sciensano

WOAH Reference Laboratory for **Lumpy skin disease**

Reference Centre World Organisation for Animal Health Founded as OIE

EU Reference Laboratory for Capripox viruses

Funded by the European Union

Food and Agriculture Organization of the United Nations

healthy all life long

IMPORTANCE OF QUALITY, SAFETY AND EFFICACY OF LSDV VACCINES

Nick De Regge

4st LSD coordination meeting for South-East Asia

28-29 November 2023, Bangkok, Thailand

.be

LSDV control measures

- Infected countries
  - Stamping out of infected animals (total vs partial)
  - Restriction of animal movements
  - Vector control

  - VACCINATION

Vaccination combined with other control measures has shown to be the most efficient way to control and eradicate LSDV:

- outbreaks in Israël 2012-2013
- outbreaks in Cyprus 2014-2015
- outbreaks in the Balkan region 2016-2017

- Free countries
  - Import restriction
  - Quarantaine of imported animals

LSDV vaccines

vaccines

MDPI

Review

Review: Vaccines and Vaccination against Lumpy Skin Disease

Eeva Tuppurainen [1,*], Klaas Dietze [1], Janika Wolff [2], Hannes Bergmann [3], Daniel Beltran-Alcrudo [4,†], Anna Fahrion [1], Charles Euloge Lamien [5], Frank Busch [1], Carola Sauter-Louis [3], Franz J. Conraths [3], Kris De Clercq [6], Bernd Hoffmann [2] and Sascha Knauf [1]

Manufacturer	Product Name and Virus Strain	Target Species	Titre, Dose, Administration	Presentation Doses/Vial
Onderstepoort Biological Products (OBP) South Africa Email: info@obpvaccines.co.za http://www.obpvaccines.co.za (accessed on 22 September 2021)	Lumpy Skin Disease Vaccine for Cattle (LSD Neethling strain)	Cattle	Not known 2 ml SC	25/50
Intervet (Pty) South Africa/MSD Animal Health http://www.msd-animal-health.co.za (accessed on 29 September 2021)	Lumpyvax™ (LSD SIS Neethling type strain)	Cattle	$10^{4.0}$TCID$_{50}$/dose 1 ml SC	20/100
MCI Santé Animale Morocco Email: contact@mci-santeanimale.com http://www.mci-santeanimale.com/en/ (accessed on 29 September 2021)	Bovivax-LSD™ (LSD Neethling strain)	Cattle	$10^{3.5}$TCID$_{50}$/dose 2 ml SC	25/50/100
Jordan Bio-Industries Center (JOVAC) Jordan Email: sales@jovaccenter.com http://www.jovaccenter.com (accessed on 29 September 2021)	LumpyShield-N™ (LSD Neethling strain)	Cattle	$10^{4.0}$TCID$_{50}$/dose 1 ml SC	5/10/25/50/100
Middle East for Vaccines (MEVAC) Egypt Email: marketing@me_vac.com https://www.me-vac.com/about (accessed on 29 September 2021)	MEVAC LSD (LSD Neethling strain)	Cattle	$10^{3.5}$TCID$_{50}$/dose 1 ml SC	10/25/50
National Veterinary Institute (NVI) Ethiopia Email: nvi-rt@ethionet.et	Lumpy Skin Disease Vaccine (LSD Neethling strain)	Cattle	$10^{3.0}$TCID$_{50}$/dose 1 ml SC	5/20/100
Kenya Veterinary Vaccines Production Institute (KEVEVAPI) http://www.kevevapi.org/ (accessed on 29 September 2021)	Lumpivax™ (Live attenuated LSDV)	Cattle	TCID$_{50}$ not known 2 ml SC	50/100/150
Pendik Veterinary Control Institute/ Ministry of Agriculture, Turkey	Penpox-M™ Live SPPV (Bakirköy SPPV strain)	Cattle	$10^{2.5}$TCID$_{50}$/dose 3 ml SC	
Vetal Company Turkey Email: vetal@vetal.com.tr http://www.vetal.com.tr (accessed on 29 September 2021)	Poxvac™ (Bakirköy SPPV strain) Lumpyvac™ (LSD Neethling strain)	Sheep Cattle Cattle	$10^{2.5}$TCID$_{50}$/dose 3ml SC $10^{3.5}$TCID$_{50}$/dose 2 ml SC	20/50/100/200 10/25/50/100
Dollvet Turkey Email: dollvet@dollvet.com.tr http://www.dollvet.com.tr (accessed on 29 September 2021)	Poxdoll™ (Bakirköy SPPV strain) LSD-NDOLL (LSD Neethling strain)	Cattle Sheep Goats Cattle	$10^{2.5}$TCID$_{50}$/dose 3ml SC $10^{3.5}$TCID$_{50}$/dose 3ml SC	50/100 10/25/50/100
FGBI-Federal Centre for Animal Health, The Russian Federation Email: mail@arriah.ru http://www.arriah.ru (accessed on 29 September 2021)	Sheep Pox Cultyral Dry™(Arriah SPPV strain)	Sheep Cattle	Not known	50/100

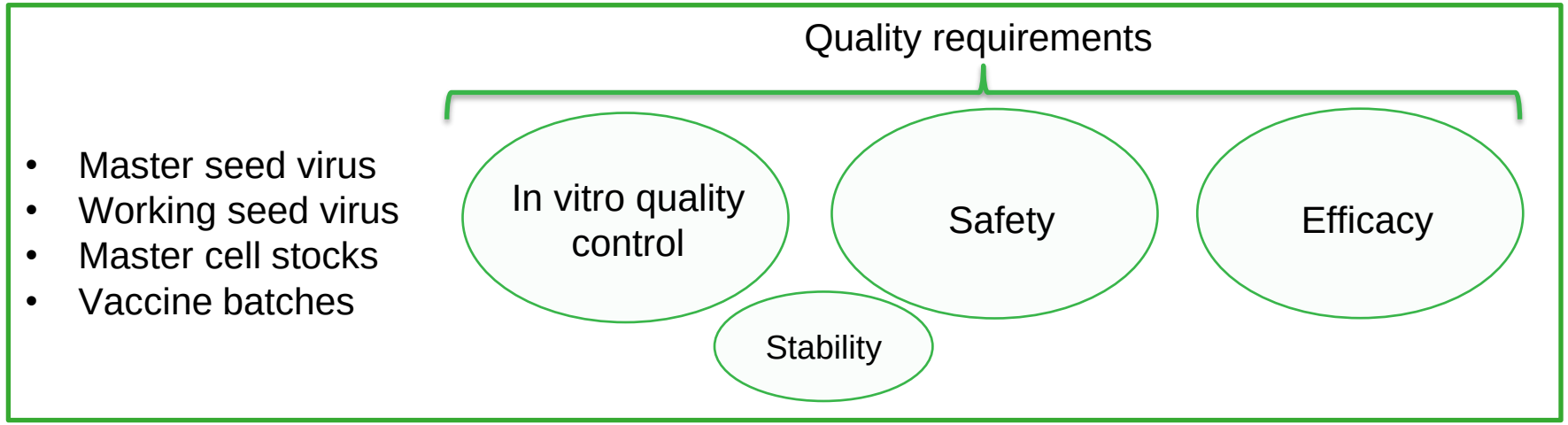
LSDV vaccine types

- Live attenuated vaccines (LAV)
  - Homologous vaccines
    - LSDV-based vaccine (Neethling strain, KSGP strain)
  - Heterologous vaccines
    - SPPV (RM65, Romania, Bakirköy, … strain) based vaccines
    - GTPV (Kedong, Isiolo, Mysorc, Gorgan, Uttarkashi … strain) based vaccines
- Inactivated vaccines (INAC)
  - Homologous
  - Heterologous
- Multivalent vaccines
- Subunit and mRNA vaccines under development

LSDV vaccine quality requirements

WOAH guidelines – In manual of diagnostic tests and vaccines for terrestrial animals:

- Principles of veterinary vaccine production
- Minimum Requirements for the Production and Quality Control of Vaccines
- Tests for sterility and freedom from contamination of biological materials intended for veterinary use.
- Chapter 3.4.12: Lumpy skin disease – part C: requirements for vaccines



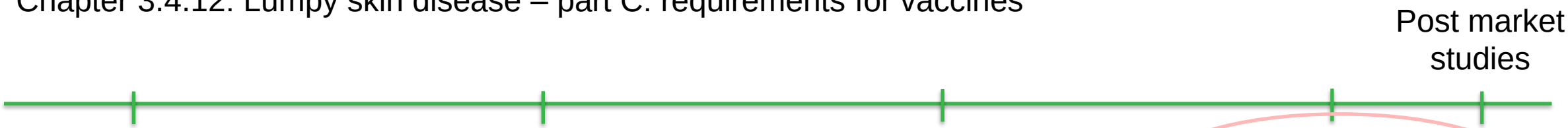
International and national legislative guidelines:

Example given:

- European pharmacopoeia
- https://www.ema.europa.eu/en/documents/scientific-guideline/guideline-requirements-production-control-immunological-veterinary-medicinal-products_en-0.pdf
- Belgium: Federal agency for medicines and health products

LSDV vaccine quality control

- Chapter 3.4.12: Lumpy skin disease – part C: requirements for vaccines



Vaccine development/ manufacturing

Quality assurance (GLP – GMP)
- master seed virus
- working seed virus
- master cell stock

Outline of production

- identity of vaccine (species – strain)
- purity: sterility/absence of contaminants (viruses, bacteria, fungi, mycoplasma, …)

Safety testing

- One dose/repeat dose test
- local reactions at inoculation site
- fever
- effect on milk production
- Neethling response
- Breed/age effect
- Overdose test
- Non-reversion to virulence
- Environmental risks
  - Vaccine viremia
  - Vaccine spread
  - Environmental persistence
- Effect in pregnant cattle

Efficacy testing

- protect against clinical symptoms
- induce strong immune responses (humoral/cellular)
- protect against viremia
- protect against excretion
- absence of virus in organs/skin

In vitro batch quality control

- identity of vaccine (species – strain)

- purity: sterility/absence of contaminants (viruses, bacteria, fungi, mycoplasma, …)

- potency/dose

LSDV vaccine in vitro batch control: case study 1

- In vitro quality control of LSDV and SPPV vaccines (manufacturer not specified)


Vaccine 34 (2016) 3317–3323

Contents lists available at ScienceDirect

Vaccine

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

Detection and isolation of Bluetongue virus from commercial vaccine batches

Velizar Bumbarov, Natalia Golender, Oran Erster*, Yevgeny Khinich

Division of Virology, Kimron Veterinary Institute, Bet Dagan, PO Box 12, 50250, Israel

➡ Infectious BTV (-9 and -26) detected in commercial LSDV and SPPV vaccines


AMERICAN SOCIETY FOR MICROBIOLOGY | Microbiology Resource Announcements

GENOME SEQUENCES

Complete Coding Sequence of a Novel Bluetongue Virus Isolated from a Commercial Sheeppox Vaccine

Paulina Rajko-Nenow,[a] Natalia Golender,[b] Velizar Bumbarov,[b] Hannah Brown,[a] Lorraine Frost,[a] Karin Darpel,[a] Chandana Tennakoon,[a] John Flannery,[a] Carrie Batten[a]

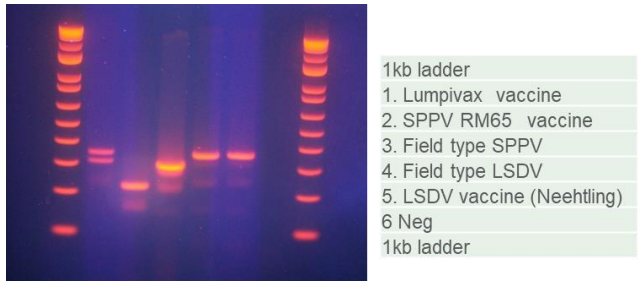
➡ SPPV vaccine (Jovac) contained BTV-26 and BTV-28 strains

LSDV vaccine in vitro batch control: case study 2

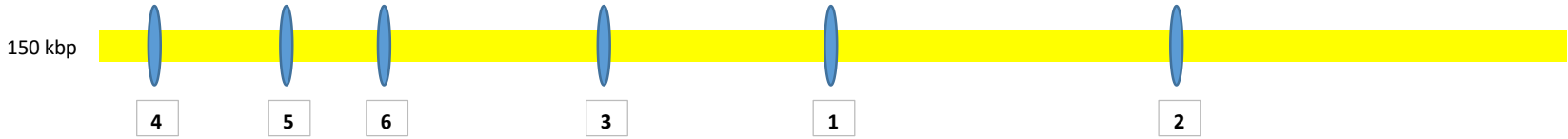
- Vaccine control of LSDV vaccine used in Kazakhstan before the emergence of recombinant strains

1. Confirmation of virus titer ✓
2. Absence of contaminants ✓
3. PCR control of strain purity

   - Pan capripox: ok
   - DIVA 1: Vac: Pos - Field type: Pos!!
   - DIVA 2: Vac: Pos - Field type: Pos!!
   - DIVA 3: LSDV - Field type SPPV/GTPV



4. Partial genome sequencing (6 regions)



5. Full length genome sequencing

LSDV vaccine in vitro batch control: case study 2

vaccines

MDPI

Article

The Importance of Quality Control of LSDV Live Attenuated Vaccines for Its Safe Application in the Field

Andy Haegeman [1,*], Ilse De Leeuw [1], Meruyert Saduakassova [2], Willem Van Campe [3], Laetitia Aerts [4], Wannes Philips [4], Akhmetzhan Sultanov [2], Laurent Mostin [3] and Kris De Clercq [1]

viruses

MDPI

Article

Recombinant LSDV Strains in Asia: Vaccine Spillover or Natural Emergence?

Frank Vandenbussche [1,†], Elisabeth Mathijs [1,†], Wannes Philips [1], Meruyert Saduakassova [2], Ilse De Leeuw [3], Akhmetzhan Sultanov [2], Andy Haegeman [3] and Kris De Clercq [3,*]

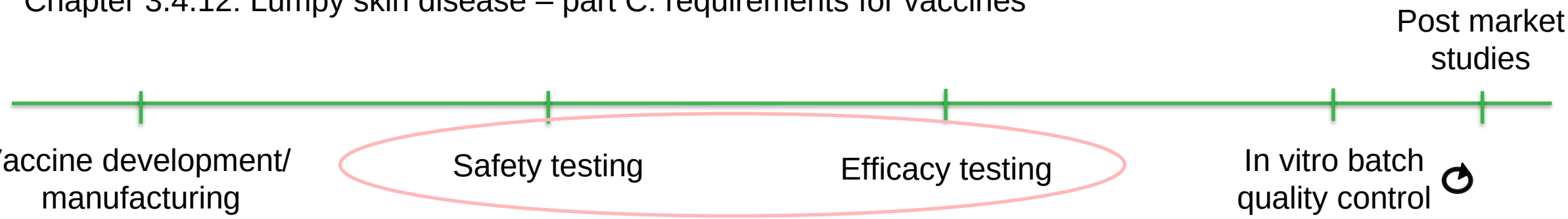
- Neethling like LSDV vaccine strain
- KSGP-like LSDV vaccine strain
- Sudan-like GTPV strain
- Multiple recombinant strains (almost) identical to recently described recombinant vaccine-like strains
- Most likely source of recombinant strains in the field

One specific badly produced and insufficiently controlled LSDV vaccine was responsible for the release of recombinant LSDV strains in the field

↳ Highlights that efforts need to be done to stimulate a thorough vaccine batch quality control

LSDV vaccine quality control

- Chapter 3.4.12: Lumpy skin disease – part C: requirements for vaccines



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  - Vaccine viremia
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- Effect in pregnant cattle

- protect against clinical symptoms
- induce strong immune responses (humoral/cellular)
- protect against viremia
- protect against excretion
- absence of virus in organs/skin

- identity of vaccine (species – strain)

- purity: sterility/absence of contaminants (viruses, bacteria, fungi, mycoplasma, …)

- potency/dose

LSDV vaccine safety/efficacy testing @sciensano

Challenge model in BSL3 animal facilities:

- Israel field isolate (cluster 1.2) / Vietnam field isolated (cluster 2.5)
- Titer $10^{5\text{-}6}$ TCID50/ml
- 5ml intravenous
- 4x0,25ml intradermal

⇩ 21 dpi monitoring

Clinical monitoring:
- Fever
- Swelling inoculation side
- Lnn swelling
- General health status
- Feed intake
- # noduli

Haegeman et al, 2021

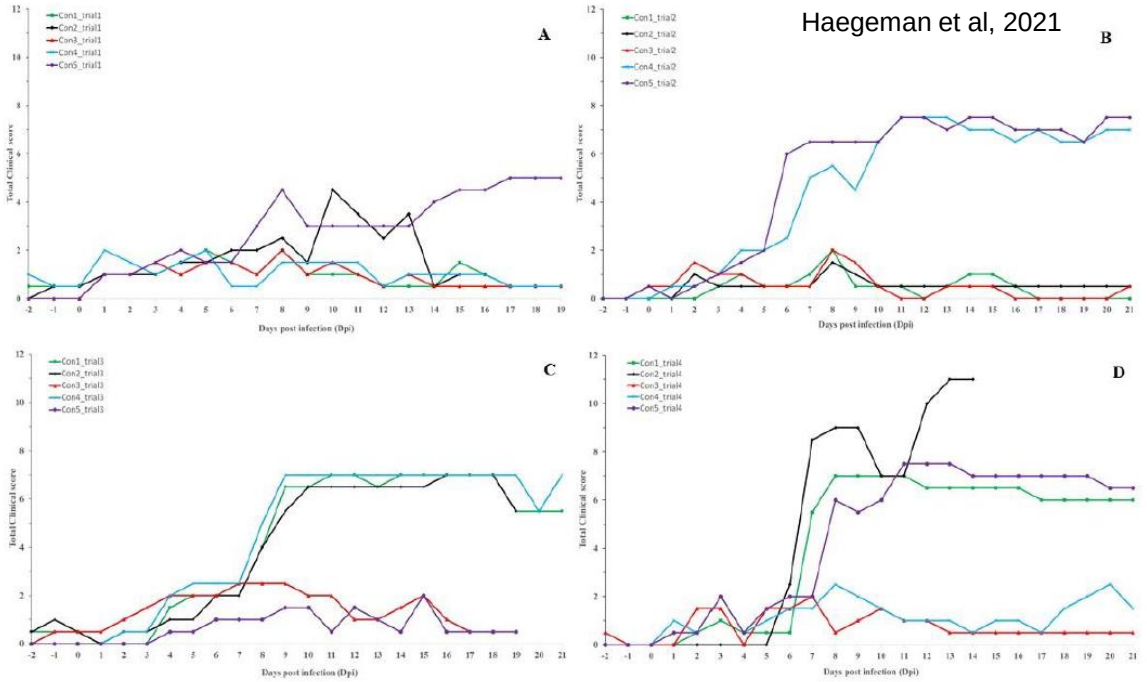
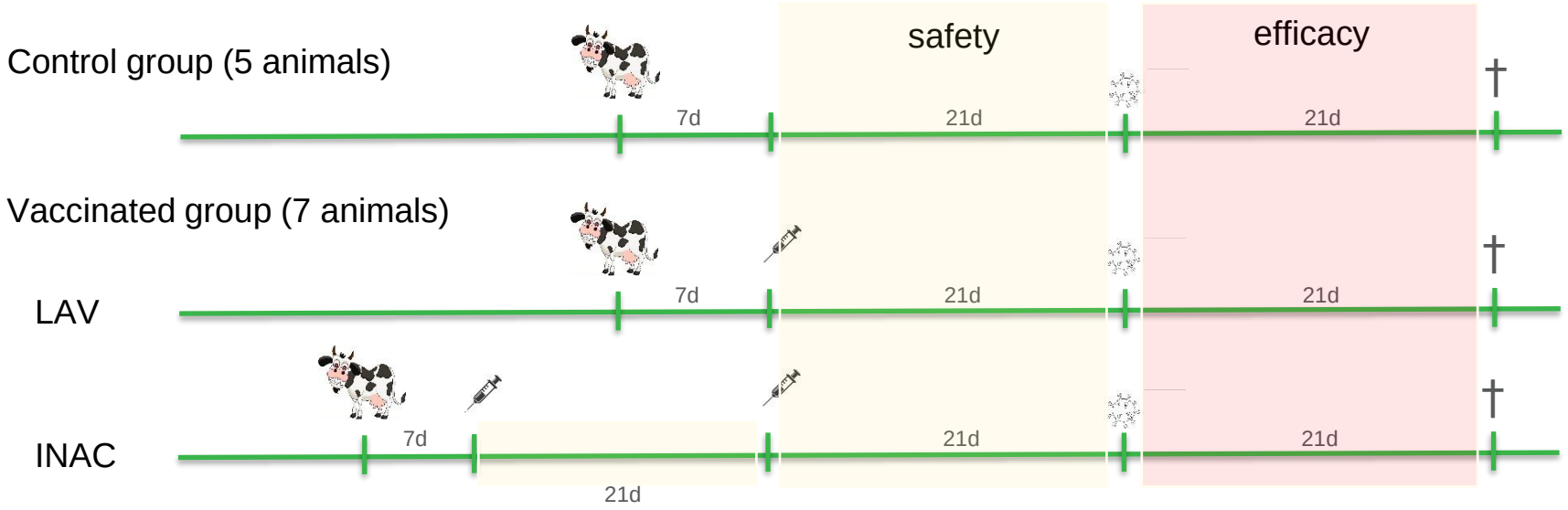


Figure 2. Total clinical score of the control animals. Infected at 0 dpi; (**A**): Trial 1; (**B**): Trial 2; (**C**): Trial 3; (**D**): Trial 4.

➡ +/-50% of inoculated animals develop clinical disease

LSDV vaccine safety/efficacy testing @sciensano

Vaccination – challenge experiments:



- Clinical scoring/monitoring: fever, lnn swelling, local reactions, nodule development, feed uptake,…
  ➡ adverse vaccine reactions/prevent clinical disease
- Intermediate sampling: - EDTA blood, swabs (PCR, isolation) ➡viremia and excretion (vaccine / challenge virus)
  - heparine blood (IFNγ testing) ➡cellular immune response
  - serum (IPMA, VNT, ELISA) ➡ humoral immune response
- Autopsy: biopts, organs (PCR, isolation) ➡ persistence of vaccine / challenge virus

LSDV vaccine safety/efficacy testing @ sciensano

type	strain	Vaccin	Company	clinical signs		IPMA		IFNgamma	viremia		swabs	organs
				post V	post C	post V	post C	post V	post V	post C	post C	post C
homologous LAV	LSDV	Lumpy Skin Dis Vac	OBP									
	LSDV	LumpyVax	MSD Animal health									
	LSDV	KenyaVac	JOVAC									
	LSDV	Herbivac	Deltamune									
	LSDV	Neethling O	MCI									
	LSDV	Lumpivax	Kevevapi									
heterologous LAV	SPPV	Abic (10x)	Phibro									
	SPPV	JoviVac	JOVAC									
	SPPV	Penpox-M (3x)	Pendik									
	SPPV	Romania (10x)	MCI									
	GTPV	CapriVac (10x)	JOVAC									
homol/heterol INAC	LSDV	Bovivax (?)	MCI									
	SPPV	Romania	MCI									

A: Absent; P: Present; *only viremic animals tested; +/-:weak; ++/--: intermediate; +++/---: strong

LSDV vaccine safety/efficacy testing @ sciensano

	type	strain	Vaccin	Company	clinical signs		IPMA		IFNgamma	viremia		swabs	organs
					post V	post C	post V	post C	post V	post V	post C	post C	post C
homologous LAV		LSDV	Lumpy Skin Dis Vac	OBP	A+	A++	+++	+	++	A+++	A+++	not tested	P-
		LSDV	LumpyVax	MSD Animal health	A+	A++	+	++	+++	A++	A+++	not tested	P-
		LSDV	KenyaVac	JOVAC	A++	A++	+	++	+++	A++	A+++	not tested	P-
		LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
		LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
		LSDV	Lumpivax	Kevevapi	P-	A+++	+++	+	++	P-	A+++	not tested	P-
heterologous LAV		SPPV	Abic (10x)	Phibro									
		SPPV	JoviVac	JOVAC									
		SPPV	Penpox-M (3x)	Pendik									
		SPPV	Romania (10x)	MCI									
		GTPV	CapriVac (10x)	JOVAC									
homol/heterol INAC		LSDV	Bovivax (?)	MCI									
		SPPV	Romania	MCI									

A: Absent; P: Present; *only viremic animals tested; +/-:weak; ++/--: intermediate; +++/---: strong

- All homologous LAV protected against clinical signs upon challenge
- Important negative safety aspects found for certain live attenuated LSDV vaccins:
  - strong local reaction
  - prolonged fever
  - Neethling respons in multiple animals
  - vaccine viremia

LSDV vaccine safety/efficacy testing @ sciensano

type	strain	Vaccin	Company	clinical signs post V	clinical signs post C	IPMA post V	IPMA post C	IFNgamma post V	viremia post V	viremia post C	swabs post C	organs post C
homologous LAV	LSDV	Lumpy Skin Dis Vac	OBP							A+++	not tested	P-
	LSDV	LumpyVax	MSD Anir							A+++	not tested	P-
	LSDV	KenyaVac	JOVAC							A+++	not tested	P-
	LSDV	Herbivac	Deltamun							A+++	P-	P--
	LSDV	Neethling O	MCI							A+++	A++	P-
	LSDV	Lumpivax	Kevevapi							A+++	not tested	P-
heterologous LAV	SPPV	Abic (10x)	Phibro									
	SPPV	JoviVac	JOVAC									
	SPPV	Penpox-M (3x)	Pendik									
	SPPV	Romania (10x)	MCI									
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homol/heterol INAC	LSDV	Bovivax (?)	MCI									
	SPPV	Romania	MCI									

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LSDV vaccine safety/efficacy testing @ sciensano

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	LSDV	LumpyVax	MSD Animal health	A+	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	KenyaVac	JOVAC	A++	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
	LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
	LSDV	Lumpivax	Kevevapi	P-	A+++	+++	+	++	P-	A+++	not tested	P-
heterologous LAV	SPPV	Abic (10x)	Phibro	A++	P--	--	+++	+	A+++	P---	P--	P---
	SPPV	JoviVac	JOVAC	A+++	P-	-	++	++	A+++	P--	P-	P--
	SPPV	Penpox-M (3x)	Pendik	A+++	P--	+	++	++	A+++	P---	P--	P--
	SPPV	Romania (10x)	MCI	A+++	P--	--	+	+	A+++	P---	P--	P---
	GTPV	CapriVac (10x)	JOVAC	A++	A+++	+++	+	+++	A++	A+++	not tested	A+++
homol/heterol INAC	LSDV	Bovivax (?)	MCI									
	SPPV	Romania	MCI									

A: Absent; P: Present; *only viremic animals tested; +/-:weak; ++/--: intermediate; +++/---: strong

- Live attenuated vaccines based on SHPV were safe, but lacked efficacy as they did not protect against clinical disease in all vaccinated animals
- Live attenuated vaccine based on GTPV showed good safety and efficacy, only one vaccine tested at 10x dose, duration of immunity?; be careful with extrapolation

LSDV vaccine safety/efficacy testing @ sciensano

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	LSDV	LumpyVax	MSD Animal health	A+	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	KenyaVac	JOVAC	A++	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
	LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
	LSDV	Lumpivax	Kevevapi	P-	A+++	+++	+	++	P-	A+++	not tested	P-
heterologous LAV	SPPV	Abic (10x)	Phibro	A++	P--	--	+++	+	A+++	P---	P--	P---
	SPPV	JoviVac	JOVAC	A+++	P-	-	++	++	A+++	P--	P-	P--
	SPPV	Penpox-M (3x)	Pendik	A+++	P--	+	++	++	A+++	P---	P--	P--
	SPPV	Romania (10x)	MCI	A+++	P--	--	+	+	A+++	P---	P--	P---
	GTPV	CapriVac (10x)	JOVAC	A++	A+++	+++	+	+++	A++	A+++	not tested	A+++
homol/heterol INAC	LSDV	Bovivax (?)	MCI									
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LSDV vaccine safety/efficacy testing @ sciensano

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	LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
	LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
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PLOS ONE

RESEARCH ARTICLE

Lumpy skin disease outbreaks in Egypt during 2017-2018 among sheeppox vaccinated cattle: Epidemiological, pathological, and molecular findings

Sherin R. Rouby[1]*, Nesreen M. Safwat[2], Khaled H. Hussein[1], Aml M. Abdel- Ra'ouf[3], Bahaa S. Madkour[3], Ahmed S. Abdel-Moneim[4], Hosein I. Hosein[1]

Contents lists available at ScienceDirect

Veterinary Microbiology

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

Goatpox virus (G20-LKV) vaccine strain elicits a protective response in cattle against lumpy skin disease at challenge with lumpy skin disease virulent field strain in a comparative study

K. Zhugunissov[a,*], Ye. Bulatov[a], M. Orynbayev[a], L. Kutumbetov[a], Ye. Abduraimov[a], Ye. Shayakhmetov[a], D. Taranov[a], Zh Amanova[a], M. Mambetaliyev[a], Zh. Absatova[a], M. Azanbekova[a], B. Khairullin[a], K. Zakarya[a], E. Tuppurainen[b,*]

VIRULENCE
2023, VOL. 14, NO. 1, 2190647
https://doi.org/10.1080/21505594.2023.2190647

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

OPEN ACCESS Check for updates

Evaluation of the safety, immunogenicity and efficacy of a new live-attenuated lumpy skin disease vaccine in India

[9,17–21]. These discrepancies in the use of heterologous vaccines in the past, together with the poor efficacy of goatpox vaccine in India, prompted us to develop a homologous vaccine which confers solid immunity against LSD

- Live attenuated vaccines based on SHPV were safe, but lacked efficacy as they did not protect against clinical disease in all vaccinated animals
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LSDV vaccine safety/efficacy testing @ sciensano

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	LSDV	LumpyVax	MSD Animal health	A+	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	KenyaVac	JOVAC	A++	A++	+	++	+++	A++	A+++	not tested	P-
	LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
	LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
	LSDV	Lumpivax	Kevevapi	P-	A+++	+++	+	++	P-	A+++	not tested	P-
heterologous LAV	SPPV	Abic (10x)	Phibro	A++	P--	--	+++	+	A+++	P---	P--	P---
	SPPV	JoviVac	JOVAC	A+++	P-	-	++	++	A+++	P--	P-	P--
	SPPV	Penpox-M (3x)	Pendik	A+++	P--	+	++	++	A+++	P---	P--	P--
	SPPV	Romania (10x)	MCI	A+++	P--	--	+	+	A+++	P---	P--	P---
	GTPV	CapriVac (10x)	JOVAC	A++	A+++	+++	+	+++	A++	A+++	not tested	A+++
homol/heterol INAC	LSDV	Bovivax (?)	MCI	A+	A++	+++	++	+++	A++	A+++	A+++	P-
	SPPV	Romania	MCI	A+++	P-	+	-	+	A+	P--	P-	P--

A: Absent; P: Present; *only viremic animals tested; +/-:weak; ++/--: intermediate; +++/---: strong

- INAC SPPV based vaccines were safe, but lack efficacy as they did not protect against clinical disease in all vaccinated animals
- INAC LSDV vaccines showed good safety and efficacy
- Two initial doses of INAC vaccines are needed; booster after 6 months

LSDV vaccine safety/efficacy testing @ sciensano

	type	strain	Vaccin	Company	clinical signs post V	clinical signs post C	IPMA post V	IPMA post C	IFNgamma post V	viremia post V	viremia post C	swabs post C	organs post C
homologous LAV		LSDV	Lumpy Skin Dis Vac	OBP	A+	A++	+++	+	++	A+++	A+++	not tested	P-
		LSDV	LumpyVax	MSD Animal health	A+	A++	+	++	+++	A++	A+++	not tested	P-
		LSDV	KenyaVac	JOVAC	A++	A++	+	++	+++	A++	A+++	not tested	P-
		LSDV	Herbivac	Deltamune	P-	A+++	++	+	+++	P--	A+++	P-	P--
		LSDV	Neethling O	MCI	P--	A++	++	++	+++	A++	A+++	A++	P-
		LSDV	Lumpivax	Kevevapi	P-	A+++	+++	+	++	P-	A+++	not tested	P-
heterologous LAV		SPPV	Abic (10x)	Phibro	A++	P--	--	+++	+	A+++	P---	P--	P---
		SPPV	JoviVac	JOVAC	A+++	P-	-	++	++	A+++	P--	P-	P--
								++	++	A+++	P---	P--	P--
homol/heterol INAC													

A: Absen


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Development and Evaluation of an Inactivated Lumpy Skin Disease Vaccine for Cattle

Jihane Hamdi[a,*], Zineb Boumart[a], Samira Daouam[a], Amal El Arkam[a], Zahra Bamouh[a], Mohamed Jazouli[a], Khalid Omari Tadlaoui[a], Ouafaa Fassi Fihri[b], Boris Gavrilov[c], Mehdi El Harrak[a]


vaccines

MDPI

Article

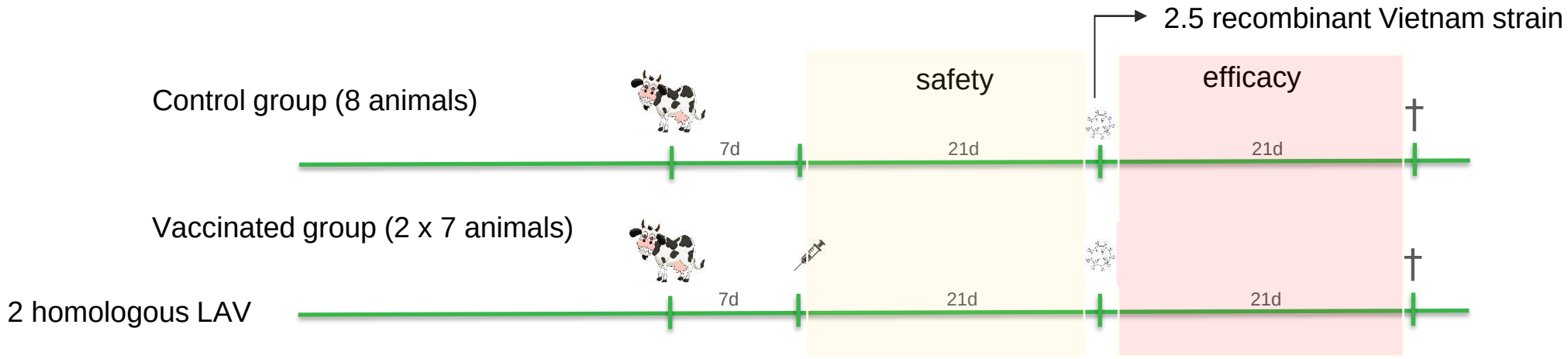
Development of a Safe and Highly Efficient Inactivated Vaccine Candidate against Lumpy Skin Disease Virus

Janika Wolff, Tom Moritz, Kore S[illegible]lottau, Donata Hoffmann, Martin Beer and Bernd Hoffmann *

- INAC SPPV based vaccines were safe, but lack efficacy as they did not protect against clinical disease in all vaccinated animals
- INAC LSDV vaccines showed good safety and efficacy
- Two initial doses of INAC vaccines are needed; booster after 6 months

Homologous LAV protect against recombinant strain

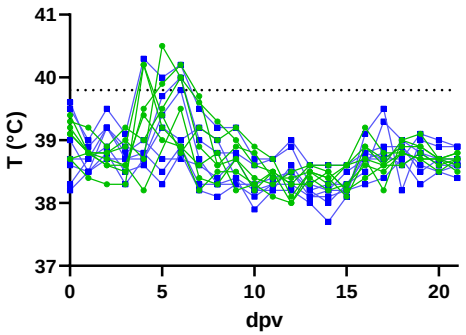
# Animals	Vaccine	Purpose
7	MSD (Lumpyvax)	Vaccine evaluation
7	OBP	Vaccine evaluation
8	N/A	Control Vaccine and infection model

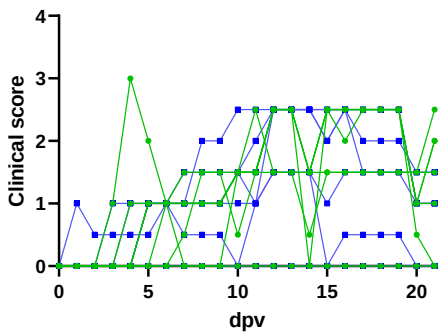


Homologous LAV protect against recombinant strain

Post vaccination

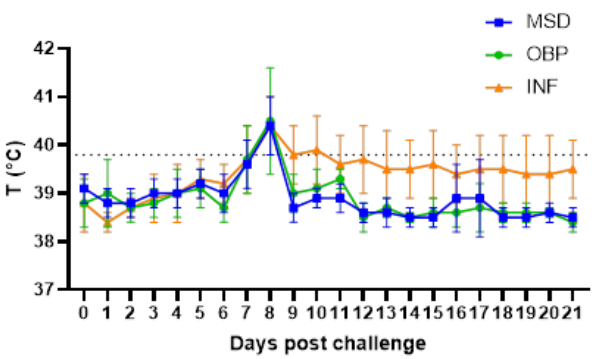
Clinical sign	Vaccinated animals
Fever	5-7 dpv
Local reaction	Limited
Nodules	No
Other	No vaccine viremia

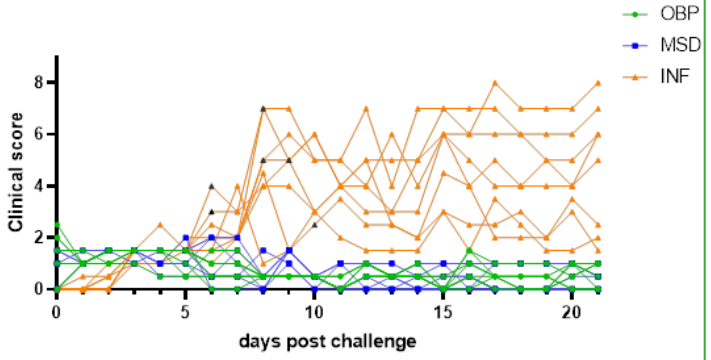




Post challenge

Clinical sign	Control animals	Vaccinated
Fever	Prolonged	7-8 dpv
Local reaction	Strong (75%)	Limited
Nodules	- 6 skin - 1 lung	No
Other	Wide variety	No





- Homologous live attenuated neethling-based strains provide protection against recombinant (clade 2.5) LSDV strains
- Efficacy of heterologous and inactivated LSDV vaccines remains to be evaluated

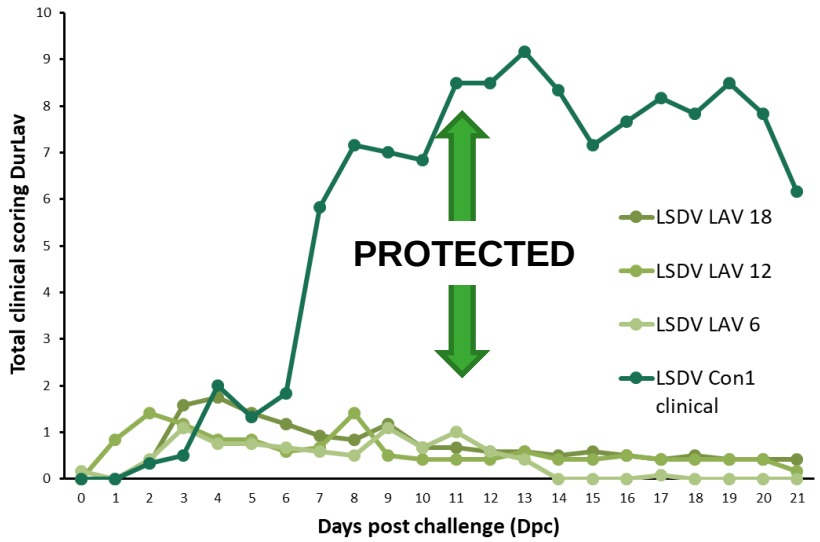
LSDV vaccines – duration of immunity

Live attenuated vaccine

Inactivated vaccine

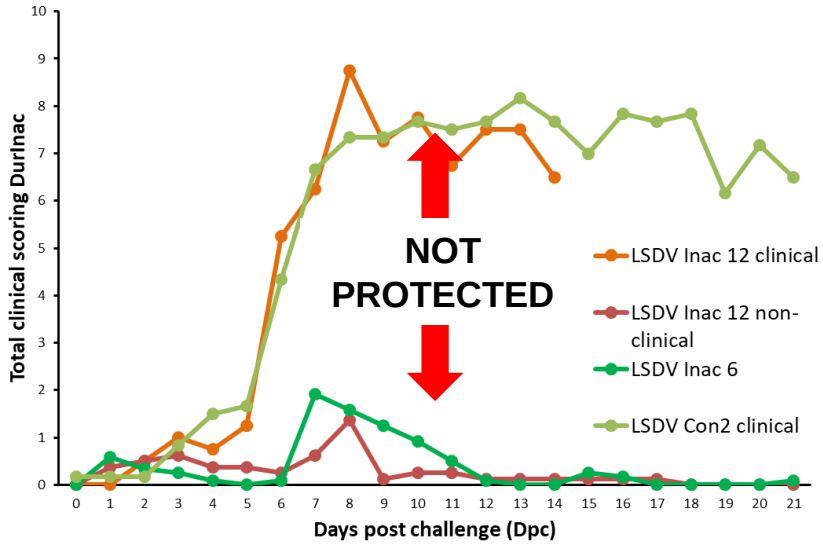
Total clinical scoring

- Almost no clinical scoring
- No nodule formation



- Only 1 vaccination necessary
- Limited side effects upon vaccination
- Complete protection for at least 1,5 years

- Clinical scoring in 2 animals LSDV Inac 12
- Nodule formation in LSDV Inac 12 (2/6)



- Prime/boost vaccination necessary
- Almost no side effects upon vaccination
- Complete protection up to six month, but not after one year

LSDV vaccines - conclusions

- Safe and efficacious LSDV vaccines are available against classical and recombinant LSDV strains
- Even for the best vaccines, limited, short lasting side-effects might be noticed (swelling at the inoculation site, temporary fever, brief drop in milk production, Neethling disease in rare cases
- Duration of immunity: > 18 months for homologous LAV; 6 months for INAC
- A proper vaccine batch quality control needs to be performed

<u>Future work</u>:

- DIVA vaccine, allowing preventive vaccination
- methods for post-vaccination monitoring

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Contact

Nick De Regge • nick.deregge@sciensano.be • +32 2 379 06 27

Sciensano • Rue Juliette Wytsmanstraat 14 • 1050 Brussels • Belgium
T +32 2 642 51 11 • T Press +32 2 642 54 20 • info@sciensano.be • www.sciensano.be

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