Canine parvovirus infection: an update on diagnosis, prevention and treatment

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Canine parvovirus: origin and evolution

CPV/FPV

FAMILY

PARVOVIRIDAE

SUBFAM.

PARVOVIRINAE

SUBFAM.

DENSOVIRINAE

NEW TAXONOMY

GENUS PROTOPARVOVIRUS

CARNIVORE PROTOPARVOVIRUS 1
(CPV-2, FPLV, MPV, BFPV)

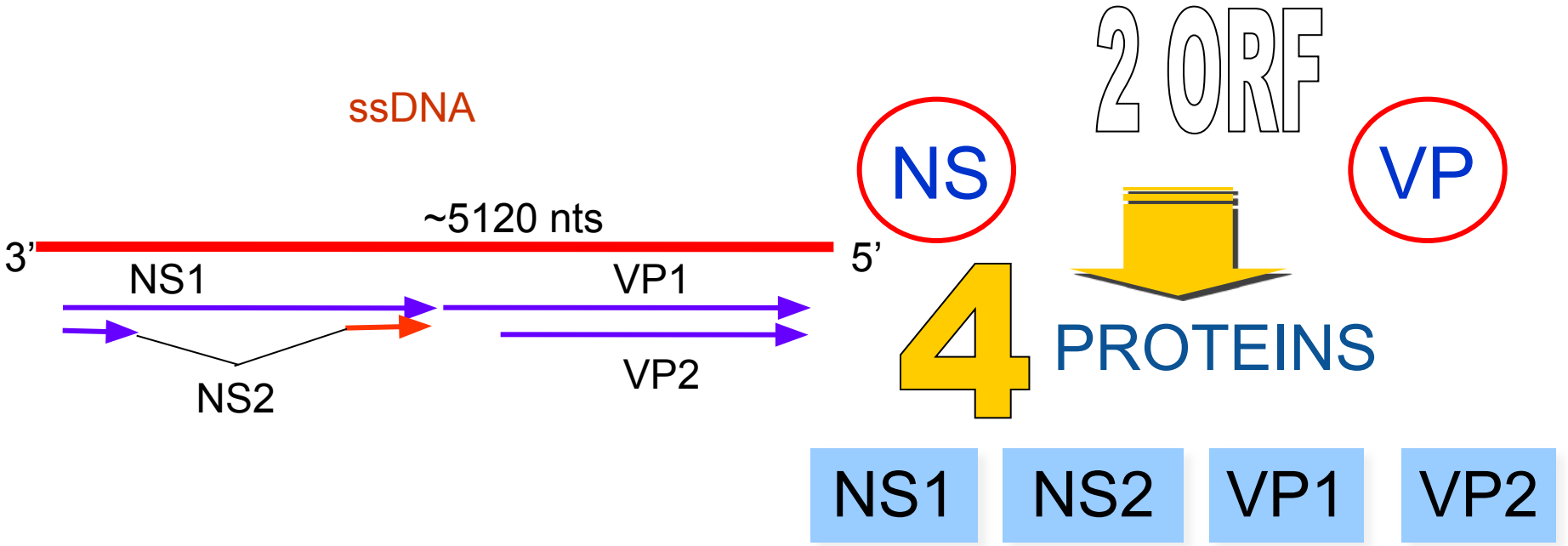
98% ID nt

ss DNA

GENOME: 5 Kb

NON-ENVELOPED PARTICLES

GENOME OF CPV



Alternative splicing of the same mRNA

GENETIC VARIABILITY OF THE VP2

CPV-2

Schackelton et al., 2005, PNAS

Substitution rates similar to RNA viruses

1.7×10^{-4} substitutions per site per year

HIGH INTRINSEC VARIABILITY (ssDNA)

POSITIVE SELECTION PRESSURE (IMMUNITY)

CPV IS STILL EVOLVING

FPV

Schackelton et al., 2005, PNAS

Lower substitution rates

9.4×10^{-5} substitutions per site per year

GENETIC STABILITY

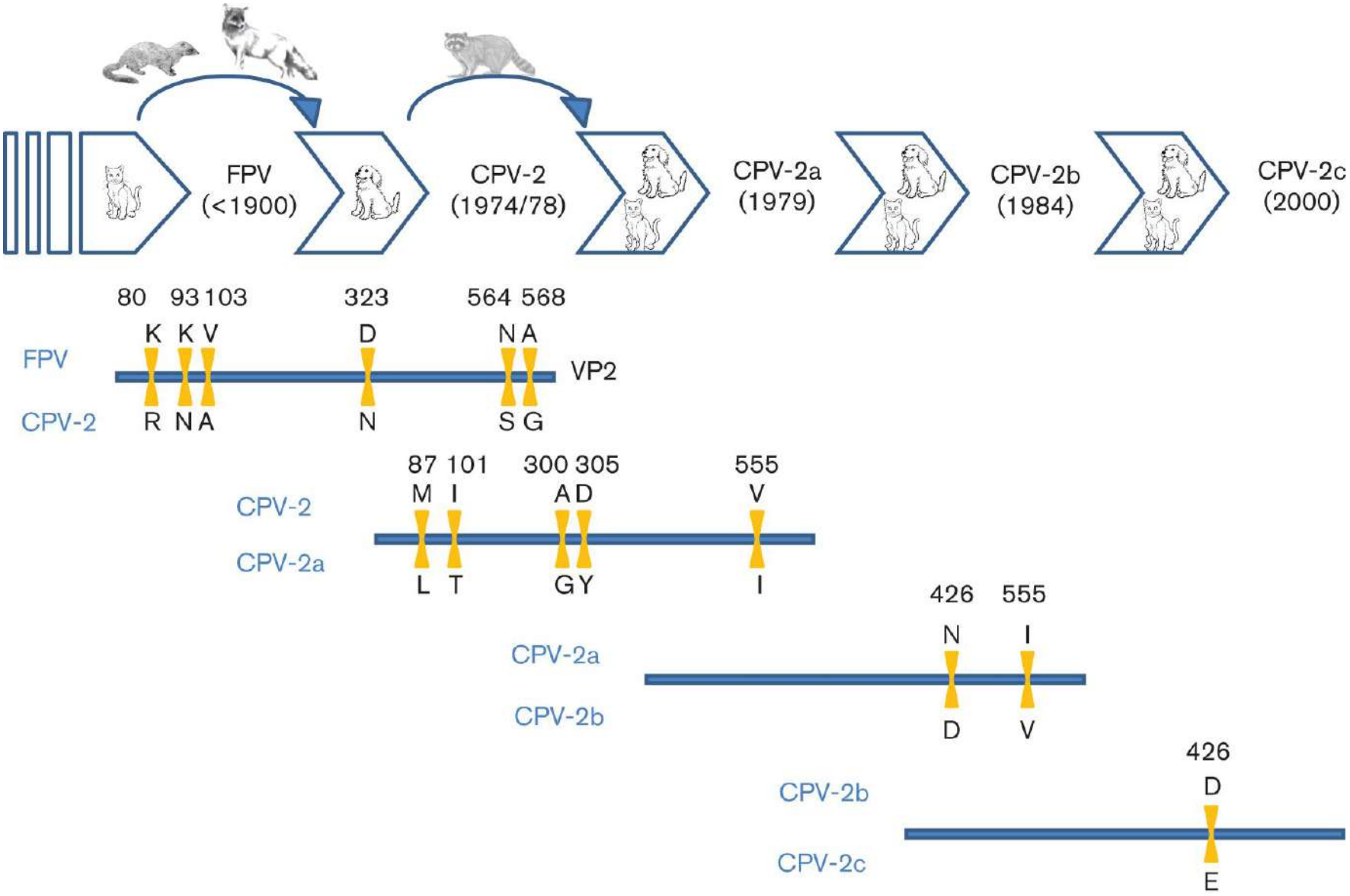

The Sporting GLOBE WEEKEND
KILLER
VIRUS HITS
DOG
Shelter on L.I. Destroys 106 Dogs in Virus Illness
Parvovirus Seen In All States
Killing Scores of
America
Corona virus thro...
Virus Fatal to Dogs
deadly canine virus is identified
ns spring shows

Journal of General Virology (2016), **97**, 2043–2057 DOI 10.1099/jgv.0.000540

Review

Canine parvovirus: the worldwide occurrence of antigenic variants

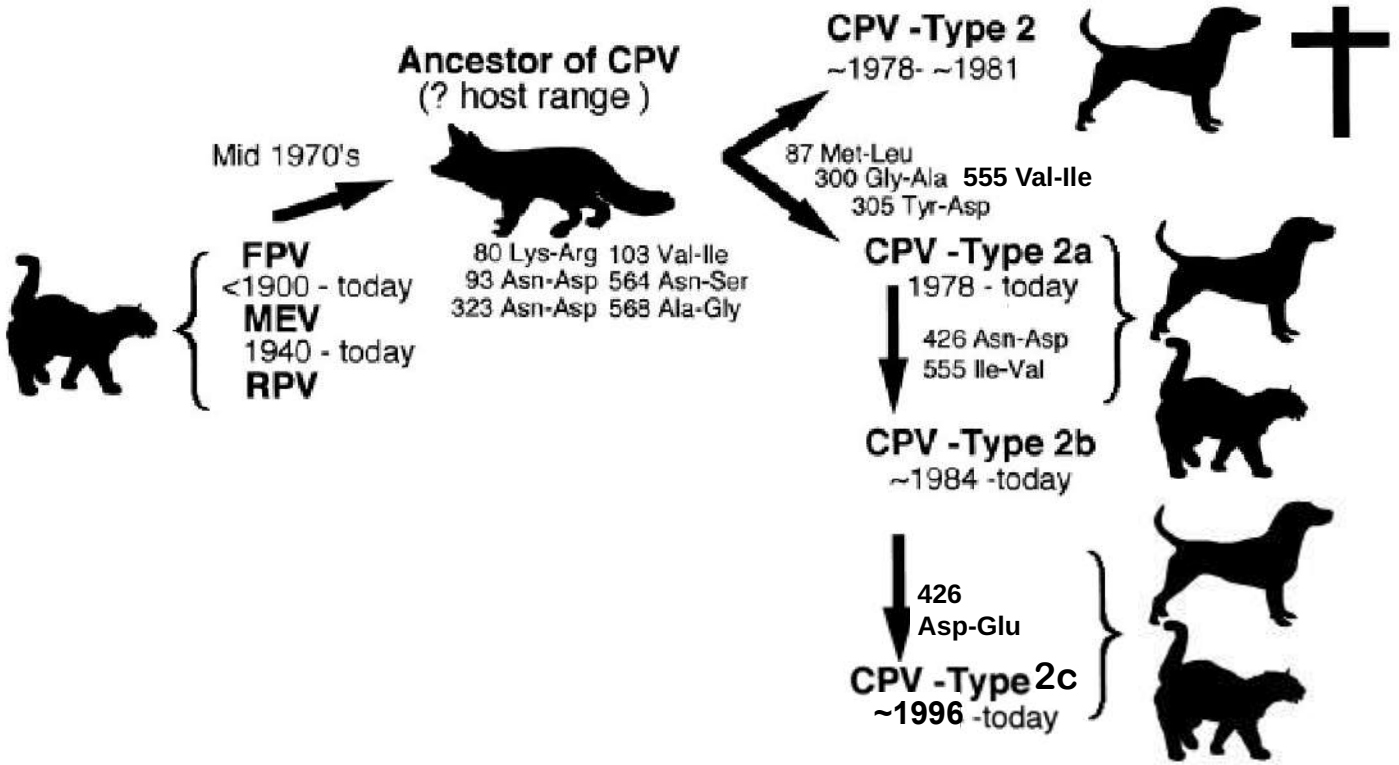
Carla Miranda[1,2] and Gertrude Thompson[1,2]



Biological features of the CPV variants

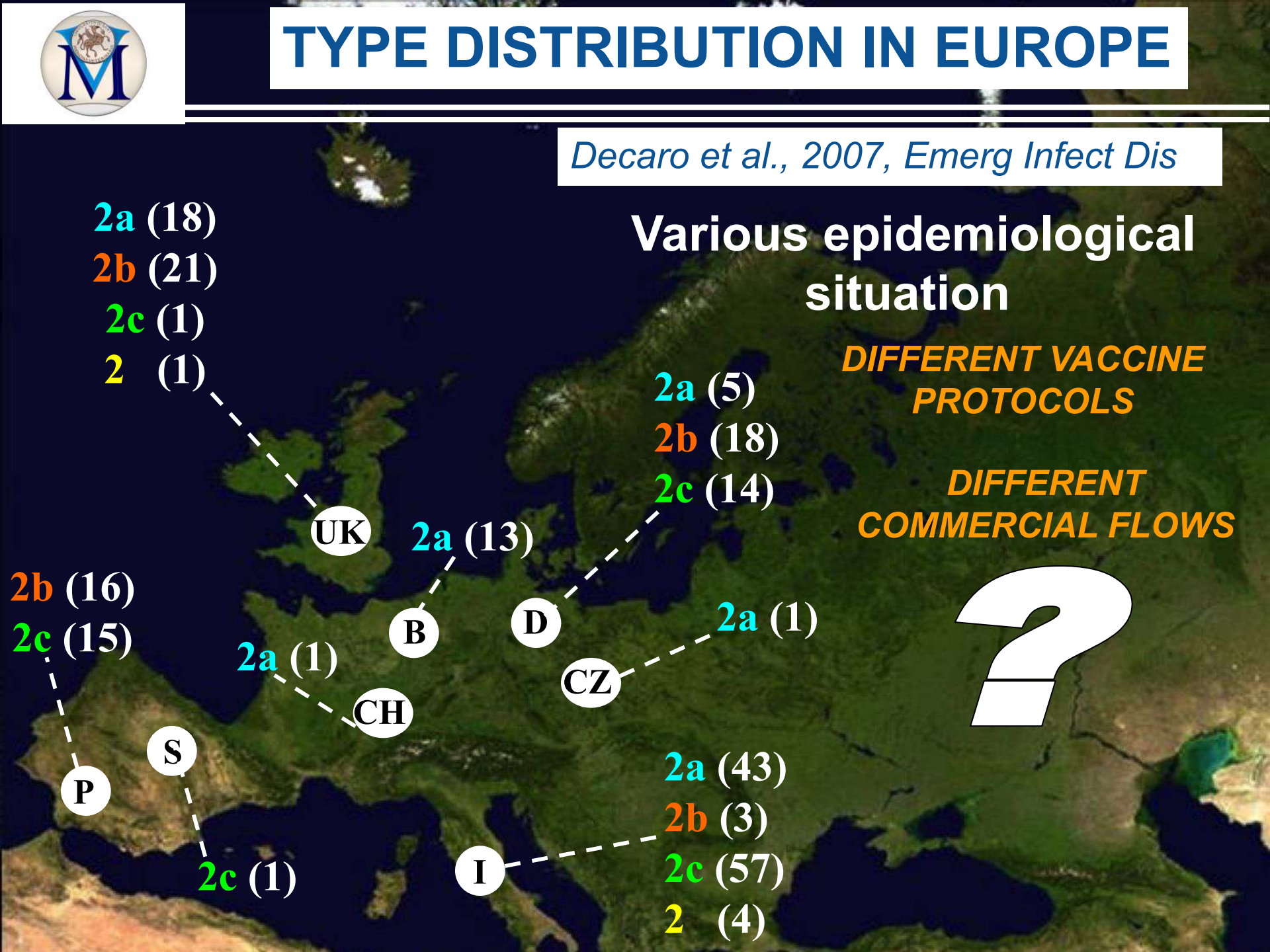
HOST RANGE

U. Truyen / Veterinary Microbiology 69 (1999) 47–50 ***(modified)***



TYPE DISTRIBUTION IN EUROPE

Decaro et al., 2007, Emerg Infect Dis



Various epidemiological situation

DIFFERENT VACCINE PROTOCOLS

DIFFERENT COMMERCIAL FLOWS

?

CPV TYPE DISTRIBUTION IN THE WORLD

Veterinary Microbiology 155 (2012) 1–12

Contents lists available at SciVerse ScienceDirect

Veterinary Microbiology

journal homepage: www.elsevier.com/locate/vetmic

Review

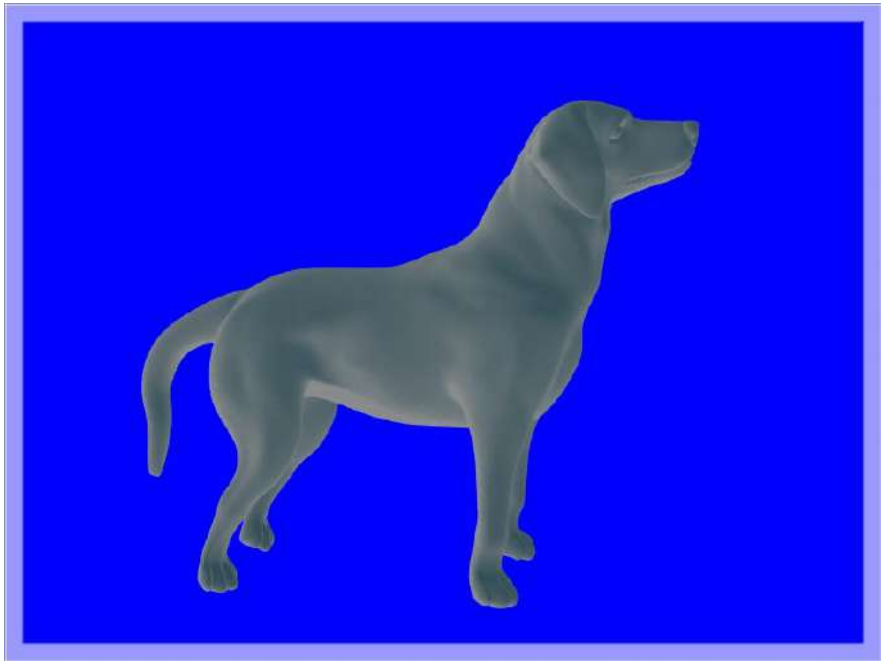
Canine parvovirus—A review of epidemiological and diagnostic aspects, with emphasis on type 2c

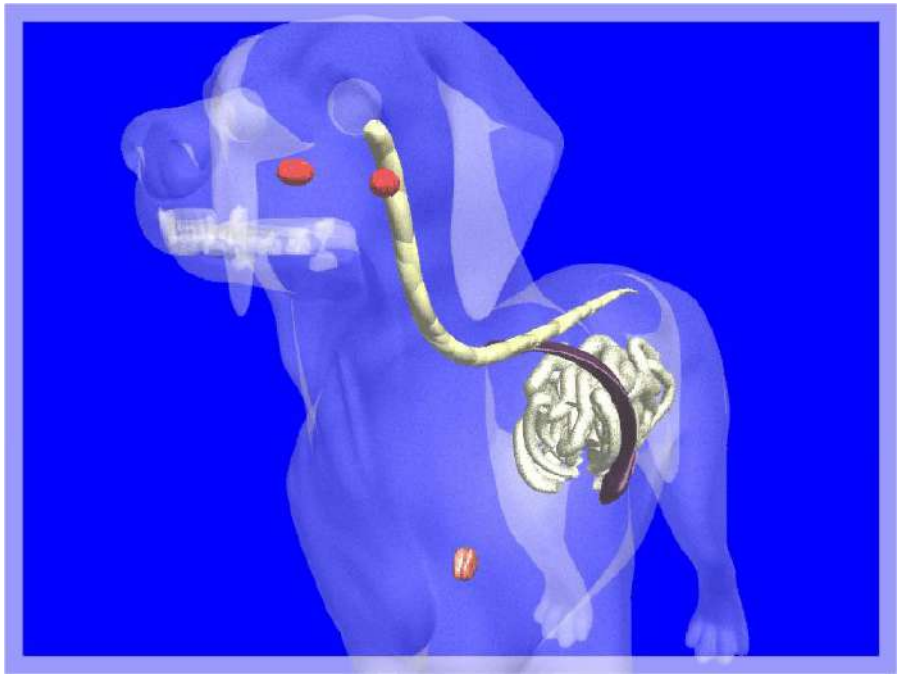
Nicola Decaro*, Canio Buonavoglia

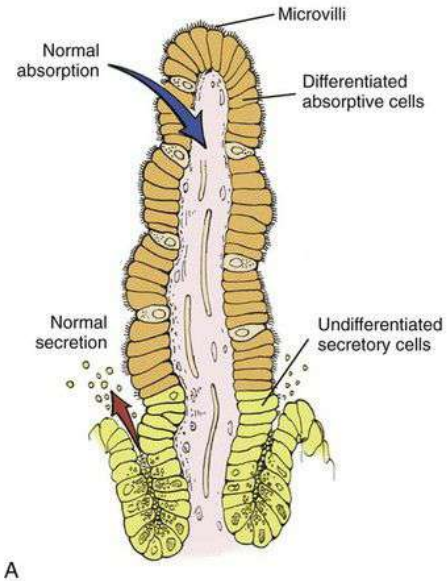
Continent/country	Number of strains detected		
	CPV-2a	CPV-2b	CPV-2c
Europe			
Italy	56	6	62
Portugal	0	16	15
Spain	3	1	9
France	0	9	7
UK	117	182	1
Belgium	17	0	9
Germany	13	18	21
Greece	81	1	2
Switzerland	1	0	0
Czech Republic	1	1	0
Romania	2	0	0
Hungary	27	0	0
Bulgaria	31	9	1
Slovenia	1	0	0
Africa			
Tunisia	15	21	14
North America			
USA	1	36	30
South America			
Uruguay	1	0	24
Argentina	9	4	14
Brazil	37	0	0
Asia			
India	37	4	0
India	[b]	[b]	3
Taiwan	2	34	0
Korea	119	7	0
Japan	4	21	0
China	27	5	0
Thailand	19	7	0
Oceania			
Australia	41	1	0

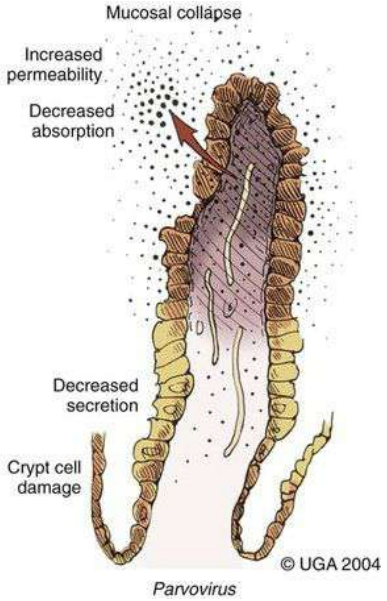
Canine parvovirus: clinical signs and diagnosis

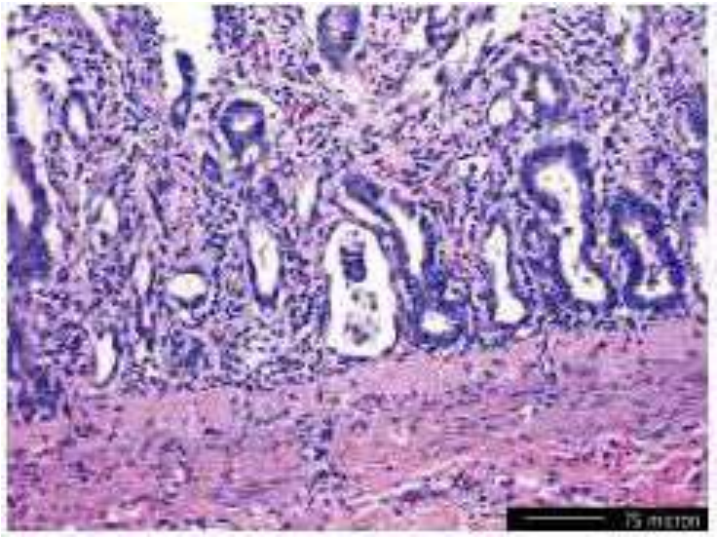
PATHOGENESIS





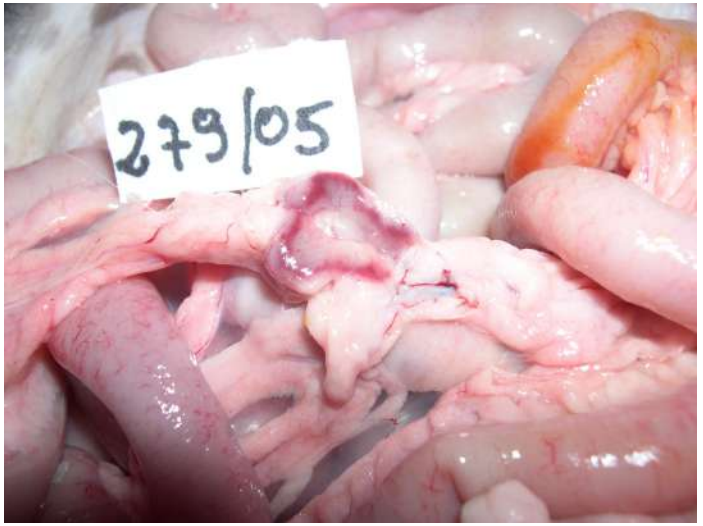






CLINICAL SIGNS OF PARVOVIROSIS

- HAEMORRHAGIC DIARRHOEA
- VOMITING
- RAPID DEHYDRATION
- FEVER (inconstant)
- LEUKOPOENIA (<3000 WBC/mm^3)
- MORTALITY



Clinical course depending on
Ab titres at the moment of infection

FAECAL SHEDDING

J Vet Diagn Invest 17:133–138 (2005)

Clinical and virological findings in pups naturally infected by canine parvovirus type 2 Glu-426 mutant

Nicola Decaro,[1] Costantina Desario, Marco Campolo, Gabriella Elia, Vito Martella, Dominga Ricci, Eleonora Lorusso, Canio Buonavoglia

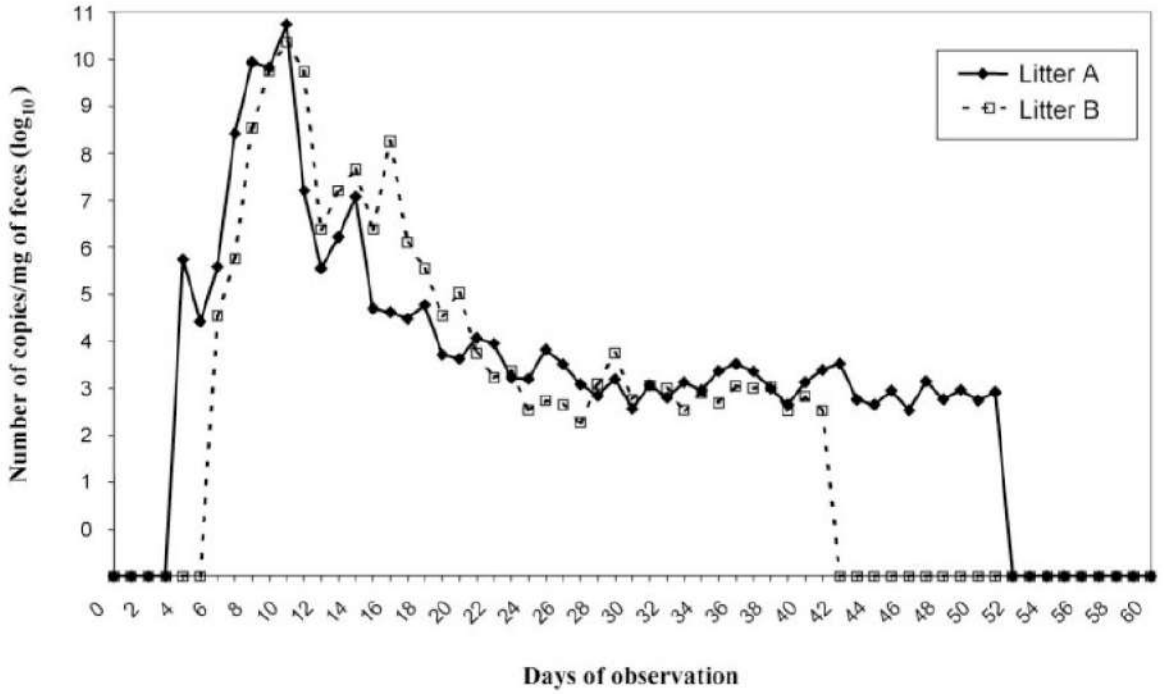
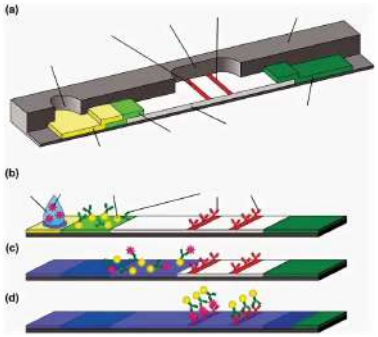


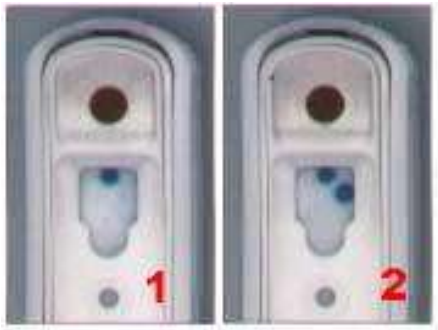
Figure 2. Number of copies (median log_{10} titers) of CPV-2 DNA detected in the fecal samples of the infected pups by real-time PCR.

CPV DETECTION

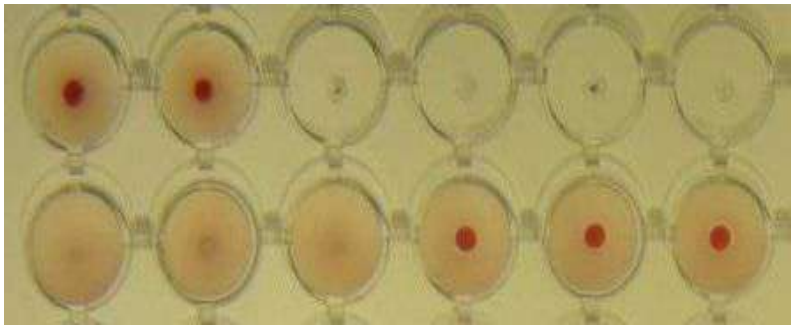
TRADITIONAL METHODS

ICT





HA



Desario et al., 2005,
J Virol Methods

Poorly sensitive in the late stage of infection

⇒ Low viral titers

⇒ Abs in the gut lumen

CPV DETECTION

TRADITIONAL METHODS

ICT

Are ELISA-based assays able to detect efficiently CPV-2c?

Rates of test failures increased in the last years paralleling the increased frequency of CPV-2c detection

Kapil et al., 2007, J Clin Microbiol

CPV DETECTION

The Veterinary Journal 184 (2010) 373–375

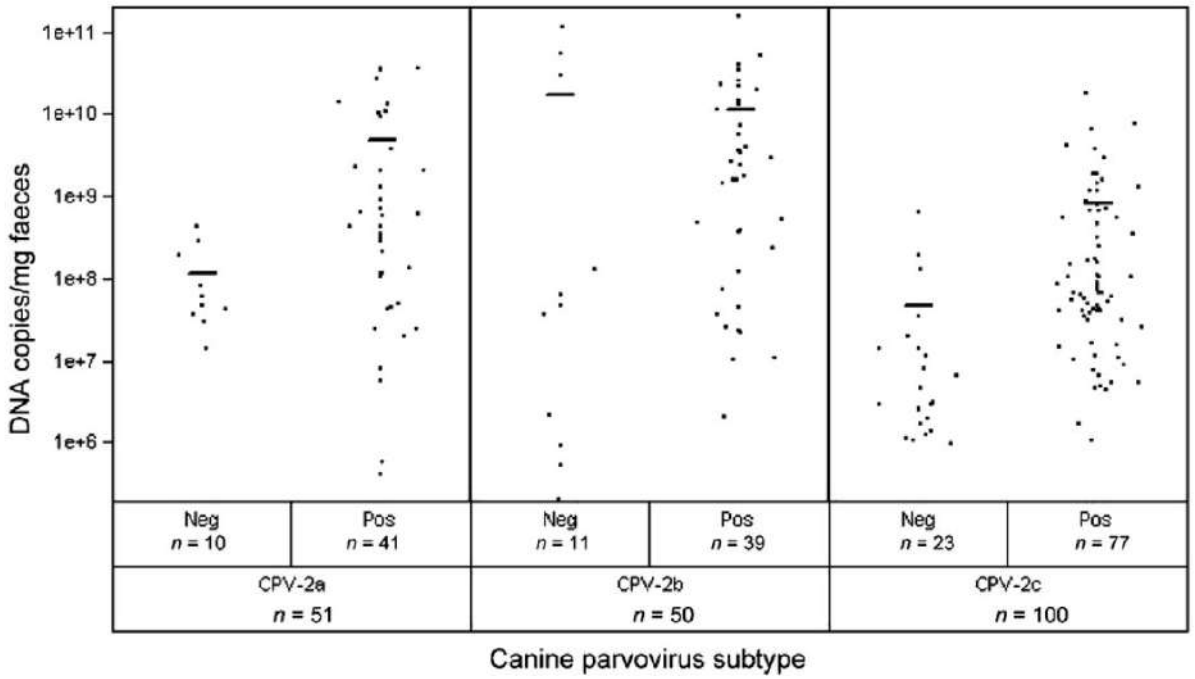
Detection of canine parvovirus type 2c by a commercially available in-house rapid test

Nicola Decaro [a,*], Costantina Desario [a], Melissa J. Beall [b], Alessandra Cavalli [a], Marco Campolo [a], Anthony A. DiMarco [b], Francesca Amorisco [a], Maria Loredana Colaianni [a], Canio Buonavoglia [a]

CPV-2a, 51

CPV-2b, 50

CPV-2c, 100



CPV-2c was detected with the same efficiency as the other antigenic variants!

CPV DETECTION

The Veterinary Journal xxx (2013) xxx–xxx

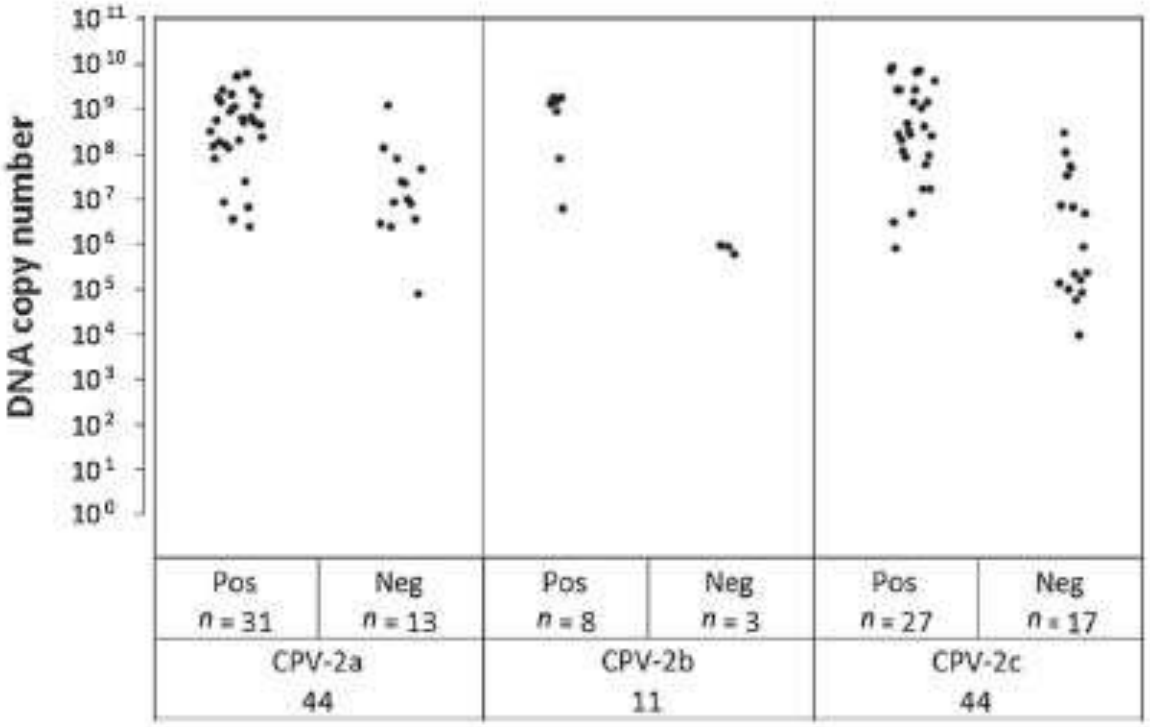
Evaluation of an in-clinic assay for the diagnosis of canine parvovirus

N. Decaro [a,*], C. Desario [a], M. Billi [b], E. Lorusso [a], M.L. Colaianni [a,c], V. Colao [a], G. Elia [a], G. Ventrella [a], I. Kusi [d], S. Bo [e], C. Buonavoglia [a]

CPV-2a, 44

CPV-2b, 11

CPV-2c, 44



CPV-2c was detected with the same efficiency as the other antigenic variants!

DOES CPV VACCINATION INTERFERE WITH IN-CLINIC ASSAYS?

Vaccine 32 (2014) 3850–3853

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Long-term viremia and fecal shedding in pups after modified-live canine parvovirus vaccination

Nicola Decaro[a,*], Giuseppe Crescenzo[a], Costantina Desario[a], Alessandra Cavalli[a], Michele Losurdo[a], Maria Loredana Colaianni[b,c], Gianpiero Ventrella[a], Stefania Rizzi[c,d], Stefano Aulicino[c], Maria Stella Lucente[a], Canio Buonavoglia[a]

[a] Department of Veterinary Medicine, University of Bari, Valenzano, Bari, Italy
[b] Istituto Zooprofilattico Sperimentale di Puglia e Basilicata, Foggia, Italy
[c] Ospedale Veterinario Pingry, Bari, Italy
[d] Cocker House – Allevamento "del Machich", Mola di Bari, Italy

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Virus shedding
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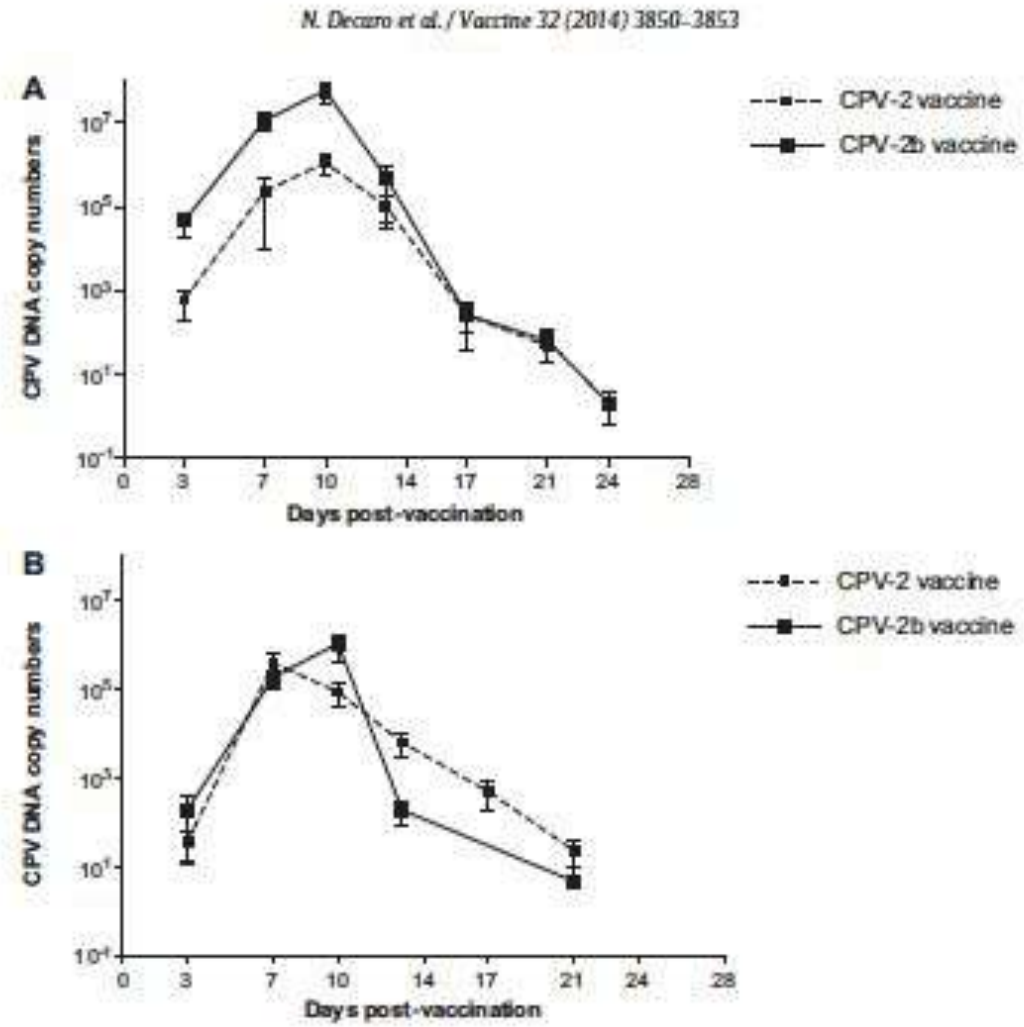
ABSTRACT

Canine parvovirus (CPV) modified live virus vaccines are able to infect vaccinated dogs replicating in the bloodstream and enteric mucosa. However, the exact duration and extent of CPV vaccine-induced viremia and fecal shedding are not known. With the aim to fill this gap, 26 dogs were administered two commercial vaccines containing a CPV-2 or CPV-2b strain and monitored for 28 days after vaccination. By using real-time PCR, vaccine-induced viremia and shedding were found to be long lasting for both vaccinal strains. Vaccinal CPV-2b shedding was detected for a shorter period than CPV-2 (12 against 19 mean days) but with greater viral loads, whereas viremia occurred for a longer period (22 against 19 mean days) and with higher titers for CPV-2b. Seroconversion appeared as early as 7 and 14 days post-vaccination for CPV-2b and CPV-2 vaccines, respectively. With no vaccine there was any diagnostic interference using in-clinic or hemagglutination test, since positive results were obtained only by fecal real-time PCR testing. The present study adds new insights into the CPV vaccine persistence in the organism and possible interference with diagnostic tests.

DOES CPV VACCINATION INTERFERE WITH IN-CLINIC ASSAYS?



VIREMIA

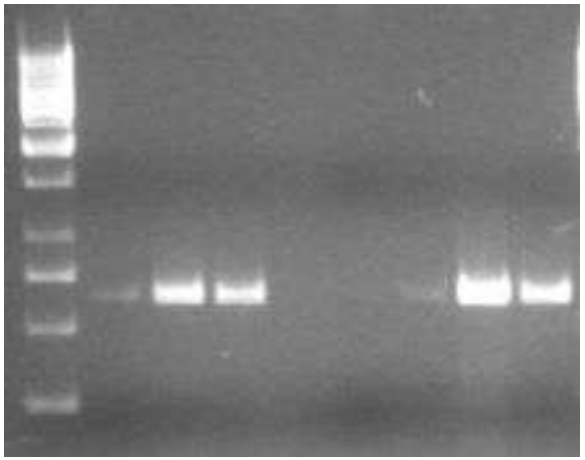
FAECAL SHEDDING

NO FAECAL SAMPLES TESTED POSITIVE BY ANTIGEN TESTING

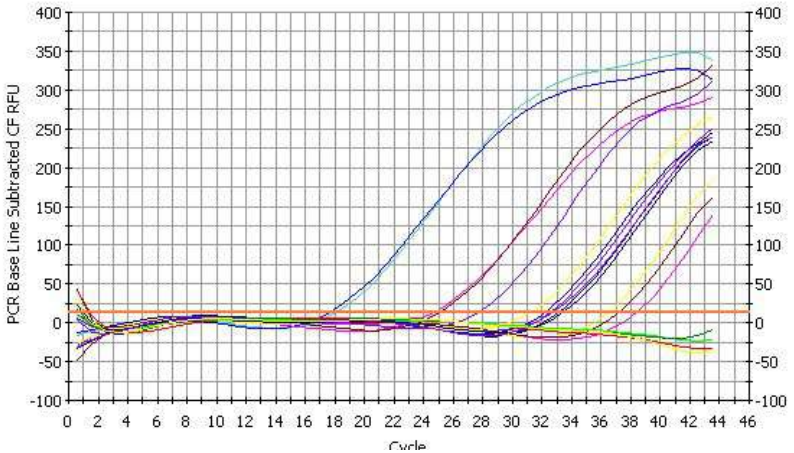
CPV DETECTION

INNOVATIVE METHODS

PCR



REAL-TIME PCR
WITH TAQMAN



Highly sensitive

Detection of nucleic acid

Available online at www.sciencedirect.com
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Veterinary Microbiology 105 (2005) 19–28
veterinary microbiology
www.elsevier.com/locate/vetmic

A real-time PCR assay for rapid detection and quantitation of canine parvovirus type 2 in the feces of dogs

Nicola Decaro[a,*], Gabriella Elia[a], Vito Martella[a], Costantina Desario[a], Marco Campolo[a], Livia Di Trani[b], Elvira Tarsitano[a], Maria Tempesta[a], Canio Buonavoglia[a]

[a]*Department of Animal Health and Well-being, Faculty of Veterinary Medicine of Bari, Strada per Casamassima Km 3, 70010 Valenzano, Bari, Italy*
[b]*Istituto Superiore di Sanità, viale Regina Elena 299, 00161 Rome, Italy*

Received 14 April 2004; received in revised form 23 September 2004; accepted 29 September 2004

Abstract

We describe a rapid, sensitive and reproducible real-time PCR assay for detecting and quantifying canine parvovirus type 2 (CPV-2) DNA in the feces of dogs with diarrhea. An exogenous internal control was added to control the assay performance from extraction to amplification. The method was demonstrated to be highly specific and sensitive, allowing a precise CPV-2 DNA quantitation over a range of eight orders of magnitude (from 10^2 to 10^9 copies of standard DNA). The reproducibility of the CPV-2 real-time PCR assay was assessed by calculating the coefficients of variation (CV) intra-assay and inter-assay for samples containing amounts of CPV-2 DNA spanning the whole range of the real-time PCR standard curve. Then, fecal specimens from diarrheic dogs were analyzed by hemagglutination (HA), conventional PCR and real-time amplification. Comparison between these different techniques revealed that real-time PCR is more sensitive than HA and conventional gel-based PCR, allowing to detect low viral titers of CPV-2 in infected dogs.

Keywords: Dog; Parvovirus; Real-time PCR; Diagnosis

CPV ANTIBODY DETECTION

IgM DETECTION

The **Veterinary Record**, May 10, 2003

Evaluation of a dot ELISA kit for measuring immunoglobulin M antibodies to canine parvovirus and distemper virus

T. WANER, S. MAZAR, E. NACHMIAS, E. KEREN-KORNBLATT, S. HARRUS

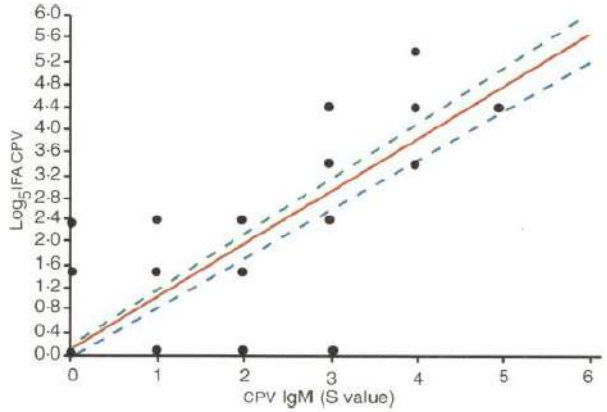


FIG 1: Correlation and 95 per cent confidence limits for the relationship between the serum immunoglobulin M (IgM) antibody titres to canine parvovirus (CPV), measured by immunofluorescence and by dot ELISA

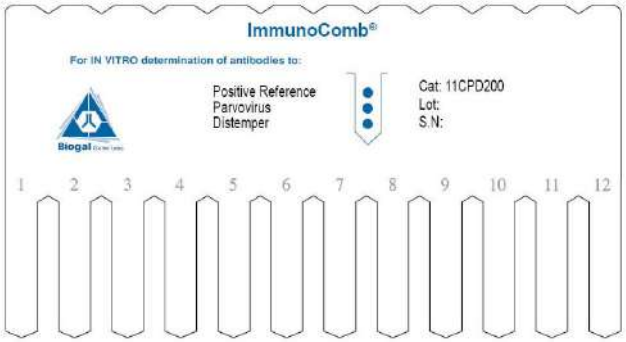
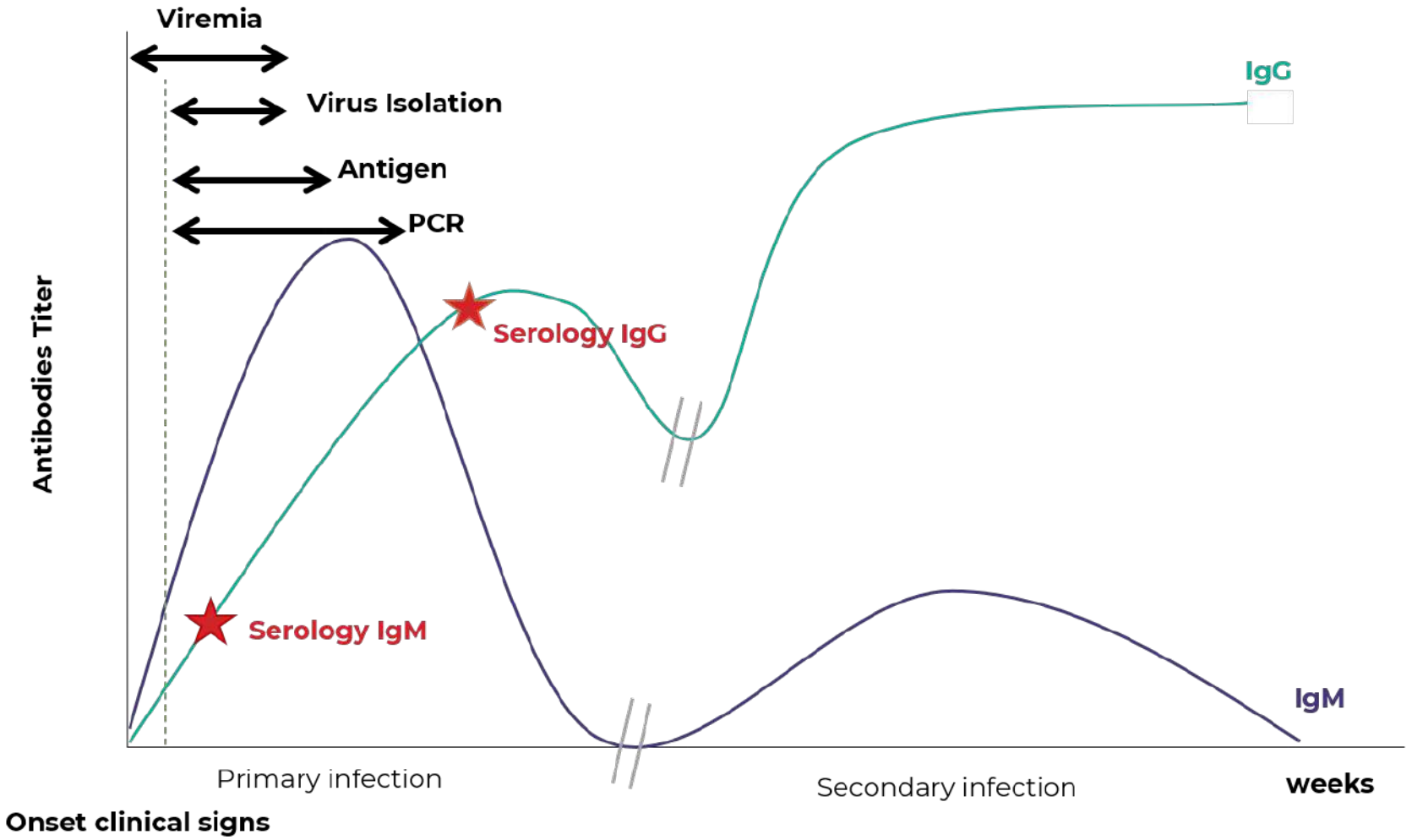


TABLE 1: Pearson's correlation coefficients (r) for the relationships between the results of the dot ELISA and immunofluorescence antibody tests for immunoglobulin M (IgM) and immunoglobulin G (IgG) to canine parvovirus (CPV) and canine distemper virus (CDV) in 100 dogs

Parameter	r	P value (two-tailed)
CPV IgM	0·777	<0·0001
CDV IgM	0·833	<0·0001
CPV IgG	0·900	<0·0001
CDV IgG	0·822	<0·0001

CPV DIAGNOSIS



Canine parvovirus: Vaccination

Veterinary Microbiology 247 (2020) 108760

Contents lists available at ScienceDirect

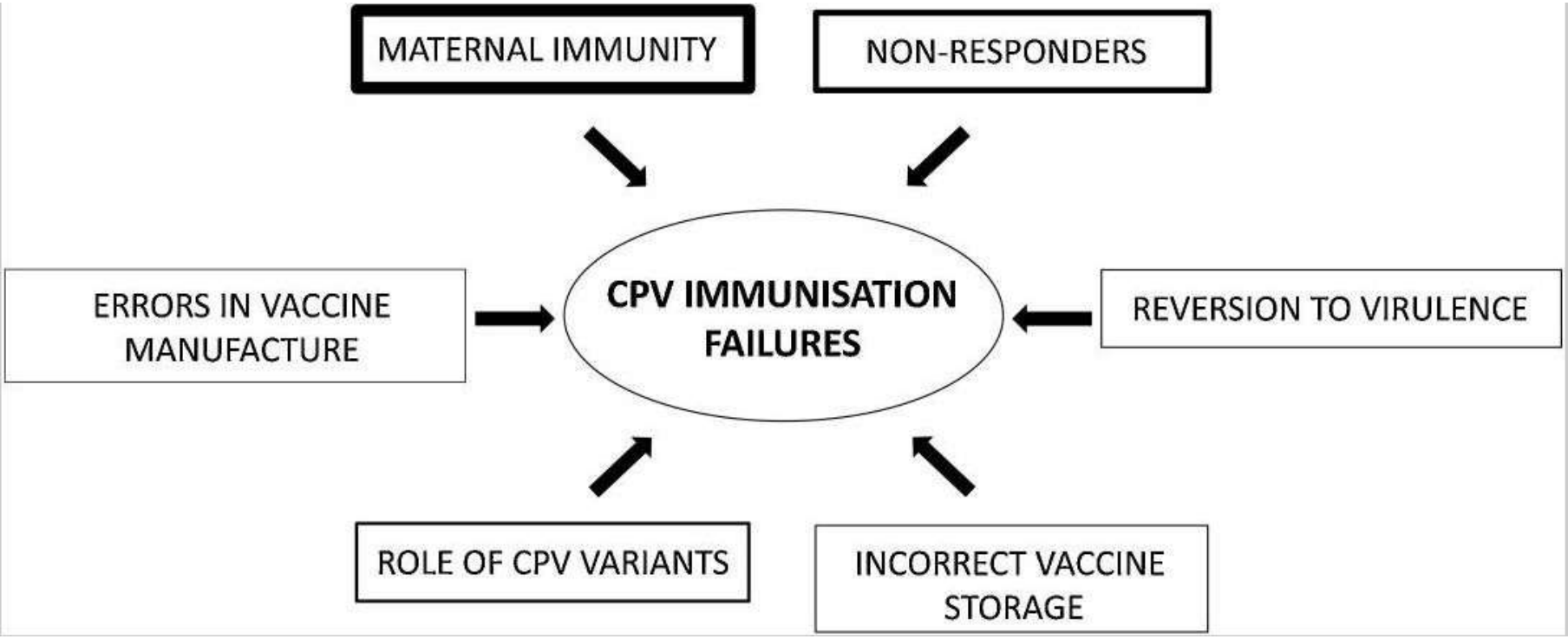
Veterinary Microbiology

journal homepage: www.elsevier.com/locate/vetmic

Canine parvovirus vaccination and immunisation failures: Are we far from disease eradication?

N. Decaro[a,*], C. Buonavoglia[a], V.R. Barrs[b]

[a] Department of Veterinary Medicine, University of Bari, Valenzano (Bari), Italy
[b] City University of Hong Kong, Department of Infectious Diseases & Public Health, Jockey Club College of Veterinary Medicine and Life Sciences, Kowloon, Hong Kong SAR, China



WINDOW OF SUSCEPTIBILITY

Correlation between MDA titres and CPV protection

TITRES <1:20 ⇒ **INFECTION AND DISEASE**

1:20< TITRES <1:80 ⇒ **ASYMPTOMATIC FORM**

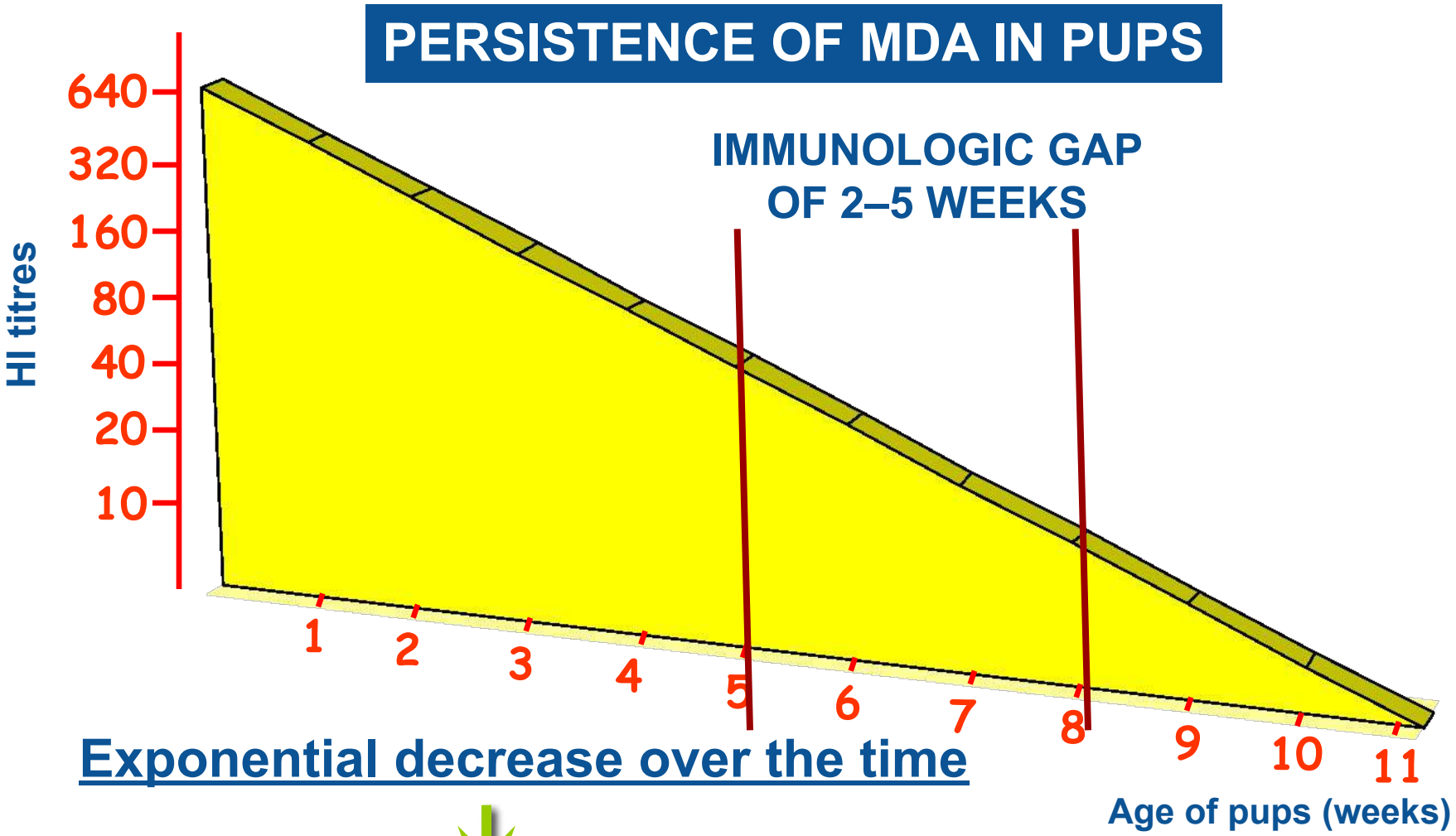
TITRES >1:80 ⇒ **FULL PROTECTION**

Correlation between MDA titres and CPV vaccination

TITRES <1:20 ⇒ **ACTIVE IMMUNISATION**

TITRES >1:20 ⇒ **INTERFERENCE**

WINDOW OF SUSCEPTIBILITY



Exponential decrease over the time

Half-life of 8.5-10 days

DURATION OF THE WINDOW OF SUSCEPTIBILITY

- BREED (SMALL VS. LARGE)
- Ab TITRE OF THE DAM
- AMOUNT OF COLOSTRUM
- GROWTH RATE

WINDOW OF SUSCEPTIBILITY

HOW TO OVERCOME THE MDA INTERFERENCE?

- MDA TITRATION **HI**
- HIGH-TITRE VACCINES **10^6-10^7 $TCID_{50}$/ML**
- INTRANASAL VACCINATION **(OFF LABEL)**

Seroconversion in the presence of MDA titres 1:80-1:160

Martella et al., 2007, Clin Diagn Lab Immunol

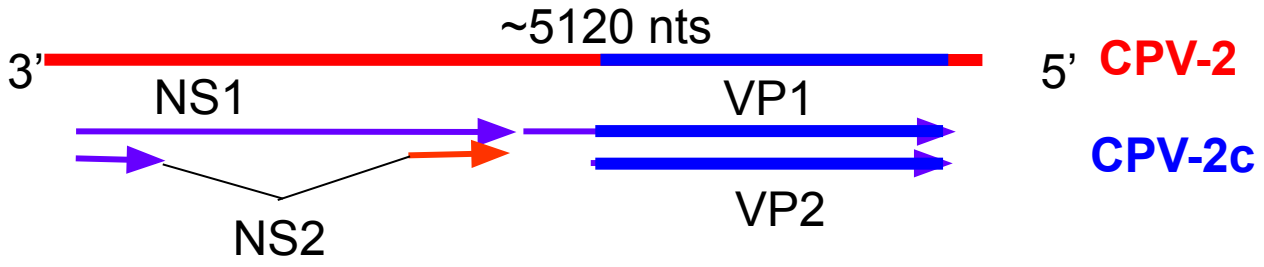
WINDOW OF SUSCEPTIBILITY

HOW TO OVERCOME THE MDA INTERFERENCE?

- HIGHLY IMMUNOGENIC VACCINES

Seroconversion in the presence of high MDA titres

RECOMBINANT VACCINE



WSAVA VACCINATION GUIDELINES

- 3-4 doses at 2-4 weeks intervals between the 6th and 16th week of age
- Booster at 6-12 months
- Revaccination every 3 years

Table 5. Core Vaccination Schedules for Puppies and Kittens First Presented Between 6–9 Weeks of Age and Revaccinated Every 3 or 4 Weeks

Age at first presentation	Core vaccination schedule
6 weeks	6 weeks, 9 weeks, 12 weeks, 16 weeks then 26 or 52 weeks or 6 weeks, 10 weeks, 14 weeks, 18 weeks then 26 or 52 weeks
7 weeks	7 weeks, 10 weeks, 13 weeks, 16 weeks then 26 or 52 weeks or 7 weeks, 11 weeks, 15 weeks, 19 weeks then 26 or 52 weeks
8 weeks	8 weeks, 11 weeks, 14 weeks, 17 weeks then 26 or 52 weeks or 8 weeks, 12 weeks, 16 weeks then 26 or 52 weeks
9 weeks	9 weeks, 12 weeks, 15 weeks, 18 weeks then 26 or 52 weeks or 9 weeks, 13 weeks, 17 weeks then 26 or 52 weeks

This table provides examples of possible vaccination schedules for puppies and kittens where vaccines are given either every 3 or 4 weeks, as would normally be done in veterinary practice for owned pet animals. Although revaccination every 2 weeks might be used in areas of high infectious disease pressure in some geographical areas, such a protocol is not shown for simplicity of presentation.
After the 26 or 52 week booster vaccine; vaccinate with core products no more frequently than every 3 years (with the exception of feline respiratory virus vaccines for higher risk cats).

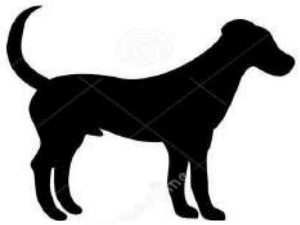
https://wsava.org/global-guidelines/vaccination-guidelines/

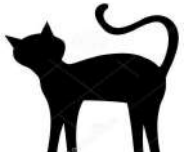
SEROLOGICAL TESTING

IN-CLINIC ASSAYS

VACCICheck® by Biogal Galed Labs.

- Dogs (CPV, CDV, CAV) and cats (FPLV, FCV, FHV)
- DOT-ELISA test
- Execution time: 20-25 min
- Visual reading
- Colorimetric comparison with standards





CPV* = 1:80 **CDV* = 1:32** **CAV* = 1:64**

FPLV* = 1:80 **FCV = 1:32** **FHV = 1:16**

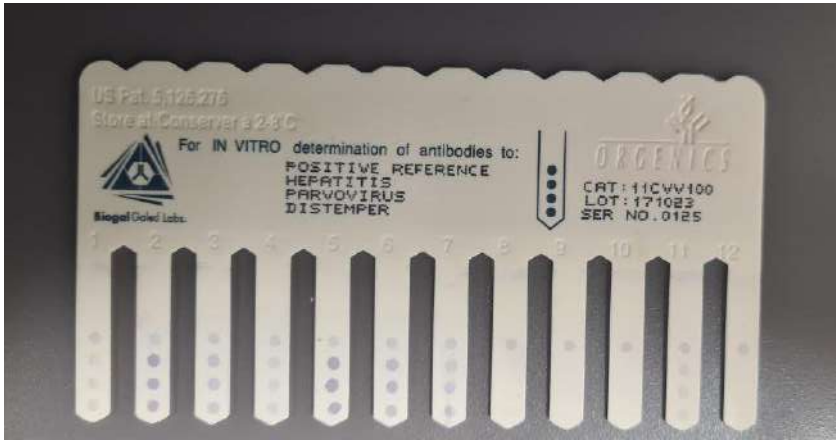
*** THE PRESENCE OF ANTIBODIES FROM ACTIVE IMMUNITY REGARDLESS THE TITRE IS CONSIDERED PROTECTIVE**

SEROLOGICAL TESTING

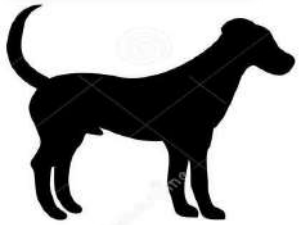
IN-CLINIC ASSAYS

VACCICheck® by Biogal Galed Labs.

- To evaluate seroconversion after primary vaccination course
- To evaluate the need for the 3-year booster
- Old dogs with a history of multiple vaccinations
- Dogs with allergic/anaphylactic reactions
- Dogs with no history/anamnesis



CPV



SEROLOGICAL TESTING

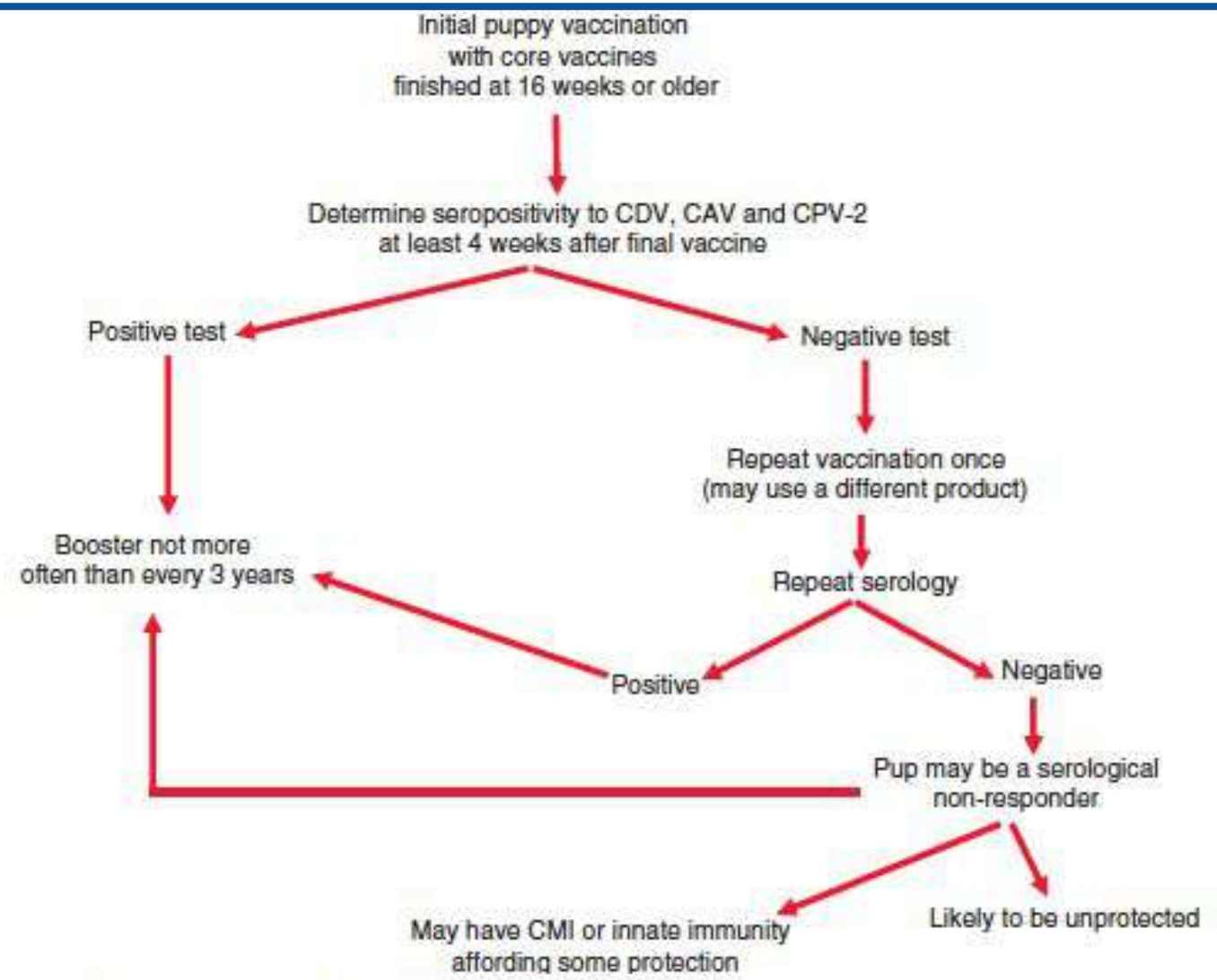


Fig 1. Flow chart for serological testing of puppies

https://wsava.org/global-guidelines/vaccination-guidelines/

Canine parvovirus: Treatment

MAINLY SUPPORTIVE/SYMPTOMATIC

Vet Clin Small Anim 50 (2020) 1307–1325
https://doi.org/10.1016/j.cvsm.2020.07.008

Update on Canine Parvoviral Enteritis

Elisa M. Mazzaferro, MS, DVM, PhD[a,b,*]

- Fluid adminstration (lactate Ringer solution)
- Antiemetic drugs
- Gastric protectors
- Whole blood/plasma transfusions
- Enteral nutrition (nasopharyngeal/nasogastric tubes)
- Broad-spectrum antibiotics

Table 1
Antibiotic choices for use in inpatient and outpatient treatment protocols for canine parvoviral enteritis

Antibiotic	Dose (mg/kg)/Route/Frequency	In/Outpatient
Ampicillin	20–40/IV/Q 8 h	Inpatient
Ampicillin-sulbactam	30–50/IV/Q 6–8 h	Inpatient
Cefovecin	8/SQ/once	Outpatient
Cefoxitin	20–30/IV/Q 8 h	Inpatient
Enrofloxacin	10/IV/Q 24 h	Inpatient
Metronidazole	10/IV/Q 8 h	Inpatient

Abbreviations: Q, every; SQ, subcutaneous.

USE OF HYPERIMMUNE PLASMA

JAVMA, Vol 240, No. 6, March 15, 2012

Clinical evaluation of a single dose of immune plasma for treatment of canine parvovirus infection

Ryan F. Bragg, DVM, MS, DACVECC; Amanda L. Duffy, DVM, MS, DACVECC; Frank A. DeCecco, DVM; Donald K. Chung, DVM; Maura T. Green; Julia K. Veir, DVM, PhD, DACVIM; Steven W. Dow, DVM, PhD, DACVIM

Table 1—Median ± SEM values of descriptive variables for 14 dogs with CPV enteritis treated with 12 mL of CPV-immune plasma (n = 7) or 12 mL of saline (0.9% NaCl) solution (placebo [7]) within 18 hours after hospital admission in addition to standard supportive care.

Variable	CPV-immune plasma–treated group	Placebo-treated group	*P* value*
Age (mo)	3.0 ± 1.52	3.5 ± 0.89	0.95
Body weight at admission (kg)	4.3 ± 3.4	9.5 ± 2.1	0.54
Duration of clinical signs prior to hospital admission (d)	24 ± 7.9	24 ± 4.4	0.68
Dose (mL/kg)	2.79 ± 1.9	1.26 ± 1.25	0.54
Weight loss during hospitalization (%)	2 ± 4.1	0 ± 4.2	0.56
Time in hospital (d)	4 ± 0.53	4 ± 0.79	0.95
Cost of treatment ($)	1,424 ± 161	1,665 ± 279	0.62

*Represents results of a Mann-Whitney *U* test; values were considered significant at $P < 0.05$.
To convert mL/kg to mL/lb, divide by 2.2.

USE OF PURIFIED IMMUNOGLOBULINS

Asian Journal of Scientific Research

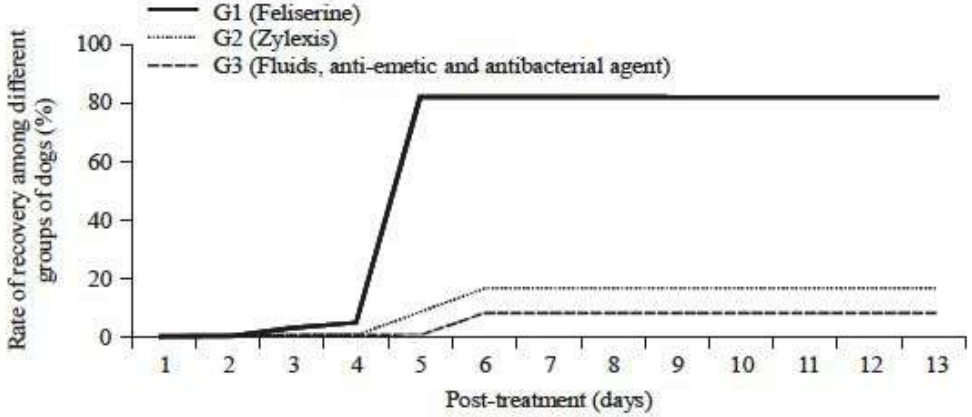
ISSN 1992-1454

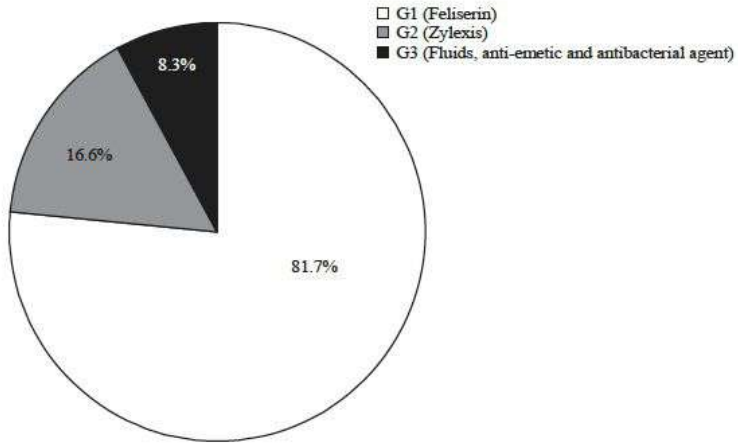
DOI: 10.3923/ajsr.2019.308.315

Research Article

Successful Treatment of Canine Parvovirus Infection in Naturally Infected Puppies

[1]Romane Adieb Awad, [2,3]Brit Martens and [2,3]Safwat Ali Hassan





USE OF INTERFERON-Ω

The **Veterinary Record**, January 25, 2003

Treatment of canine parvoviral enteritis with interferon-omega in a placebo-controlled field trial

K. DE MARI, L. MAYNARD, H. M. EUN, B. LEBREUX

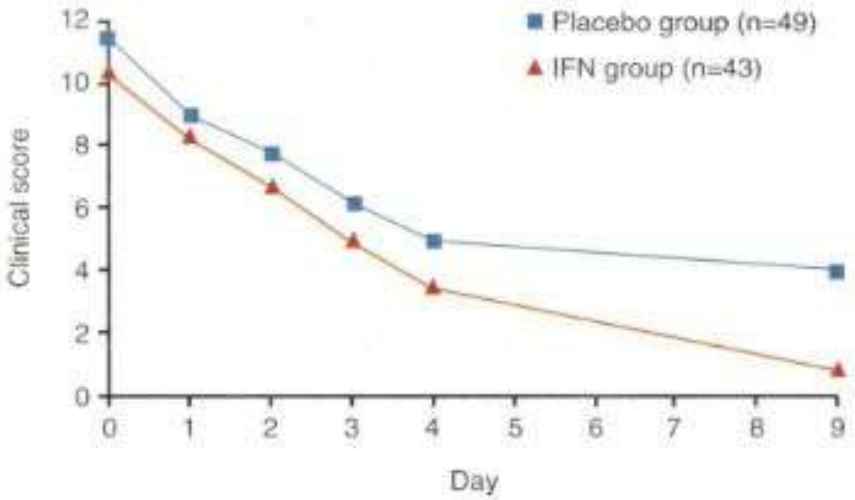


FIG 1: Time course of the clinical scores of the dogs in the interferon (IFN)-treated and placebo groups. The clinical scores for dead dogs were taken into account by using the method of last observation carried forward

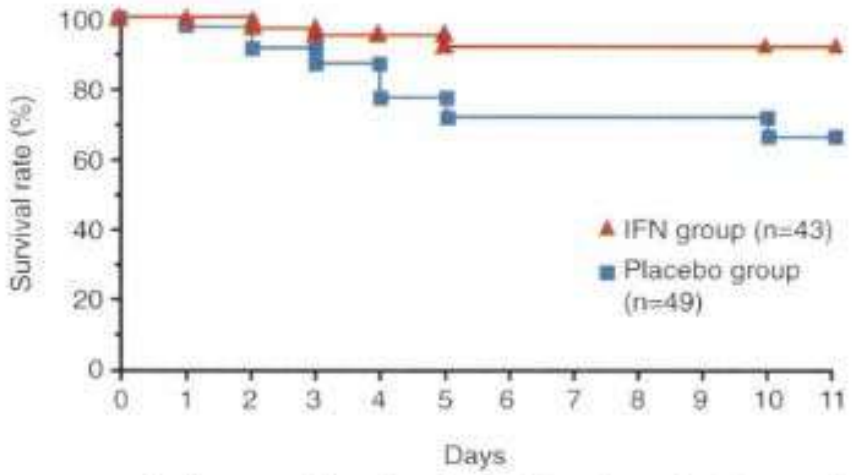


FIG 2: Survival rates of the dogs in the interferon (IFN)-treated and placebo groups

USE OF rcG-CSF

Veterinary Microbiology 231 (2019) 177–182

Use of recombinant canine granulocyte-colony stimulating factor to increase leukocyte count in dogs naturally infected by canine parvovirus

Andrea Armenise[a], Paolo Trerotoli[b], Francesco Cirone[c], Anna De Nitto[a], Costantina De Sario[c], Walter Bertazzolo[d], Annamaria Pratelli[c,*], Nicola Decaro[c]

Table 2
Adjusted means and 95% confidence interval of cells counts. P-values refers to post-hoc adjusted comparison between treated and non-treated groups at each time point.

	Days	Group A			Group B			P-value#
		Mean (1000cells/µl)	LCL* (1000cells/µl)	UCL* (1000cells/µl)	Mean (1000cells/µl)	LCL* (1000cells/µl)	UCL* (1000cells/µl)	
WBC	1	1.71	1.49	1.96	1.54	1.28	1.87	0.9979
	2	5.42	4.54	6.54	1.65	1.27	2.17	< 0.0001
	3	16.42	13.95	19.46	2.92	2.31	3.77	< 0.0001
	4	24.97	17.89	35.97	5.82	4.40	7.89	< 0.0001
	5	29.24	20.94	42.11	12.17	9.40	16.08	0.0028
Lymphocytes	1	0.99	0.79	1.25	0.78	0.61	0.99	0.9139
	2	2.89	2.40	3.53	0.82	0.64	1.08	< 0.0001
	3	9.31	7.09	12.51	1.53	1.13	2.10	< 0.0001
	4	13.46	6.61	32.63	3.22	2.36	4.53	0.0072
	5	12.62	5.15	41.72	4.05	2.69	6.47	0.4458
Monocytes	1	0.58	0.46	0.74	0.42	0.32	0.56	0.7987
	2	2.42	1.96	3.03	0.68	0.50	0.94	< 0.0001
	3	4.40	3.50	5.62	1.13	0.84	1.56	< 0.0001
	4	5.12	2.69	11.34	2.44	1.96	3.09	0.5044
	5	6.16	3.24	13.61	4.91	3.53	7.07	0.9999
Neutrophils	1	0.09	0.06	0.14	0.31	0.22	0.46	0.0004
	2	0.13	0.10	0.16	0.16	0.09	0.29	0.9986
	3	0.40	0.20	0.87	0.38	0.22	0.66	1
	4	0.86	0.33	2.91	0.69	0.41	1.24	1
	5	2.05	0.57	14.63	1.22	0.62	2.74	0.9995

USE OF rcG-CSF

Veterinary Microbiology 231 (2019) 177–182

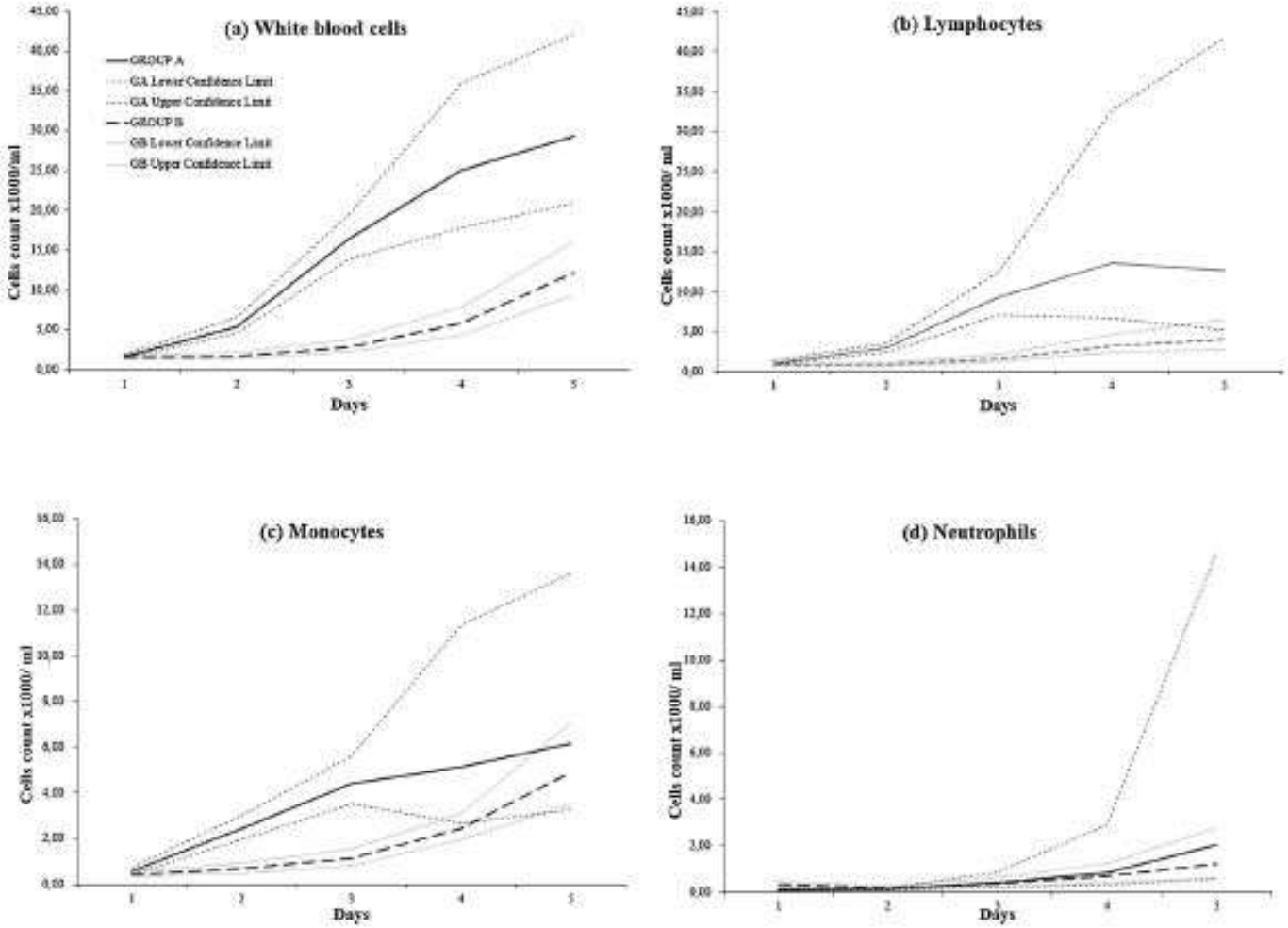


Fig. 1. Profile of least-square means and 95% confidence interval by treatment groups (Group A: treated; Group B: not treated) and days after therapy. a) WBC counts. b) Lymphocytes counts. c) Monocytes counts. d) Neutrophils counts.

THANKS FOR YOUR ATTENTION

BARI, ITALY