lab	Test	Test Code	Cost	Cost/10 dogs	Cost/100 dogs
IDEXX	CIRD PCR Panel	2524	$158	$1,600	
	H3N2 CIV PCR	3730	$107		$11,000
	CnPnV PCR	3546	$82		$8,000
Cornell	CIRD PCR Panel	CRPNL	$101	$1,000	
	Flu A PCR	IVMPCR	$41		$4100
	CnPnV PCR	PNVPCR	$41		$4100

Disease Outbreak Management Goals

- Maximize life-saving
- Minimize disruption of shelter operations
- Achieve the quickest resolution possible
- Be financially responsible

Traditional Management Strategy for H3N2 CIV and CnPnV



Traditional Strategy Challenges

- H3N2 CIV/CnPnV infection rates can reach 70-100%
  - Number of sick dogs overwhelms Isolation housing capacity
  - Many shelters do not have Isolation housing
- High susceptibility and rapid virus transmission guarantees exposure of nearly every dog
  - Number of exposed dogs overwhelms Quarantine housing capacity
  - Restarts with waves of new cases every 2-4 days stretches Q time to weeks
- Prolonged total response time
  - Isolation of each new case for 2 or 3 weeks
  - Extended Q time for many weeks

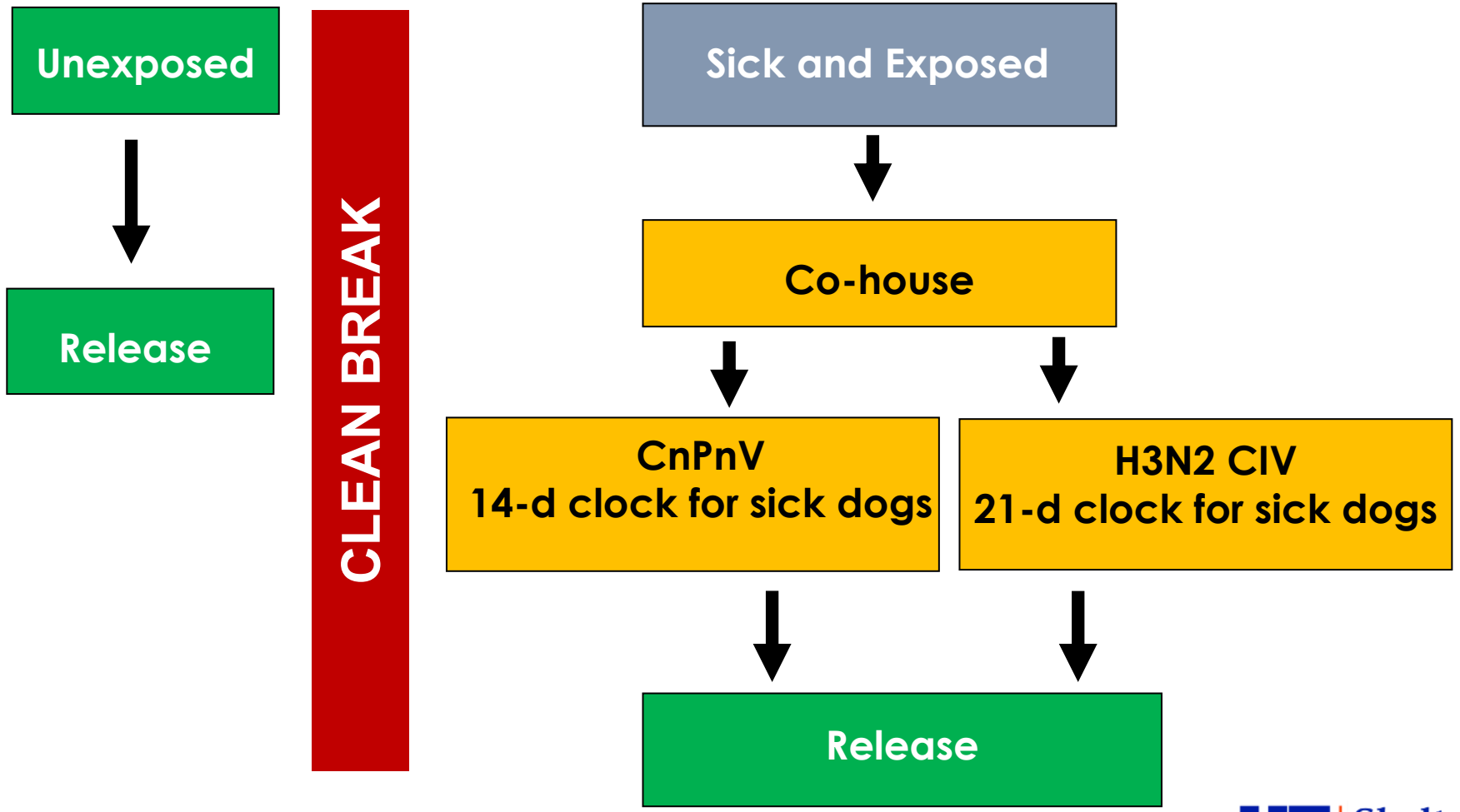
Alternative Management Strategy

- Co-house sick and exposed dogs together
  - “Chickenpox party” strategy
  - Force the viruses to move quickly through the population
  - Synchronize infection
- Virus die-off when no more susceptible dogs to sustain transmission
- Reduces response time by 50%
  - Traditional strategy response time: 8-12 weeks
  - Alternate strategy response time: 4-6 weeks

Alternative Strategy Key Steps

- House sick and exposed dogs in place
  - All new clinical cases are assumed to be due to H3N2 CIV or CnPnV
- Set a clock on each sick dog
  - Start the first day of illness
  - Duration = max shedding period
  - 21-day clock for H3N2 CIV
  - 14-day clock for CnPnV
- Release when each dog's clock expires
- Clean Break

Chickenpox Party Strategy for H3N2 CIV and CnPnV



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Chickenpox Party Challenges

- Are all sick dogs noninfectious and safe to release by 14 or 21 days?
- What about dogs that remain asymptomatic?
  - Uninfected?
  - Subclinical infection?
  - Lack of enough virus exposure?
  - Immune to infection?
  - How do you determine their status?
  - When are they released?

CnPnV Release

- PCR testing of >100 sick dogs in 4 different shelters
  - Tested on 10, 12, or 14 days after onset of illness
  - Most dogs were PCR negative on day 10
  - Small number of PCR+ dogs on day 12
  - No PCR+ dogs on day 14
  - Safe to release clinical cases after day 14
- Release asymptomatic dogs at the same time as the last clinical case
- Can perform CnPnV PCR on each dog prior to release
  - Is this cost-effective? $41/dog (Cornell)

H3N2 CIV Release

- Can clinical cases be released before 21 days?
  - Earlier release shortens response time
  - H3N2 CIV PCR test for each dog? What does a negative PCR mean?
- Paired PCR and antibody titer for each dog on day 14
  - Determines both the shedding and immune status of the dog

	Test	Test Code	Readout	Cost	Total cost /dog
Cornell	H3N2 CIV PCR	IVMPCR	Ct	$41	$66
	H3N2 CIV HI	CIVHI	Endpoint antibody titer	$25	

H3N2 CIV Release

- Interpretation of paired PCR and antibody titers on **day 14** for **clinical cases**

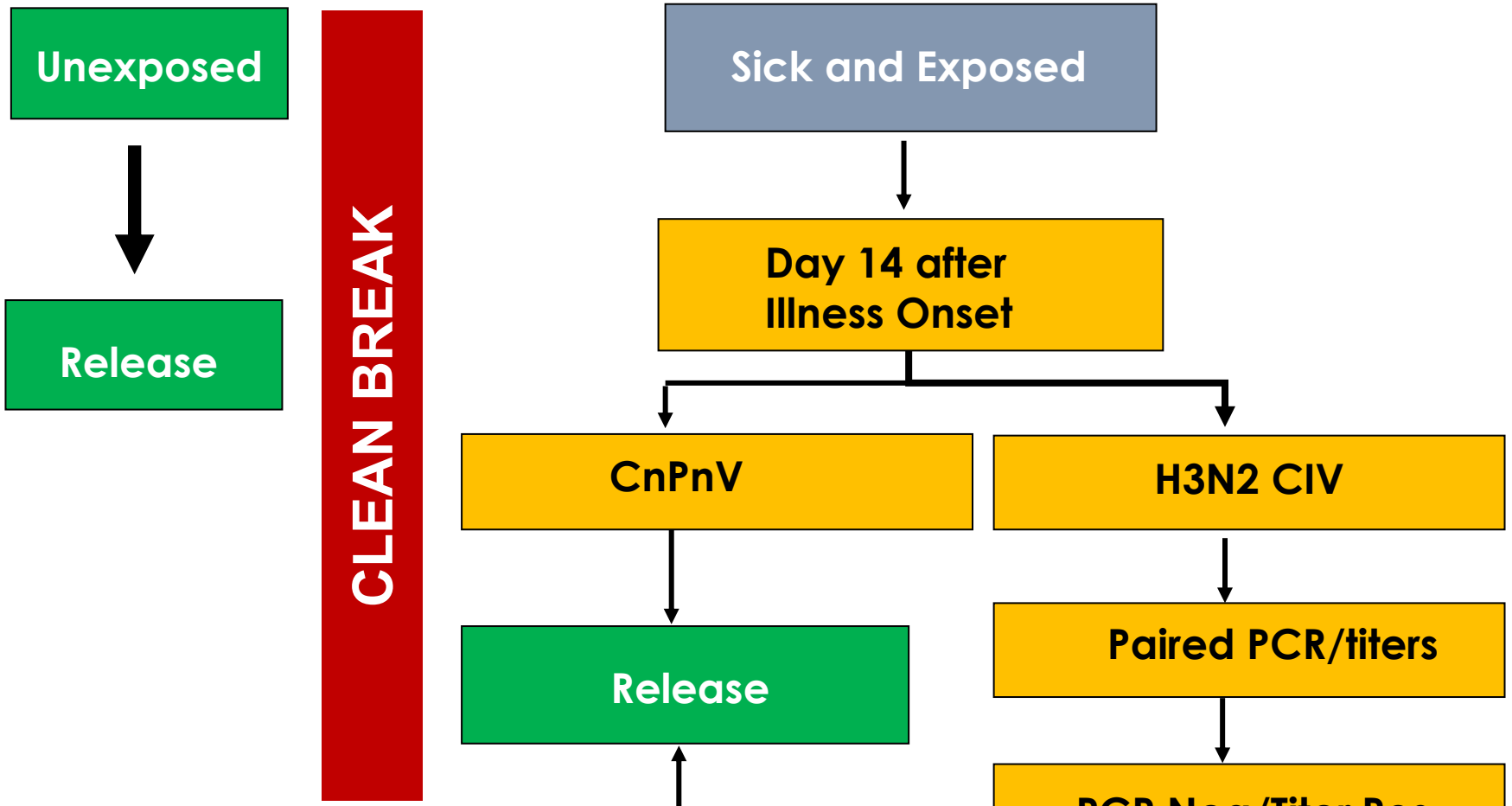
PCR	Antibody Titer	Interpretation	Action
Negative	Positive	Noninfectious/immune	Release
Negative	Negative	Has not been infected No immunity	Retest in 1 week
Positive	Negative or Positive	Infectious	Retest in 1 week

H3N2 CIV Release

- When can dogs that remain asymptomatic be safely released?
- Paired PCR and antibody titer after 2-4 weeks of exposure

PCR	Antibody Titer	Interpretation	Action
Negative	Negative	Has not been infected No immunity	Retest after last clinical case
Negative	Positive	Recovered from subclinical infection or had pre-existing immunity	Release
Positive	Negative or Positive	Subclinical infection	Retest in 1 week

Chickenpox Party Strategy for H3N2 CIV and CnPnV



Nevada Shelter

- Large private nonprofit with municipal contract
- Oct 3, 2022
  - Sharp uptick in coughing dogs
  - 17 dogs CnPnV PCR+ (Idexx CIRD PCR Panel)
- **Oct 10 (Day 1):** started the chickenpox party
  - Co-housed sick and exposed dogs in the shelter (133 dogs)
  - Transferred some dogs to foster homes without other dogs
- Restricted intake to “must admits” and closed adoptions
  - New admits housed in the Isolation Room
  - Strict biosecurity

Nevada Shelter

- New clinical cases every 2-3 days for the first 2 weeks followed by 8 cases in the subsequent 2 weeks
  - No deaths from pneumonia
- 14-day clock for clinical cases
  - CnPnV PCR (Cornell) on Day 14 for each dog – all were negative
  - Cleared dogs released to the adoption housing area
- Asymptomatic dogs
  - Released at the same time as the last clinical case
- **Day 42:** outbreak resolution
  - No new cases in the previous 14 days

Pennsylvania Shelter

- Large municipal shelter
- April 10, 2022
  - Sharp uptick in coughing dogs
  - 8 dogs CnPnV PCR+ (Idexx CIRD PCR Panel)
- **April 12 (Day 1):** started the chickenpox party
  - Co-housed sick and exposed dogs in one large room (120 dogs)
- Restricted intake to “must admits” and closed adoptions
  - Struggled for the first 2 weeks in limiting admissions
  - New admits housed in a makeshift Isolation Room
  - Strict biosecurity

Pennsylvania Shelter

- **Days 1-21:** 80% clinical cases (108 dogs)
  - Spot testing confirmed CnPnV
  - No pneumonia cases or deaths
- 14-day clock for clinical cases
  - Negative CnPnV PCR (Cornell) on Day 14 for 22 dogs
  - Continued release of dogs on Day 14 without testing
- **Day 22:** moved 70 sick and exposed dogs to a vacant school
  - Recovered dogs past their 14-day mark stayed in the shelter
  - Opened the shelter for admissions and adoptions

Pennsylvania Shelter

- School population
  - All 70 dogs were sick by 7 days after arrival
  - Last clinical case on Day 29
- **Day 43:** outbreak resolution
  - 14 days after the last case at the school
  - All dogs transferred back to the shelter

North Carolina Shelter

- Private nonprofit with a municipal contract
- Nov 2022: spike in number of coughing dogs
  - H3N2 CIV was circulating in the community
- **Dec 6 (Day 1):** 10 dogs w/ confirmed H3N2 CIV (Idexx CIRD PCR Panel)
  - Started co-housing sick/exposed dogs (150 dogs)
  - 21-day clock for each sick dog
  - H3N2 CIV PCR (Idexx) on Day 21 before release (external funding)

Shelter vet: *"the new protocol to throw a chickenpox party has made several of our staff cry...happy tears! Particularly our senior manager of shelter operations, who was single-handedly, trying to find places to isolate sick dogs."*

North Carolina Shelter

- **Day 2:** restricted intake to “must admits”
  - Housed in a different room in the shelter
  - Separate staff and strict biosecurity
- **Day 10:** sick dogs in the clean break housing area
  - PCR testing confirmed H3N2 CIV
  - Relocated all clean break dogs to the sick/exposed population
  - Cross-contamination may have been due to a behavior team
  - Restarted the clean break – this also failed due to confirmed H3N2 CIV
- **Day 17:** Found an off-site facility for housing new admits
  - Started H3N2 CIV vaccination of these dogs

North Carolina Shelter

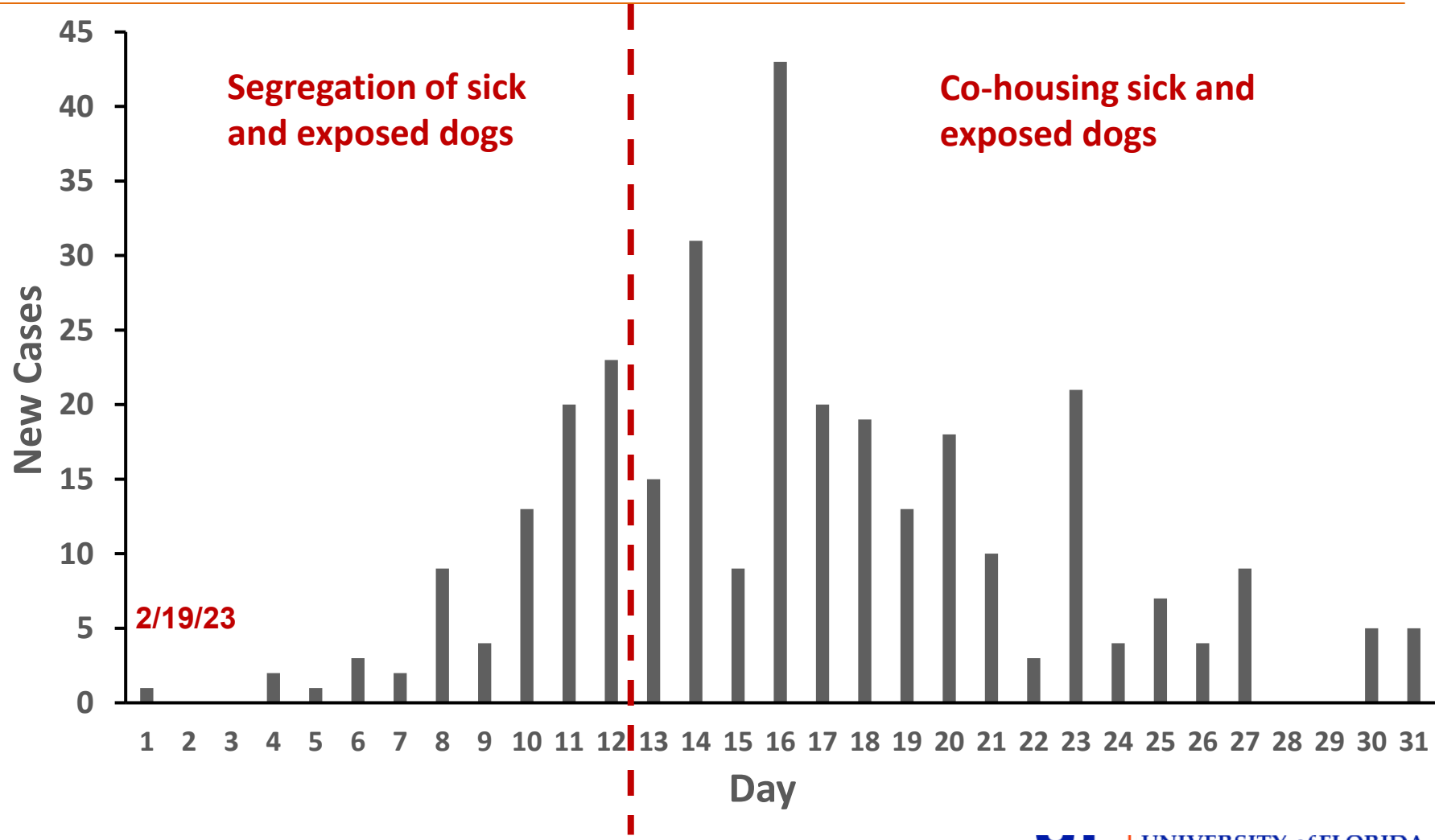
- **Days 1-21**: 88% clinical cases (106 dogs)
  - All were PCR neg (Idexx) on Day 21
- **Days 34-46**: paired PCR/titer testing (Cornell) on asymptomatic dogs
  - 19/21 dogs were PCR neg/titer positive – recovered from subclinical infection
  - 2/21 dogs were PCR neg/titer neg – started H3N2 CIV vaccination
- **Day 54** (Jan 30, 2023): outbreak resolution
  - Last clinical cases tested PCR neg
  - All clean break dogs moved back to the shelter after 2 doses of H3N2 CIV vaccine

Texas Shelter

- Private nonprofit shelter with municipal contract
- H3N2 CIV circulation in the community
- Increasing number of coughing dogs from 2/19 to 3/2/23
  - Confirmed H3N2 CIV in 15 dogs (Idexx CIRD PCR Panel)
  - 30 new cases from 2/28 to 3/2 (3-day period)
  - # sick dogs > isolation housing capacity
- **3/3/23 (Day 1):** started co-housing sick/exposed dogs (324 dogs)
- **Day 2:** Started clean break – "must admits" housed in a separate building
  - $250 stipend for fosters and free adoptions

Texas Shelter

Day 18:
93% clinical cases
(300 dogs)



Texas Shelter

- Initial plan: release dogs on Day 21
  - No PCR test for confirmation
  - Released 62 dogs (initial cases from 3/1 to 3/5/23)
- Do dogs stop shedding virus before Day 21?
- New plan: test dogs on Day 14
  - H3N2 CIV PCR + H3N2 CIV antibody titers (Cornell)
  - Release PCR neg/titer positive dogs
  - PCR+ dogs - repeat tests on Day 21

Texas Shelter

Date	H3N2 CIV PCR	H3N2 CIV Titer	# Dogs	Interpretation	Action
Day 21	NA	NA	67	Noninfectious?	Released
Day 14	Negative	Positive	225	Recovered from infection Immune	Release
Day 14	Negative	Negative	24	Not infected Not immune	Release/house w/ recovered dogs
Day 14	Positive	Positive	8	Infectious	Retest Day 21
Day 21	Negative	Positive		Recovered from infection Immune	Release

- **Day 40 (April 12):** outbreak resolution

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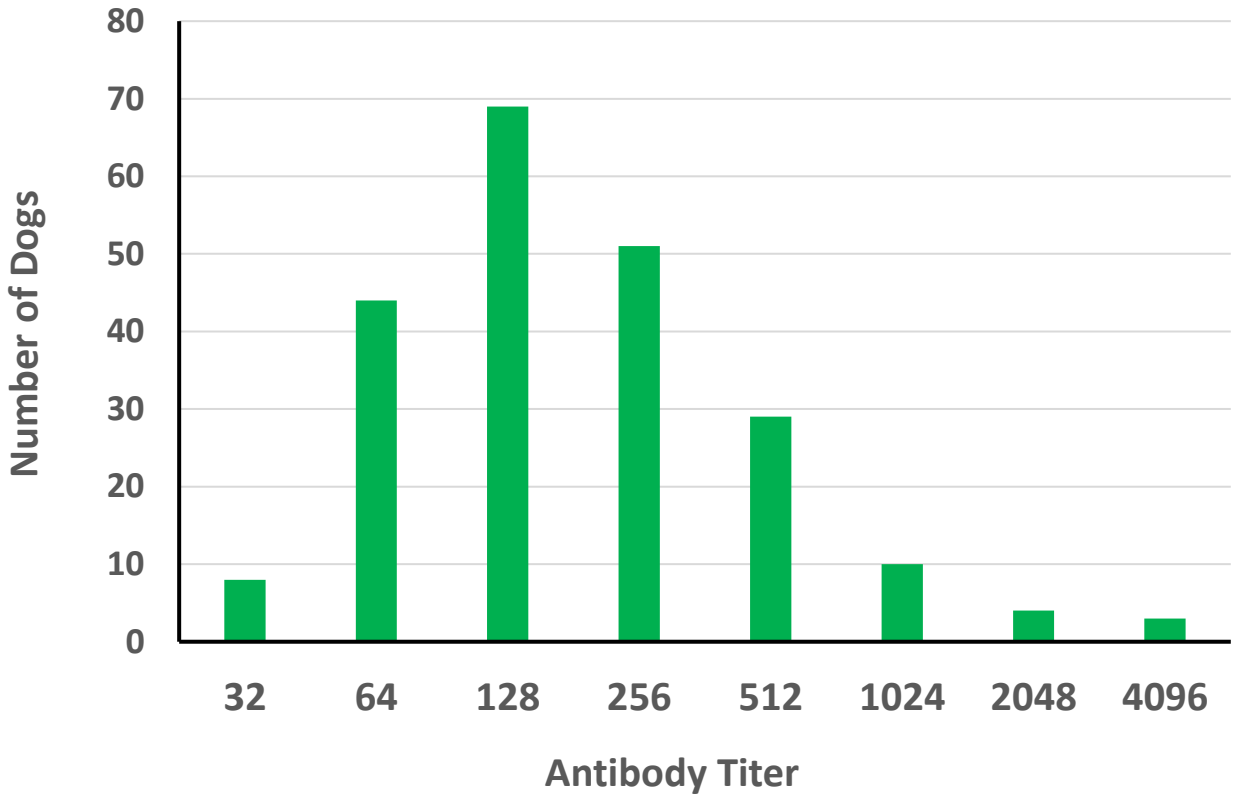
Texas Shelter

- H3N2 CIV antibody titers on Day 14



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Nevada Shelter

- Private nonprofit shelter with municipal contract
- H3N2 CIV circulation in the community
- 2/19/24: increasing number of coughing dogs
  - Confirmed H3N2 CIV in 6 dogs (Idexx CIRD PCR Panel)
  - # sick dogs > isolation housing capacity
- **2/21/24 (Day 1):** started co-housing sick/exposed dogs (112 dogs)
- **Day 2:** Started clean break – "must admits" housed in the Isolation Rooms

Nevada Shelter

- Tested 104 dogs on Day 14
  - H3N2 CIV PCR + H3N2 CIV antibody titers (Cornell)
  - Release PCR neg/titer positive dogs
  - PCR+ dogs - repeat tests on Day 21

Nevada Shelter

Date	H3N2 CIV PCR	H3N2 CIV Titer	# Dogs	Interpretation	Action
Day 14	Negative	Positive	76	Recovered from infection/immune	Release
Day 14	Negative	Negative	24	Not infected Not immune	Release/house with recovered dogs
Day 14	Positive	Positive	4	Infected	Retest Day 21
Day 21	Negative	Positive		Recovered from infection/immune	Release

- **Day 28 (March 20):** outbreak resolution

Florida Shelter

- H3N2 CIV circulation in the community
- Municipal shelter
- **6/4/24:** 75% of the dog population coughing
  - Confirmed H3N2 CIV (Idexx CIRD PCR Panel)
  - No isolation kennel
- **Day 1:** started co-housing sick/exposed dogs
- **Day 2:** started clean break – “must admits” housed in a separate building

Florida Shelter

- Tested 56 dogs on Day 14
  - H3N2 CIV PCR + H3N2 CIV antibody titers (Cornell)
  - Released 54 PCR neg/titer positive dogs
  - 2 PCR+ dogs – PCR neg on Day 21
- **Day 27** (6/30/24): outbreak resolution

My Lessons Learned

- CnPnV and H3N2 CIV cause epidemic-scale outbreaks in shelters (70 to 100% infection rates)
- Diagnosis must be confirmed by PCR testing
- CnPnV shedding duration = <14 days
- H3N2 CIV shedding duration = 2 to 3 weeks
- “Chicken pox party” strategy for quicker resolution
- CnPnV: release dogs on Day 14 (no testing)
- H3N2 CIV: paired PCR/antibody titer testing on Day 14
- Outbreak resolution in 4 to 6 weeks