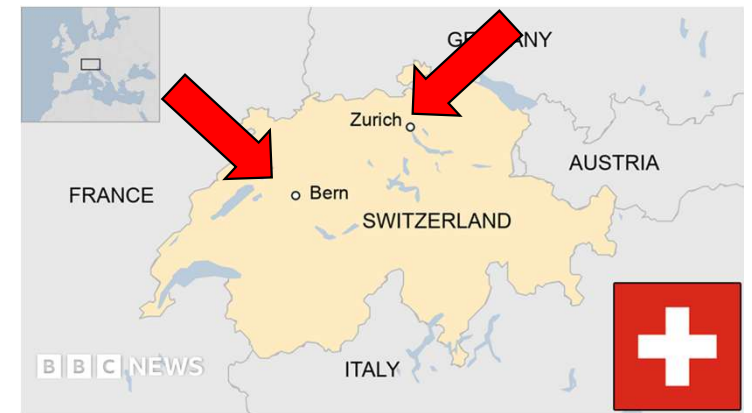




The role of small animal clinics in the selection and spread of antimicrobial resistant organisms

Prof Dr habil Simone Schuller, DEA, Dipl ECVIM, PhD
Small animal veterinary hospital
Vetsuisse Faculty University Bern

Small Animal Hospital Vetsuisse Faculty University Bern



- > One of two training centres for veterinary medicine in Switzerland
 - Vetsuisse Faculty Bern and Zurich
- > Important referral clinic for Western and Central Switzerland
 - 120 employees, 80 students, 24/7 service, approx. 7000 patients/year (dogs, cats)
 - Modern building and infrastructure
- > Multidisciplinary university referral clinic
 - Internal Medicine, Nephrology, Cardiology, Oncology
 - General Surgery, Neurosurgery, Oncosurgery
 - Emergency and intensive care
 - Neurology, Anaesthesia, Radiology (CT, MRI, US, Rö), Dermatology





National Strategy on AMR

- > Adopted by the Federal council 2015
- > 8 fields of action
- > Research funding

2018: FSVO funding: Role of small animal clinics in the spread of AMR in Switzerland

Strategie Antibiotikaresistenzen



Informationssystem Antibiotika in der Veterinärmedizin (IS ABV)

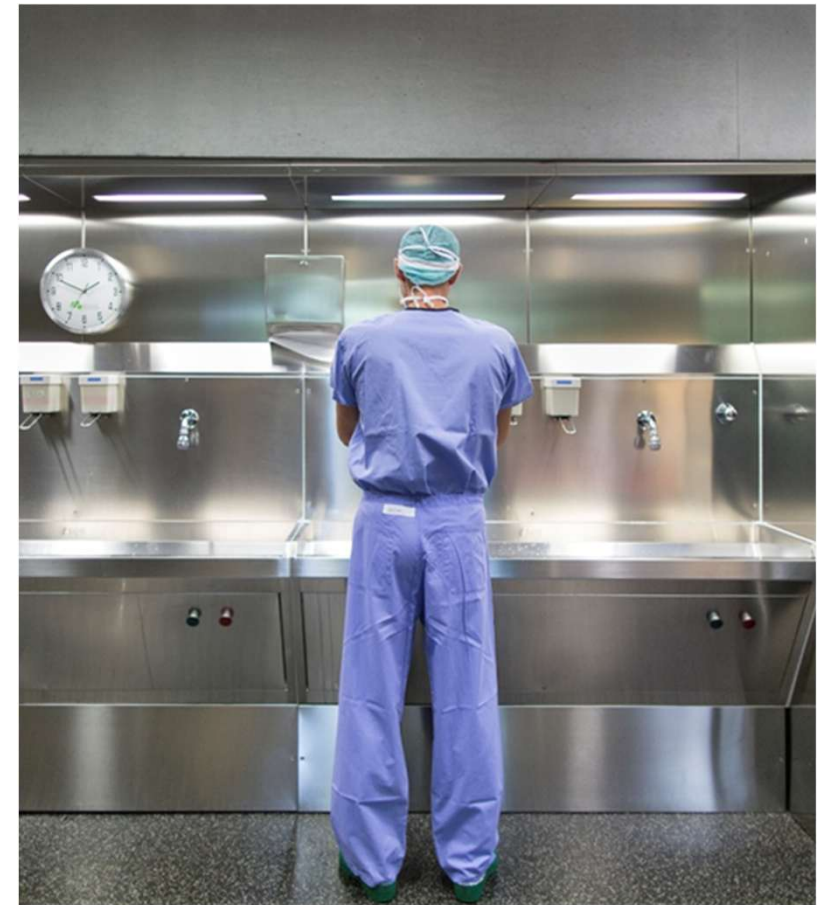
- > All Prescriptions of Antimicrobials are transmitted to Federal Food Safety and Veterinary office
- > Introduced 1.1.2019
- > Evaluation of efficacy of antimicrobial stewardship measures
- > Comparison Prescriptions
 - Longitudinally
 - Regional and international



IS ABV
Informationssystem Antibiotika
in der Veterinärmedizin

Do small animal clinics contribute to the spread of MDR bacteria ?

- Multidisciplinary multicentre study
 - 4 clinics/1 practice in Switzerland
- Samples of **dogs, cats, owners, staff** and **clinic environment**
 - MR Gram pos
 - 3GCR Gram neg
- Risk factors for MDR colonization
- Audits of hygiene standards



Sampling

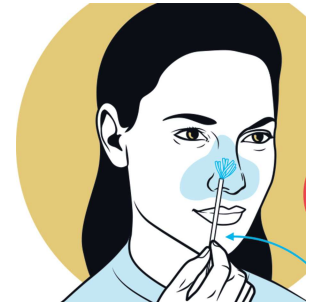
> Dogs and cats

- Expected hospitalisation >48 h
- Admission and discharge
- Nasal/oropharyngeal/rectal



• Owners and Staff

- Self sampling at home
- Nasal swab
- Stool sample

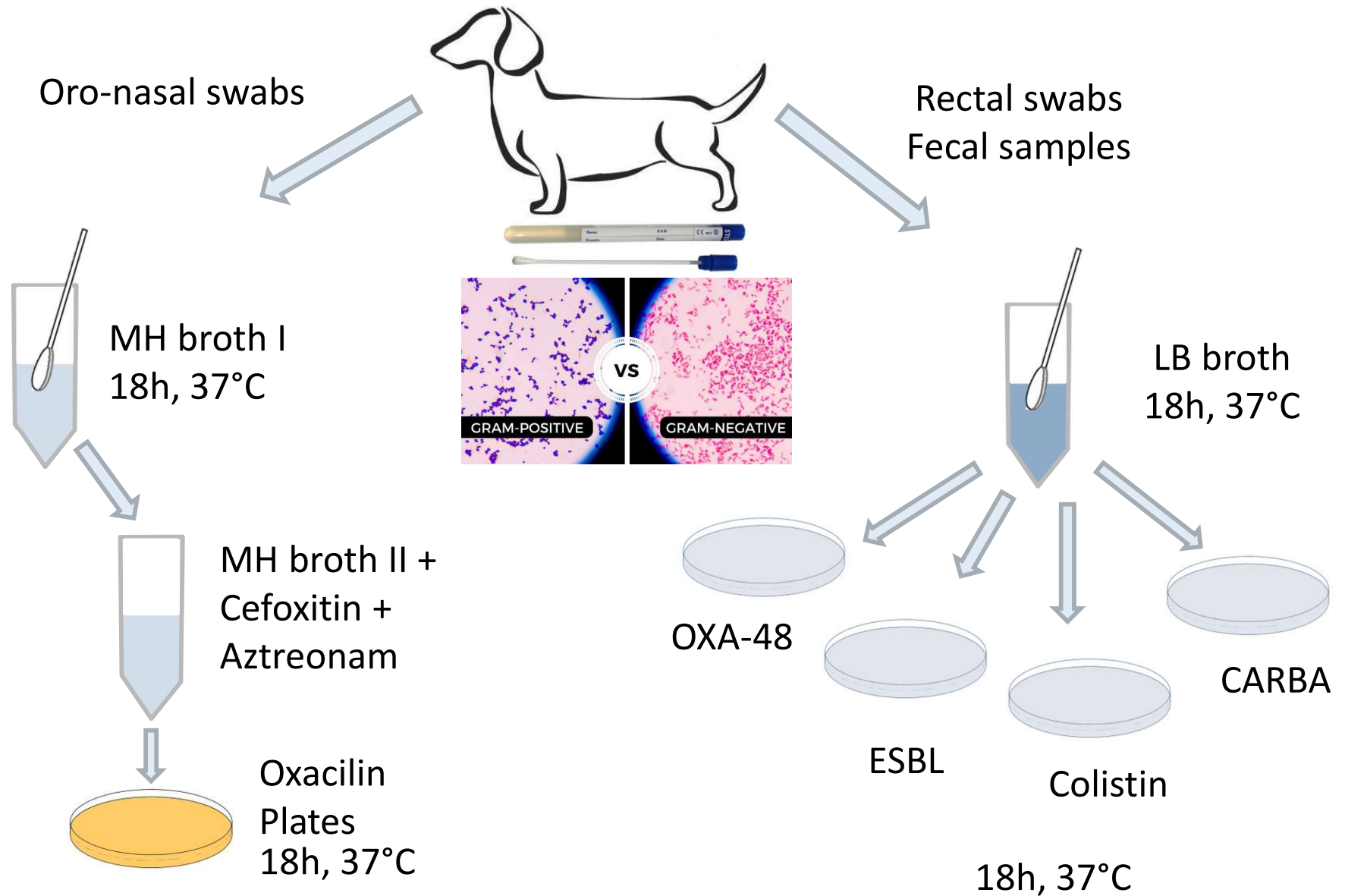


• Follow up

- Monthly until 2 negative samples

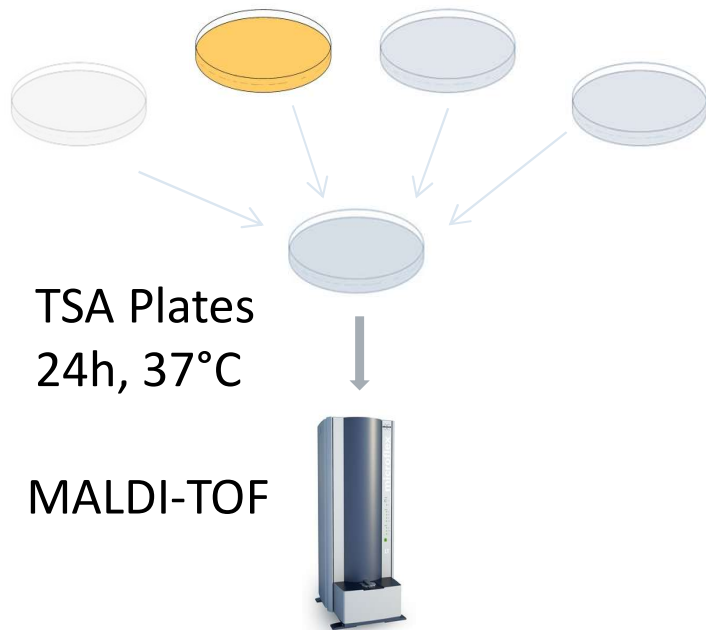


Culture and Isolation



Identification

Species identification

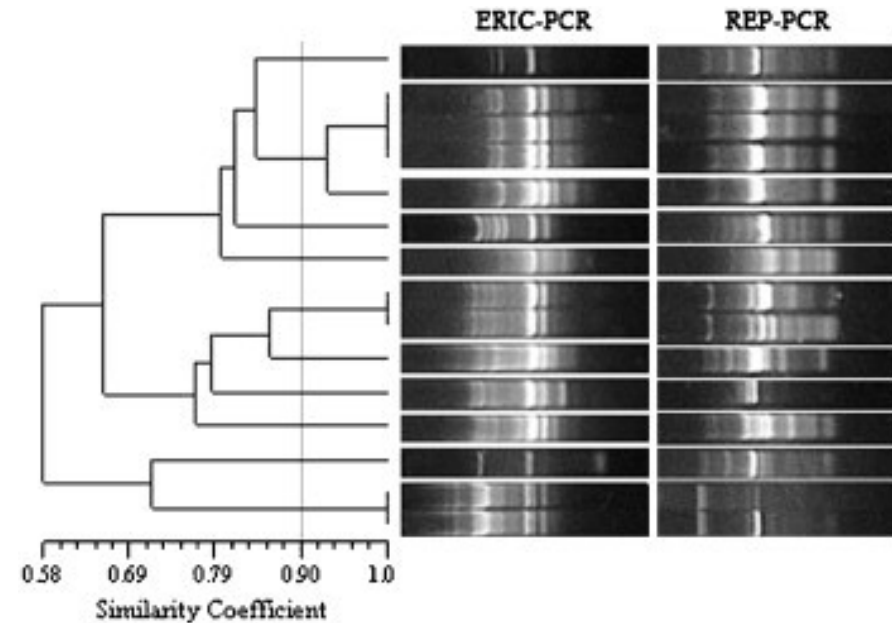


Resistance phenotype

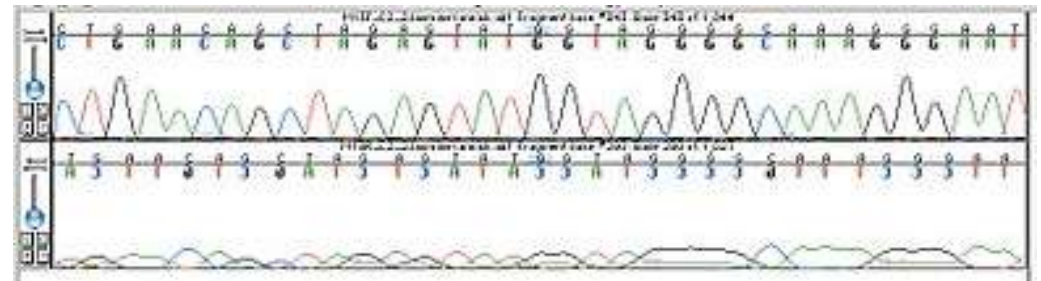
MIC: panel of 16 antimicrobials



Sequence typing and Clonality



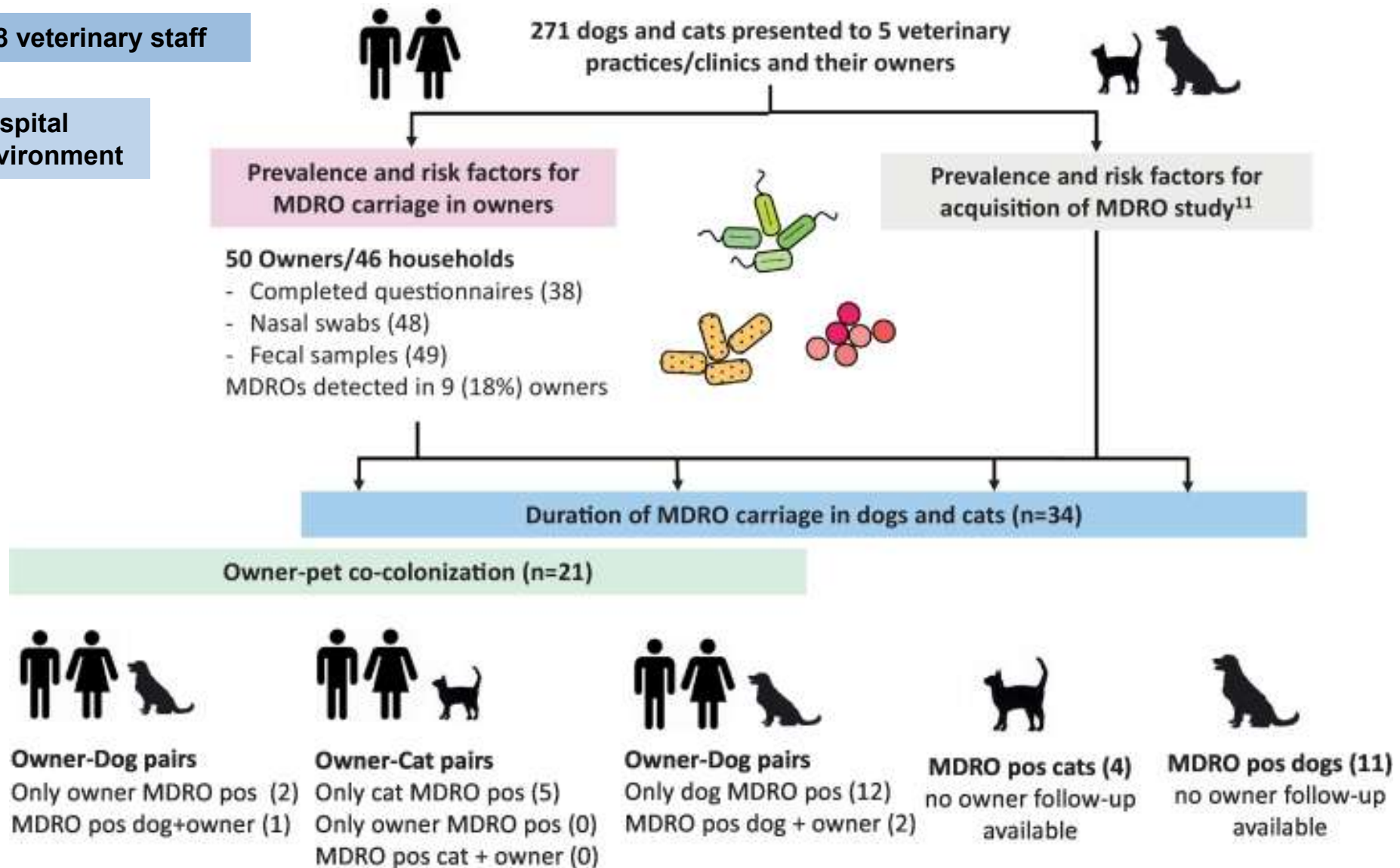
Whole Genome Sequencing



Results

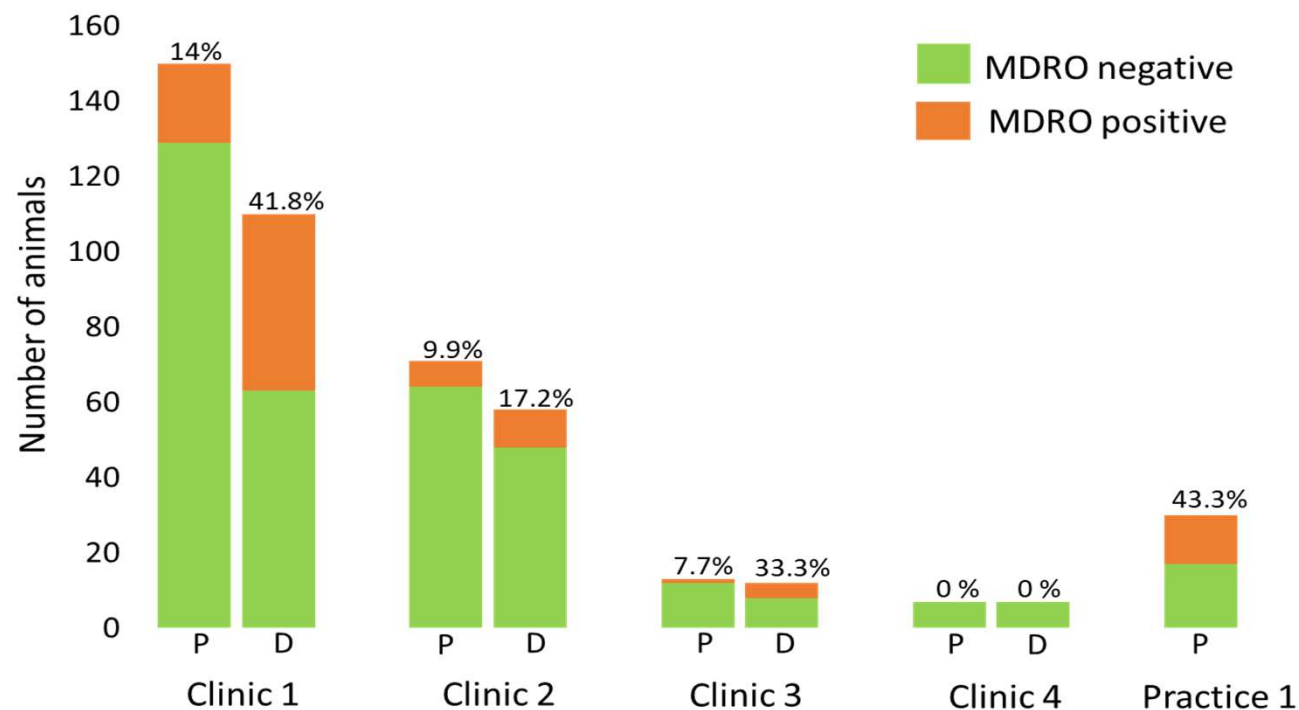
108 veterinary staff

Hospital environment

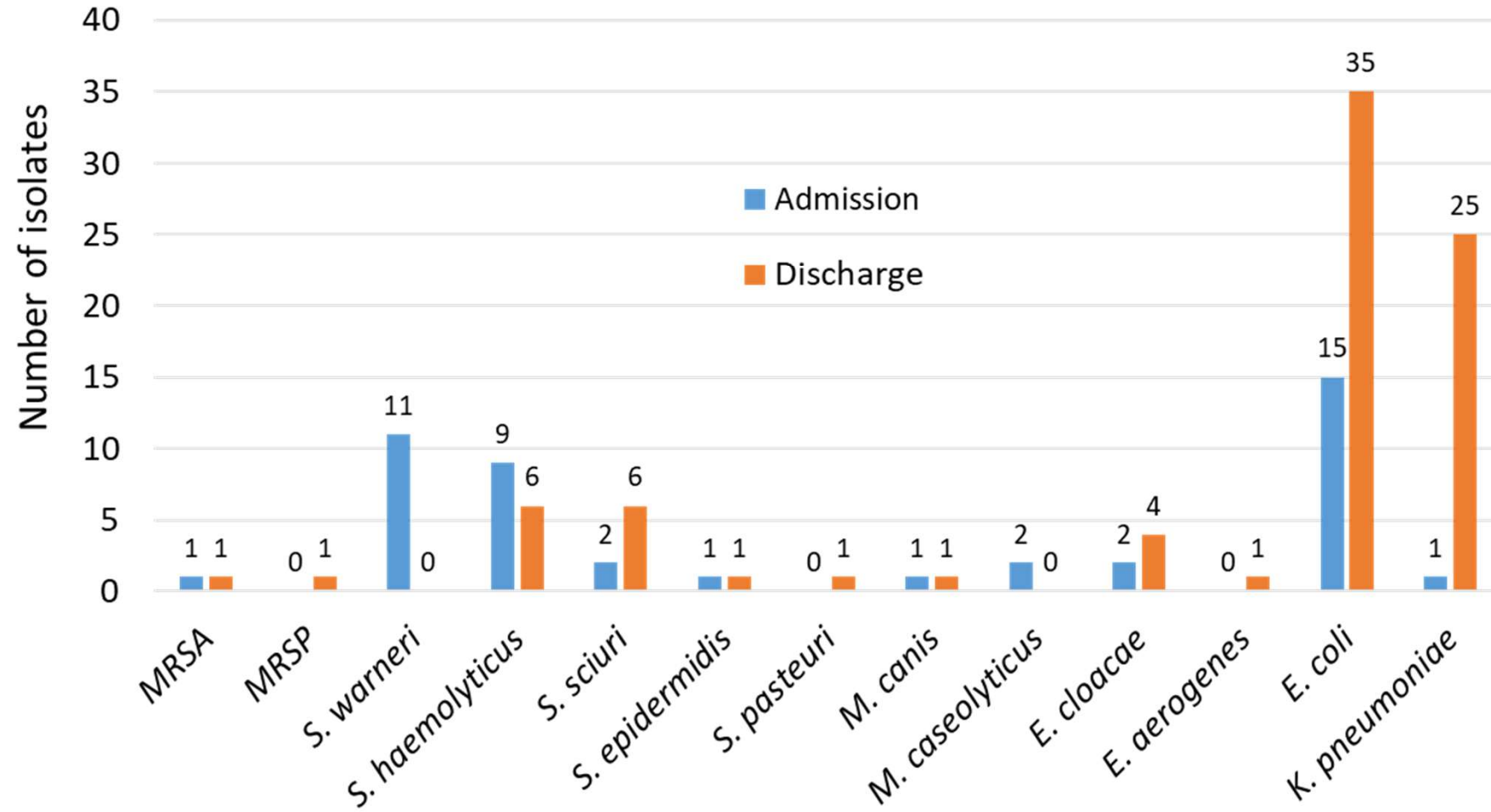


Prevalence and Acquisition of MDR bacteria dogs and cats

- > **MDRO Colonisation at presentation**
 - > **15.5%** (CI 95%, 11.4-20.4%)
 - > Dogs 18%; 10.2% Cats
- > **MDRO Acquisition during Hospitalisation**
 - > **28.3 %** (CI 95%, 22-35.4)
 - > 32.3% dogs, 20.6 % cats



Enterobacterales are common in nosocomial colonisation



E. coli

- > 42.7% of Isolates at discharge
- > 71.4% (25/35) **carbapenemase producing**
 - Genotypes (WGS)
 - *bla*_{oxa-181} (22 Isolate; Clinic 1)
 - *bla*_{oxa-48} (1 Isolate; Clinic 1)
 - *bla*_{NDM-5} (2 Isolate; Clinic 2)

Resistenzprofil (MIC)

- > 3rd-gen. Cephalosporine
- > β -Laktam Antibiotika/ β -Laktamase Inhibitoren
- > Fluoroquinolone
- > Chloramphenicol
- > Ertapenem

- > **Cluster 21 Isolate ST410 (Clinic 1)**
 - Carbapenemase gen *bla*_{OXA-181}
 - pAmpC Cephalosporinase gen *bla*_{CMY-42}
 - Quinolonresistenzmutationen (*qnrS1*+topoisomerases II (GyrA) and IV (ParC))

► Euro Surveill. 2019 Sep 26;24(39):1900071. doi: [10.2807/1560-7917.ES.2019.24.39.1900071](https://doi.org/10.2807/1560-7917.ES.2019.24.39.1900071) 

Shedding of OXA-181 carbapenemase-producing *Escherichia coli* from companion animals after hospitalisation in Switzerland: an outbreak in 2018

[Aurélien Nigg](#)¹, [Michael Brilhante](#)^{1,2}, [Valentina Dazio](#)³, [Mathieu Clément](#)^{2,5}, [Alexandra Collaud](#)¹, [Stefanie Gobeli Brawand](#)¹, [Barbara Willi](#)⁴, [Andrea Endimiani](#)⁵, [Simone Schuller](#)³, [Vincent Perreten](#)¹

K. pneumoniae

- > 30.5% isolate at discharge
- > Sequence type ST11 predominant
- > Broadly resistant
- > 1/25 Isolate **carbapenemase**
 - Responsible genotype (WGS) **bla_{OXA-48}**
- > **Clinic 1**
 - Isolates closely genetically related
 - Isolates from dogs and cats
 - Isolates from clinic environment

Resistenzprofil (MIC)

- > 3rd-gen Cephalosporine
- > β -Lactam Antibiotika/ β -Lactamase Inhibitores
- > Fluoroquinolones
- > Chloramphenicol
- > Sulfonamides
- > Gentamicin
- > Rifampin

> [J Antimicrob Chemother.](#) 2021 Apr 13;76(5):1140-1149. doi: 10.1093/jac/dkab028.

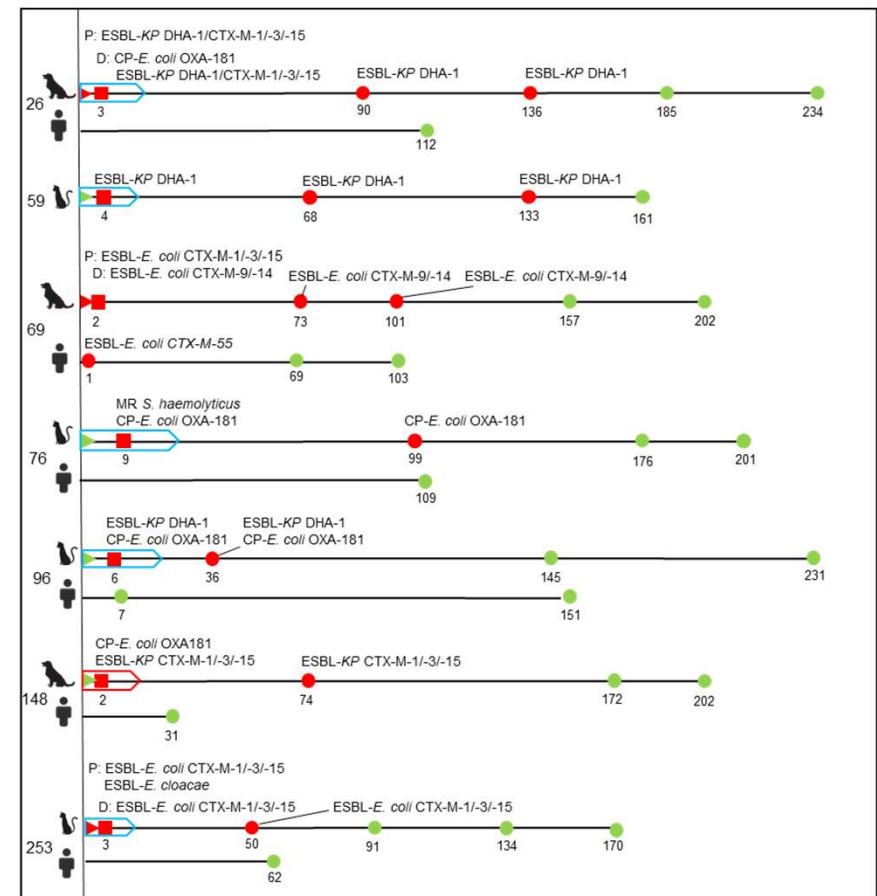
Two high-risk clones of carbapenemase-producing *Klebsiella pneumoniae* that cause infections in pets and are present in the environment of a veterinary referral hospital

Michael Brilhante ^{1 2}, Stefanie Gobeli Brawand ¹, Andrea Endimiani ³, Helene Rohrbach ⁴,
Sonja Kittl ¹, Barbara Willi ⁵, Simone Schuller ⁴, Vincent Perreten ¹

Pets remain colonized for several months with low risk of owner co-colonisation



- MDRO carriage pets up to 136 days
- 9/50 (18%) Owners colonised
 - ESBL *E. coli* ($bla_{CTX-M-55}$, $bla_{CTX-M-15}$, $bla_{CTX-M-1}$)
 - MRCoNS
 - MRSA
- **No pet-owner co-colonisation despite close contact**



> One Health. 2021 Aug 31;13:100322. doi: 10.1016/j.onehlt.2021.100322. eCollection 2021 Dec.

Duration of carriage of multidrug-resistant bacteria in dogs and cats in veterinary care and co-carriage with their owners

Valentina Dazio ¹, Aurélien Nigg ², Janne S Schmidt ³, Michael Brilhante ²,
 Edgar I Campos-Madueno ⁴, Nico Mauri ⁵, Stefan P Kuster ⁶, Stefanie Gobeli Brawand ²,
 Barbara Willi ³, Andrea Endimiani ⁴, Vincent Perreten ², Simone Schuller ¹

Risk factors for MDRO Colonisation

- > At presentation
 - Antimicrobial therapy
 - Bone And Raw Meat (BARF)
- > At discharge
 - Hospitalisation in clinic 1
 - Duration of Hospitalisation
 - Antimicrobial therapy during Hospitalisation



**JOURNAL OF
VETERINARY INTERNAL MEDICINE**
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Acquisition and carriage of multidrug-resistant organisms in dogs and cats presented to small animal practices and clinics in Switzerland

van den Bunt *et al* 2020
Schmidt *et al* 2015
Wedley *et al* 2017
Baede *et al* 2015

Valentina Dazio, Aurélien Nigg, Janne S. Schmidt, Michael Brilhante, Nico Mauri, Stephan P. Kuster, Stefanie Gobeli Brawand, Gertraud Schüpbach-Regula, Barbara Willi, Andrea Endimiani, Vincent Perreten, Simone Schuller ... See fewer authors

Transient colonization of Veterinary staff with MDRO

- > 108 staff sampled, 2 staff MDRO positive
 - Clinic 1: *E.coli* *bla*_{oxa-181}
 - Clinic 2: *E.coli* *bla*_{NDM-5}
 - Clonal with isolates from animals and clinic environment



J Antimicrob Chemother 2020; **75**: 766–768
doi:10.1093/jac/dkz470
Advance Access publication 9 December 2019

Employees of Swiss veterinary clinics colonized with epidemic clones of carbapenemase-producing *Escherichia coli*

Andrea Endimiani ^{1*}, Michael Brilhante^{2,3},
Odette J. Bernasconi¹, Vincent Perreten²,
Janne S. Schmidt⁴, Valentina Dazio⁵, Aurélien Nigg²,
Stefanie Gobeli Brawand², Stefan P. Kuster⁶,
Simone Schuller^{5†} and Barbara Willi^{4†}

Infection prevention and control standards

- > High environmental contamination in some clinics
- > Audit revealed deficits in several areas
 - Hygiene infrastructure
 - Management
 - Surveillance
 - Quarantine
 - Hand hygiene

Multicenter Study > Antimicrob Resist Infect Control. 2020 Jun 23;9(1):93.

doi: 10.1186/s13756-020-00742-5.

Poor infection prevention and control standards are associated with environmental contamination with carbapenemase-producing Enterobacterales and other multidrug-resistant bacteria in Swiss companion animal clinics

Janne S Schmidt ¹, Stefan P Kuster ², Aurélien Nigg ³, Valentina Dazio ⁴, Michael Brilhante ^{3, 5}, Helene Rohrbach ⁶, Odette J Bernasconi ⁷, Thomas Büdel ⁷, Edgar I Campos-Madueno ⁷, Stefanie Gobeli Brawand ³, Simone Schuller ⁴, Andrea Endimiani ⁷, Vincent Perreten ³, Barbara Willi ⁸

Examples for deficits



- > Gloves at every patient contact
- > Refillable dispensers in the wrong places
- > Spray disinfection
- > Use of alcoholic disinfectant for cleaning purposes
- > No surveillance of clinical infections

To summarise

- Colonisation of dogs and cats with MDR bacteria
 - At presentation 15.5 %
 - Acquisition rate 28.3%
- Broadly resistant organisms; Carbapenemase producing Enterobacterales
 - *E.coli* *bla*_{oxa181}
 - *E.coli* *bla*_{oxa48}
 - *K. pneumoniae* *bla*_{oxa48}
 - *E.coli* *bla*_{NDM-5}
- Colonisation of veterinary staff
- High environmental contamination associated with low IPC standards
- **No** co-colonisation of pets and their owners



Dazio *et al* 2020
Nigg *et al* 2019
Endimiani *et al* 2020
Schmidt *et al* 2020
Dazio *et al* 2021



Antibiotikaresistenzen machen nicht vor der Speziesgrenze halt. Beim Umgang mit Haustieren sollten deshalb gewisse Hygieneregeln befolgt werden.

Kuscheln auf eigene Gefahr

Hunde, Katzen und Co. können multiresistente Keime aus Tierkliniken nach Hause tragen. Fachleute sind alarmiert. **Von Theres Lüthi**

Auf den Intensivstationen liegen viele alte und geschwächte Patienten mit Vorerkrankungen, die Chemotherapien erhalten, schwere Operationen hatten und mit Antibiotika behandelt werden», sagt Barbara Willi. Bei den Patienten handelt es sich für einmal nicht um Menschen, sondern um Hunde und Katzen. Willi ist Leiterin der Klinischen Infektiologie und Spitalhygiene an der Klinik für Kleintiermedizin der Universität Zürich und beobachtet die Entwicklungen mit gemischten Gefühlen. «Mit der immer intensiveren Versorgung von Haustieren, mit den Möglichkeiten, sie bis ins hohe Alter zu therapieren, müssen wir dafür sorgen, dass in den Kleintierkliniken die Hygienestandards Schritt halten.» Denn in einer Untersuchung mit 11 Fachkern: Das

«Wir hatten nicht viel erwartet, doch die Resultate waren ein ziemlicher Schock. Wir waren über das Ausmass des Problems erstaunt.»

Menschen an bakteriellen Infektionen, die sich durch Antibiotika nicht mehr bekämpfen lassen, weltweit sind es 700 000 Menschen, Tendenz steigend, Antibiotika sind die am meisten verordneten Medikamente der Welt, je mehr Antibiotika zum Einsatz kommen, umso eher können sich Resistenzen verbreiten. Doch geht es um resistente Keime, ist vor allem vom Menschen die Rede oder von Nutztieren. Praktisch unbeachtet blieben bisher die Haustiere.

Tier und Mensch im gleichen Bett

«In der Heimtiermedizin werden regelmässig Antibiotika eingesetzt», sagt Simone Schuller, Leiterin der Abteilung Innere Medizin an der Kleintierklinik der Universität Bern. Von den Mengen her sind es zwar deutlich weniger als in der Nutztierhaltung. «Wir behandeln keine 500 Kilogramm schweren

Um sich einen Überblick über die Verbreitung solcher Keime zu verschaffen, spannten vor einigen Jahren Forscherinnen der Vetsuisse-Fakultät Zürich und Bern zusammen und untersuchten Tiere in kleineren und grösseren Kleintierkliniken der Schweiz. «Wir hatten nicht viel erwartet», erinnert sich Schuller, «doch die Resultate waren ein ziemlicher Schock. Wir waren erstaunt über das Ausmass des Problems.»

Für die Studie entnahmen die Forscherinnen Abstriche aus Nase, Maul und Enddarm von 183 Hunden und 88 Katzen in vier Kleintierkliniken und einer Tierarztpraxis. Zur grossen Überraschung wiesen 15 Prozent der Tiere beim Eintritt in die Klinik multiresistente Keime auf. «Manche Tiere kommen also schon als Träger solcher Keime ins Spital», sagt Schuller. Isoliert wurden Bakterien mit breitem Resistenzspektrum. Diese, die mit Antibiotika schwer

Lots needed to be done.....

- > Implement annual deep cleaning of clinic
- > Review of all products for cleaning and disinfection
- > Improve hand hygiene
 - Restrict wear of non sterile gloves
 - Improve Infrastructure for hand hygiene
 - Training and education of staff and students
 - Monitoring
- > Implement passive surveillance
- > Improve quarantine and isolation measures

- > Overhaul Hygiene Handbook/ produce pocket version



How to improve hand hygiene adherence

- > Qualitative study, social marketing approach
- > Identify benefits and barriers
- > Derive suitable interventions to foster HH adherence

- > Methods
 - Semi-structured interviews
 - 8 groups, 32 staff
 - Nurses, junior and senior clinicians, students
 - Subject areas
 - Physical context
 - Social factors
 - Personal factors



Research and Evaluation

Improving Hand Hygiene Adherence in Small Animal Hospitals: A Social Marketing Approach

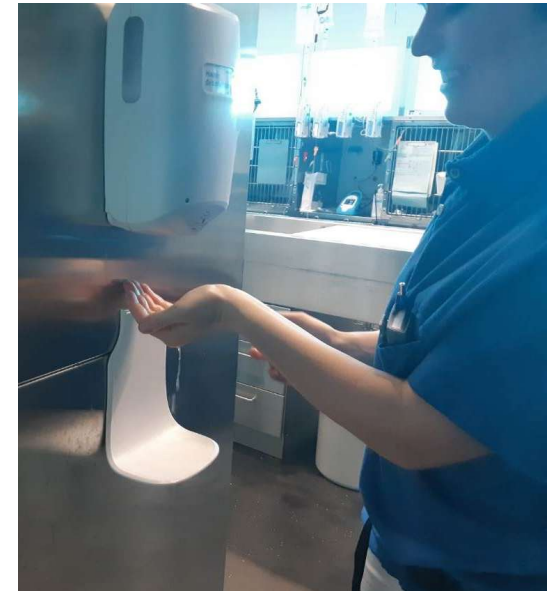
Social Marketing Quarterly
2023, Vol. 0(0) 1–17
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DOI: 10.1177/15245004231191567
journals.sagepub.com/home/smq



Bettina Höchli¹, Michael Dorn¹, Geraldine Holenweger¹,
Claude Messner¹, Simone Schuller², and Helene Rohrbach²

Hand hygiene

- Knowledge about problem does not necessarily translate into correct behaviour – invisible enemy
- Welfare of patients main motivator
- **Barriers**
 - Stress, multi-tasking, fragmented workflows
 - Limited access to dispensers
 - Poor feedback culture
 - No rewards for good adherence



How habits are formed

Interventions

- Dispensers as visual cues to perform hand hygiene
- Handy hygiene adherence part of performance review
- Fostering bottom-up feedback
- Share surveillance data to make benefits visible



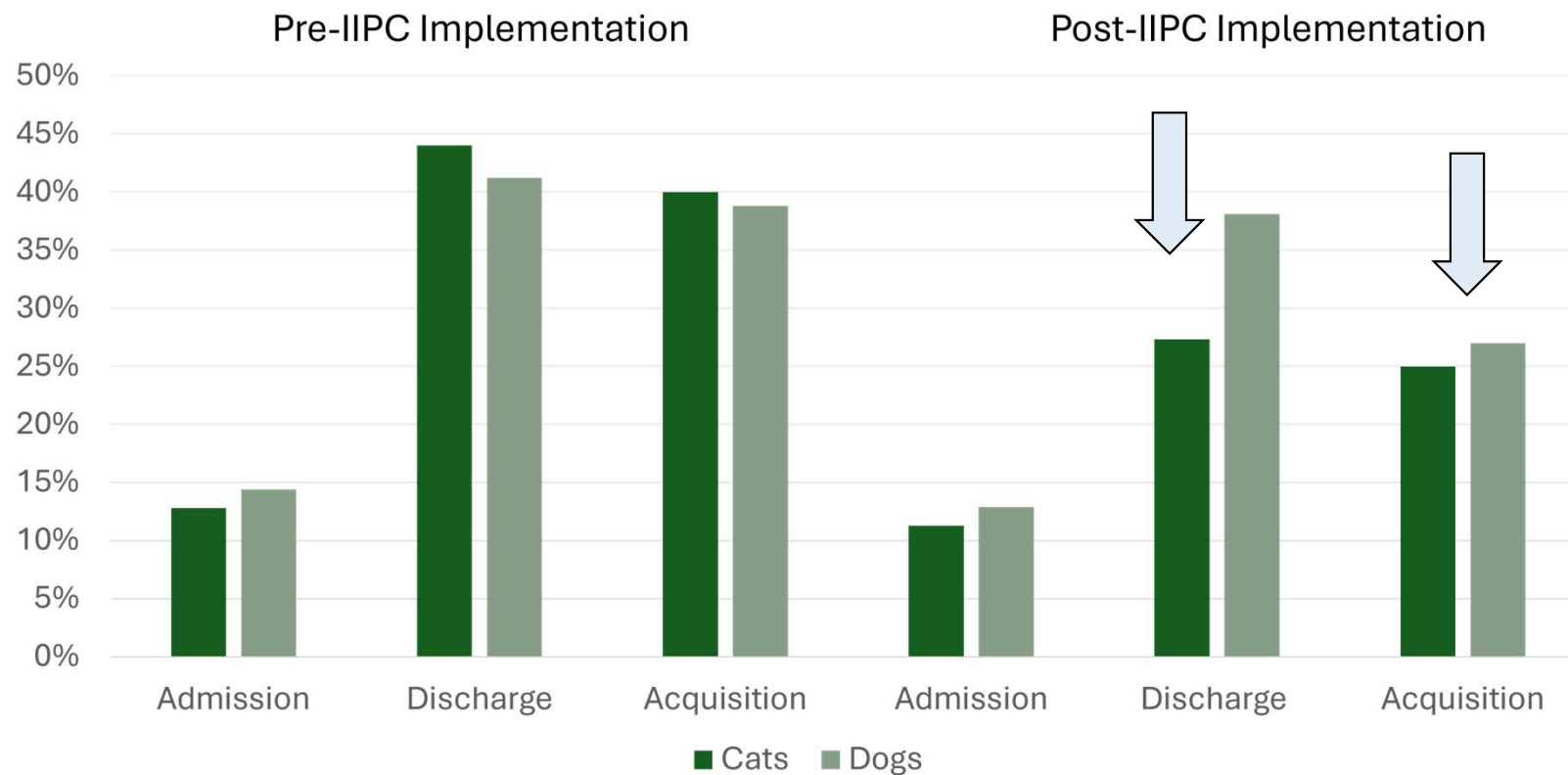
Figure 1. Three Components of Habit Formation. Note. Own illustration based on “Healthy Through Habit: Interventions For Initiating & Maintaining Health Behavior Change” by W. Wood and D. T. Neal, 2016, *Behavioral Science & Policy*, 2(1), <https://doi.org/10.1353/bsp.2016.0008>.



Hygiene Audit: comparison 2018 - 2021

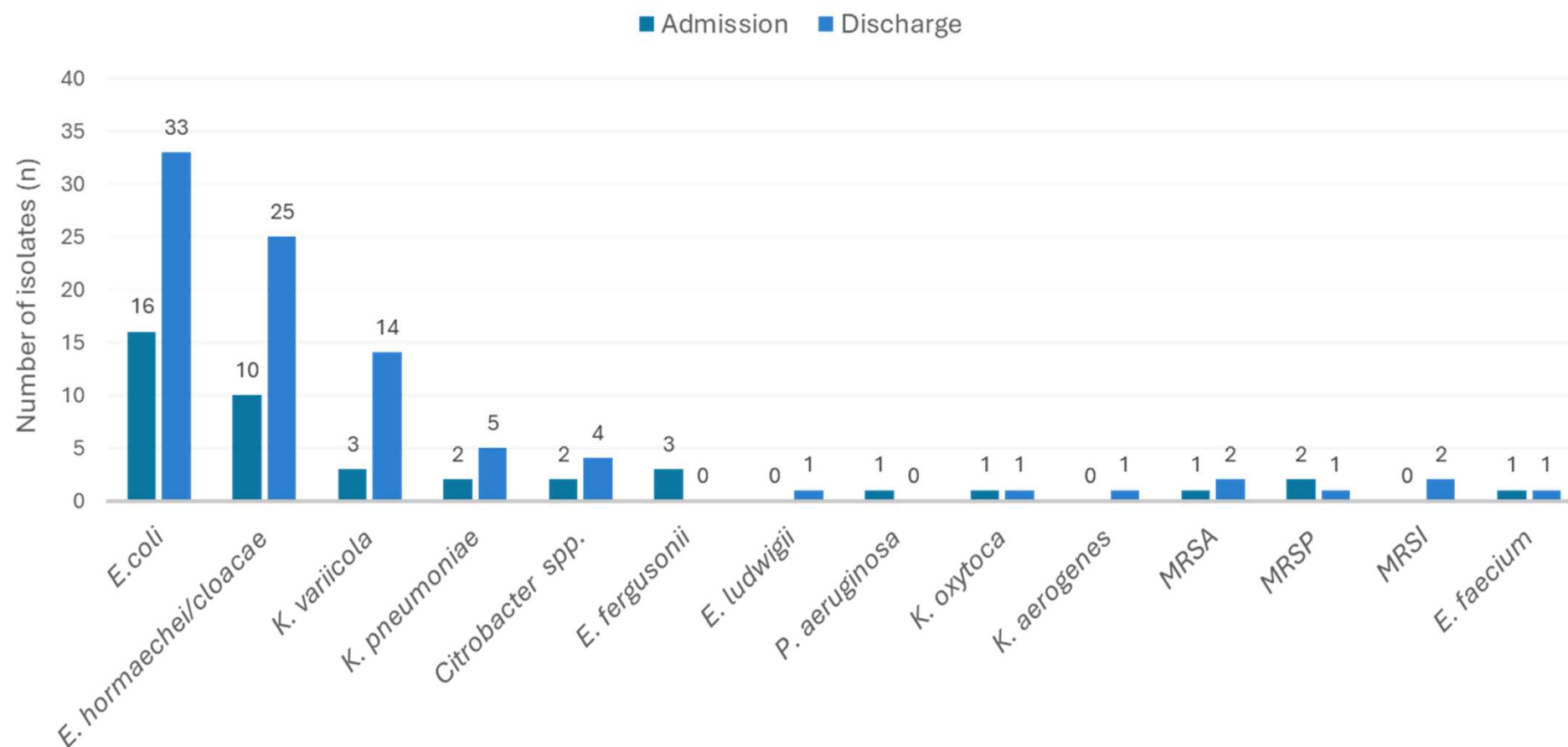
IPC Area	Obtained scores		Maximal Score
	2018	2021	
Hygiene management	2	6	6
Staff education, monitoring and feedback	4	4	6
Environmental cleaning and disinfection	2	5	6
Isolation and Quarantine	1	4	6
MDRO management	3	3	4
Hand hygiene management	3	7	8
Personal hygiene	7	11	12
Health and Safety	3	3	4
Personal protective equipment	4	5	6
Medication management	2	5	6
Antimicrobial Stewardship	4	3	4
Total Score (% of max score)	35 (51.5%)	56 (82.4%)	68 (100%)

No significant difference in MDR acquisition rates post implementation of hygiene measures

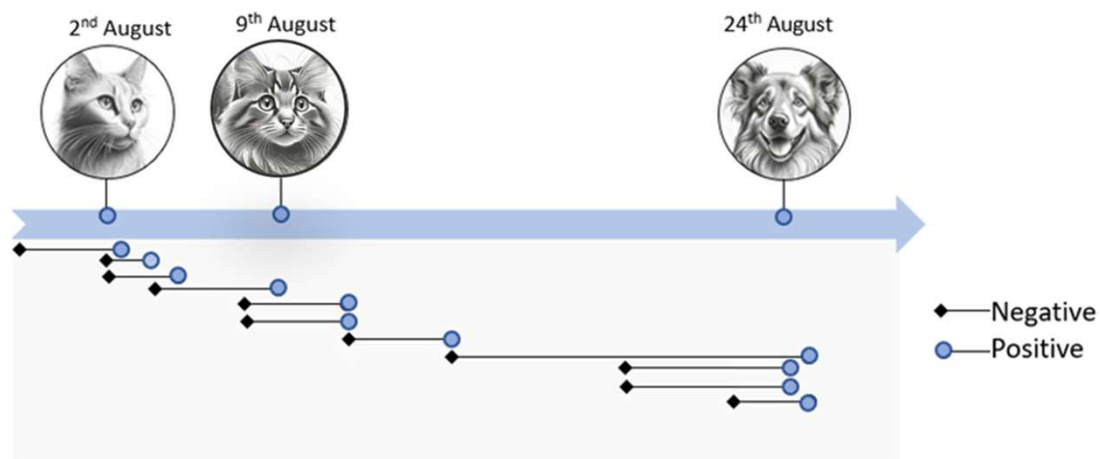


MDR Isolates after improvement of IPC

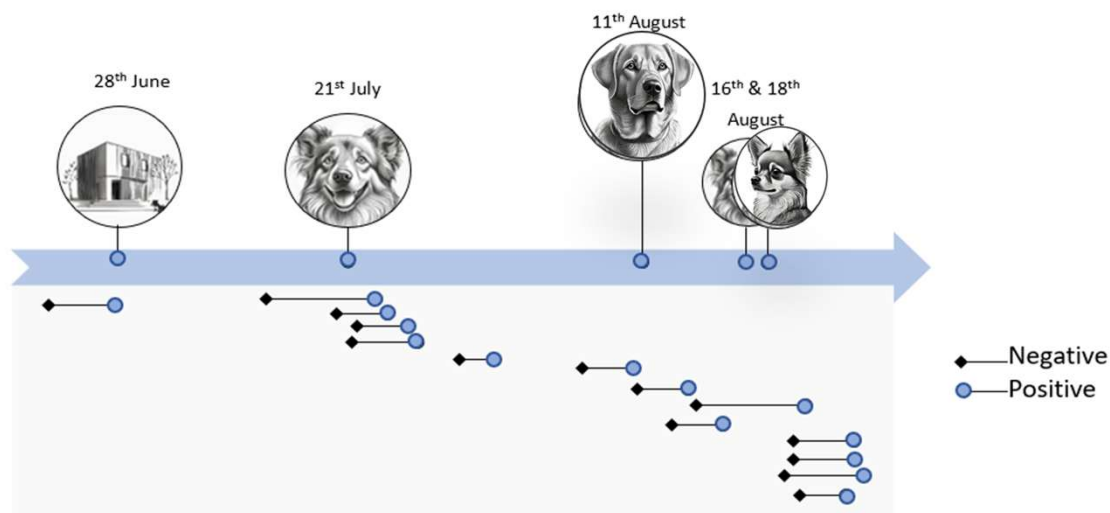
- 14 CPE cluster
- *E.coli* **bla_{OXA-48}**
- *E. hormaechei* ST418 *bla_{ACT}*, *bla_{xOXA-1}*, *bla_{DHA-1}*, **bla_{OXA-48}**
- *K. variicola* ST270 **bla_{OXA-48}**



Infection chains inside (and possibly outside) the hospital



Timeline for the cluster including K. variicola ST1270 bla_{OXA-48} during August 2022. Of 14 animals. 3 tested positive on arrival (top section) and 11 positive at discharge (bottom section).



Timeline for the cluster including E. hormaechei ST418 between the 21st of June and the 25th of August. 18 animals concerned, i.e. 4 tested positive on arrival (top section) and 14 positive following their stay (bottom section).

Hospital garden as reservoir for OXA-type carbapenemases



J Antimicrob Chemother 2026; **81**: dkag144
<https://doi.org/10.1093/jac/dkag144>

**Journal of
Antimicrobial
Chemotherapy**

The veterinary clinic backyard lawn used for relief walks of hospitalized dogs is a hotspot for OXA-type carbapenemases in multiple *Enterobacterales*

Yvonne Spahr ^{1,2}, Javier E. Fernandez ¹, Andrea Endimiani ³, Simone Schuller ⁴,
Helene Rohrbach ⁴ and Vincent Perreten ^{1*}

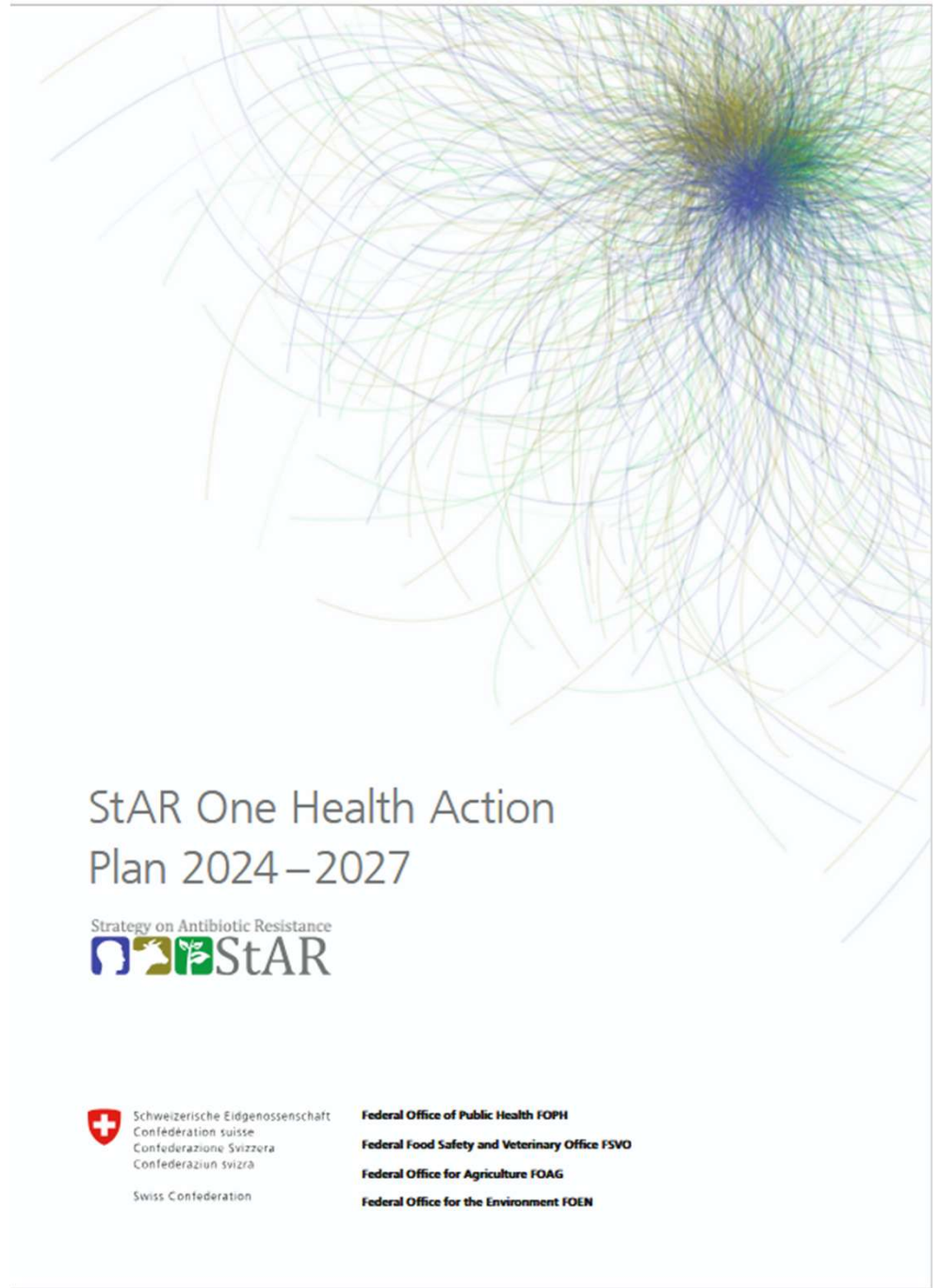
Conclusions

- > Small animal hospitals are hubs for selection and dissemination of MDR bacteria
- > Stringend IPC necessary – constant effort
- > Under discussion on national level
 - Binding measures for larger clinics
 - CPE montioring
 - Obligatory IPC concepts
 - Make CPE in pets notifiable in Switzerland



On a national level

- > Prudent use of antimicrobials
 - > Prevention
 - > One health surveillance
 - > Education
 - > Research
-
- > Binding measures
 - > Innovation
 - > Sustainability



Acknowledgements



Antimikrobielle Resistenz
Nationales Forschungsprogramm



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Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Federal Department of Home Affairs FDHA
**Federal Food Safety and
Veterinary Office FSVO**

Dagmar Heim
Nadine Metzger

Hygiene Committee Small animal clinic

Collaborators

Hanspeter Naegeli, Barbara Willi, Gertraud Schüppbach, Cedric Müntener, Ruth Peter, Stefan Kuster, Andrea Endimiani; Sonja Kittl, Vincent Perreten, Andrea Endimiani, Stefan Kuster.....

Doktorand*Innen und MasterstudentInnen

Valentina Dazio, Aurélien Nigg, Tobias Gees, Sophie Schmidt, Kira Schmitt, Cléa Hochard, Anna-Lea Diggelmann, Carole Mauron.....