



Food and Agriculture Organization
of the United Nations

Risk of transmission of SARS-CoV-2 at the human-animal interface: what is known so far?

FAO's qualitative exposure assessment



Ihab El Masry and Sophie von Dobschuetz
Surveillance Team, AGAH/ECTAD, FAO-HQ



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

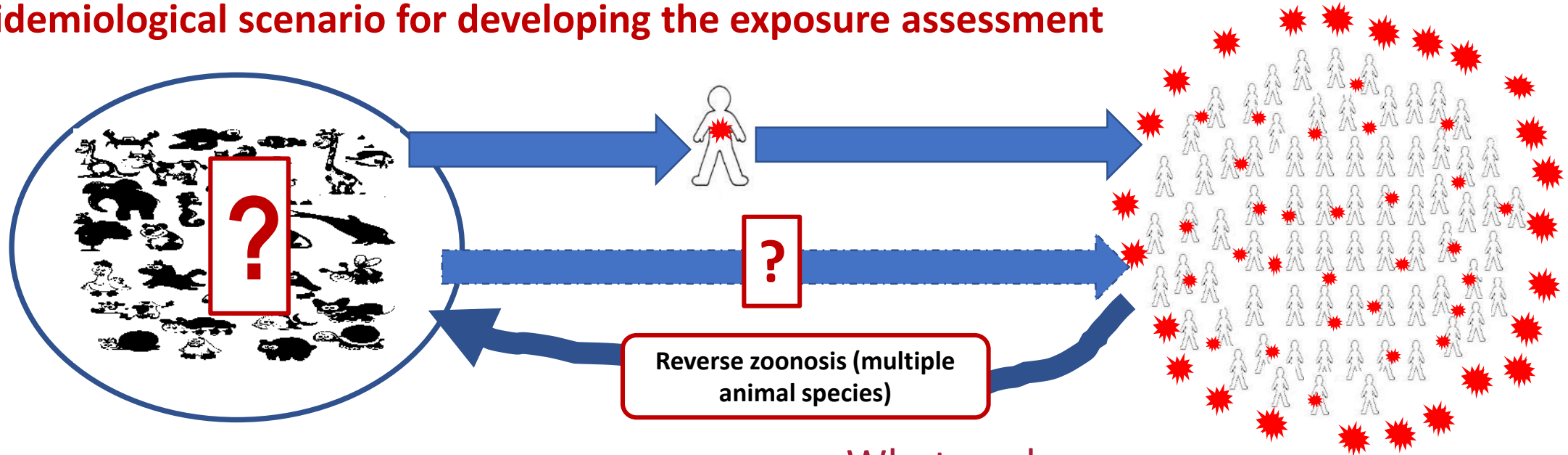
Rationale and Objectives

- Member countries requested FAO to provide advice on surveillance or testing for SARS-CoV-2 in animals
- The assessment was conducted in collaboration with external experts in coronavirus virology, epidemiology, wildlife and risk assessment
- Results can inform One Health partners, including veterinary services and research institutions, to :
 - Conduct country-specific risk assessment
 - Implement One Health investigations and targeted studies in animals
 - Develop risk-based mitigation measures



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Epidemiological scenario for developing the exposure assessment



What we don't know

- The original animal reservoir species or location of spillover to humans.
- Whether SARS-CoV-2 (or a progenitor virus) is still circulating in the original animal reservoir

What we know

- Pandemic proportions of human-to-human SARS-CoV-2 spread result in massive environmental contamination (by humans!!).
- Reverse zoonosis was confirmed (human to minks, cats and dogs), potentially creating new animal reservoirs and opportunities for zoonotic spillover (mink to human).



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Risk questions assessed

What is the likelihood of **exposure** of humans or animals to SARS-CoV-2 in COVID-19 affected areas through contact with, handling or consumption of

1. **wild animals** or their **products**?
2. **livestock** or their **products**?
3. **companion animal species** or handling or consumption of **dog and cat products**?
4. **aquatic animals** or their **products**?



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Qualitative exposure assessment

FAO ANIMAL PRODUCTION AND HEALTH / PAPER 181



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Notes

- It is an **exposure** assessment



Likelihood of human or animal **infection** (post-exposure) **is not assessed in the document.**





Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Main considerations

1. Drivers and barriers of emerging zoonoses.
2. Coronavirus host range, with emphasis on *betacoronaviruses*.
3. Environmental stability of SARS-CoV-2.
4. Natural and experimental infection of animals with SARS-CoV-2 and closely clustered SARS-CoV-related viruses.
5. Spillover of SARS-CoV and SARS-related CoVs.
6. Epidemiological animal-related data on SARS-CoV-2 available to date.
7. Affinity of ACE2 receptors found in wild animal species to bind SARS-CoV-2 RBD.
8. Animals preying on potential SARS-CoV-2 reservoir or intermediate hosts (i.e predators of bats and pangolins).
9. Wildlife movement, captive breeding/ranching and wild meat consumption.



180 articles related to the global context of the document have been cited



Country-specific articles and national reports should be identified and used for national-level risk assessment

Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Description of qualitative likelihood levels used:

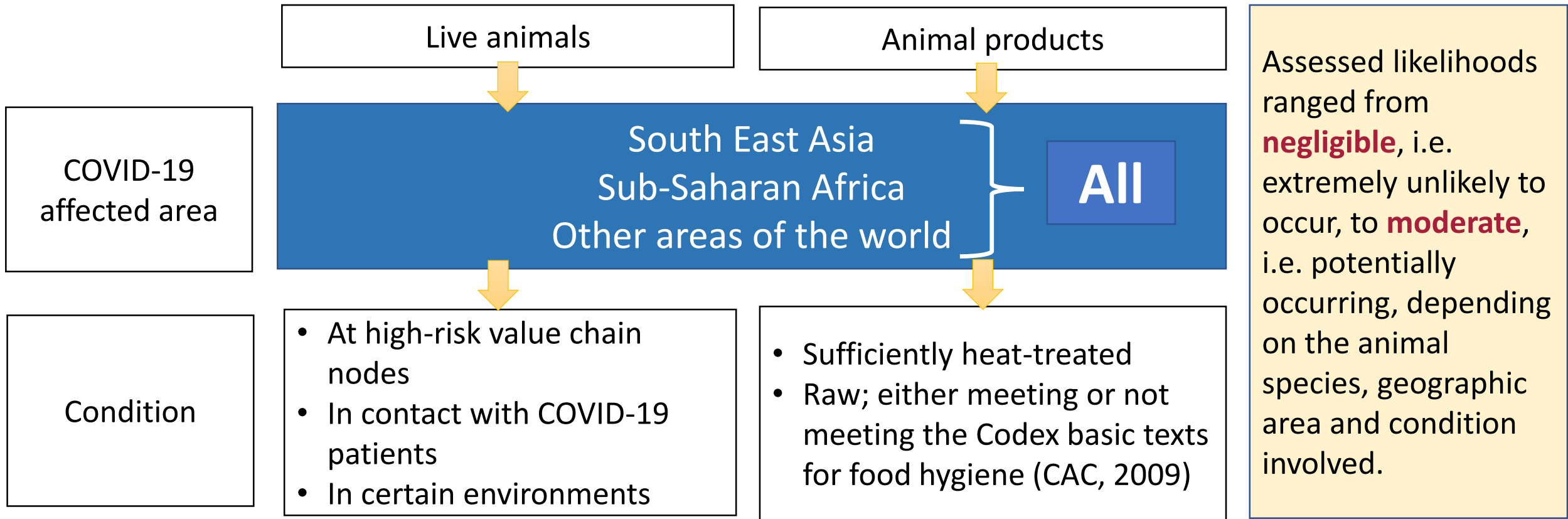
- **High** (highly likely to occur/result in exposure);
- **Moderate** (potential to occur/result in exposure);
- **Low** (unlikely to occur/result in exposure);
- **Very low** (very unlikely to occur/result in exposure); and
- **Negligible** (extremely unlikely to occur/result in exposure).





Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Likelihood assessment



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Species/families assessed (results shown here only for contact with live animals)

Wildlife

- Wild felines
 - Old and new world monkeys
 - Bats and Pangolins
 - *Mustelidae* and *Cricetidae*
 - *Tupaiidae*
 - Birds, suids - *negligible*
 - Other wildlife species (products only)
- very low to low*

Livestock

- Pigs
 - Poultry
 - Bovine, ovine, caprine, camelid and rabbit (products only)
- negligible*

Companion

- Dogs – *very low to low*
 - Cats
 - Ferrets
 - Hamsters
 - Birds - *negligible*
- low to moderate*

Aquatic

- Mammals
 - Fish
 - Molluscs
 - Crustaceans
 - Amphibians
- *all negligible*

Cannot assess other species as the data currently available is not sufficient



Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Likelihood assessment, cont.

- Increased relative exposure risk should be considered for occupational risk groups when compared to the general public, owing to their increased frequency and intensity of contact with certain animal species, e.g.:
 - Hunters
 - Butchers
 - Market middlemen
 - Retailers
 - Farmers
 - Veterinarians
 - Etc.





Exposure of humans or animals to SARS-CoV-2 from wild, livestock, companion and aquatic animals

Additional Outputs of the exposure assessment

- Summary of available evidence for SARS-CoV-2 susceptibility of different animal species;
- Evidence-based recommendations on how to prioritize animal species for targeted field investigations or research studies;
- Identification of current knowledge gaps regarding the zoonotic origin or animal-human spillover of SARS-CoV-2 ;
- Recommendations for targeted One Health investigations and epidemiological, laboratory, anthropological or seasonality studies to fill critical knowledge gaps evidenced.



Exposure of humans or animals to SARS-COV-2 from wild, livestock, companion and aquatic animals

Qualitative exposure assessment

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Thank you



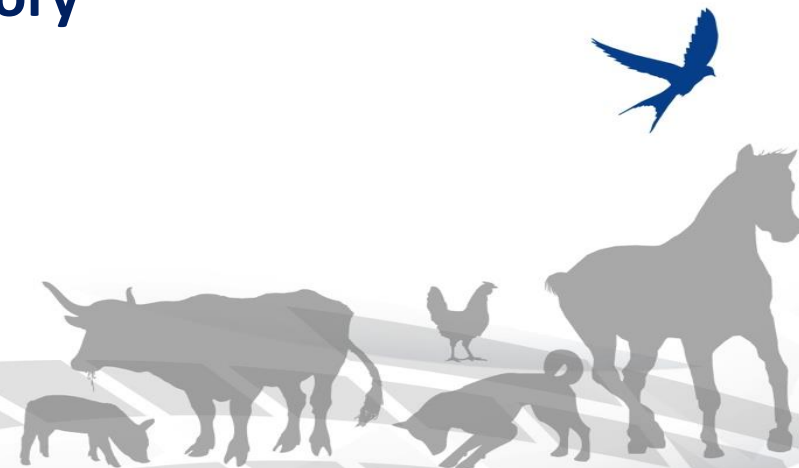
Protecting people, animals, and the environment everyday



**IZSAM G. CAPORALE
TERAMO**

**Interpretation of SARS-CoV-2 laboratory
results**

Alessio Lorusso, 29 July 2020



Key points (general)

Contamination - Microorganisms loosely attached to tissues without invading the tissue or triggering an immune response. In general, low PCR titres.

Infection - Microorganisms multiply, bind to tissue and elicit an immune response. In general, high PCR titres,



Key points (general)

Contamination - Microorganisms loosely attached to tissues without invading the tissue or triggering an immune response. In general, low PCR titres.



Infection - Microorganisms multiply, bind to tissue and elicit an immune response. In general, high PCR titres, shedding of infectious virus



Key points (general)

- The strength of PCR diagnostic tests is based on the ability to design pathogen-specific PCR primers and probes
- A positive PCR test result indicates the presence of pathogen genetic material but does not necessarily confirm active replication
- A negative PCR test result indicates the absence of pathogen genetic material but not necessarily rule out active infection
- **Intepretation is the key. Ideally with a combination of multiple factors and tests**

PCR Result	Standard Result	General Interpretation	Alternative Interpretation
Positive	Positive	Pathogen present	—
Positive	Negative	Pathogen DNA present (no indication of live pathogen)	False-positive PCR result (due to contaminating DNA) <i>or</i> False-negative standard result (due to pathogen being present but dead or too rare to isolate, errors in handling or processing the sample, or prior antibiotic use)
Negative	Positive	Pathogen present	Lack of pathogen DNA in PCR sample <i>or</i> False-negative PCR result (due to the presence of inhibitory substances, poor DNA extraction, or poor reaction performance)
Negative	Negative	No pathogen present	—

◀ 1, low titers

◀ 2, next slide

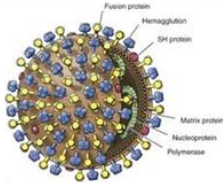
2



Phenomenon common to many pathogens

- CPV-2 in dog's feaces
- Feline morbillivirus in cat urine samples
- Arboviruses in insects
- Enteric viruses in shellfish
- Swine flu viruses in BALs

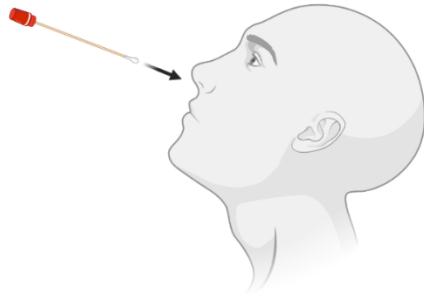
- **Generally**, high viral titers (PCR) result in successful virus isolation
- **Generally**, low viral titers (PCR) result in unsuccessful virus isolation
- However, **the «titer issue» is not the only explanation for isolation failures or an assurance for virus viability**



COVID-19 Molecular Diagnostic Test through RT-PCR

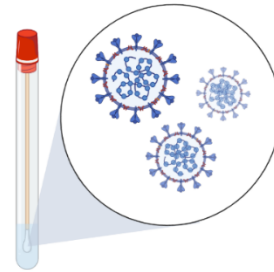
1 Nasopharyngeal (NP) or Oropharyngeal (OP) swab

Cotton swab is inserted into nostril to absorb secretions. <15 min



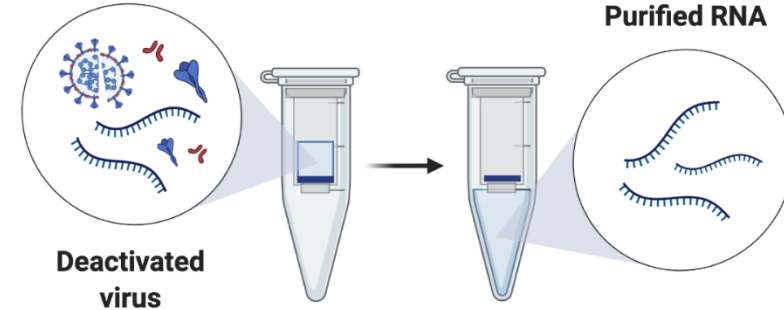
2 Collected specimen 0-72 h

Specimen is stored at 2-8°C for up to 72 hours or proceed to RNA extraction.



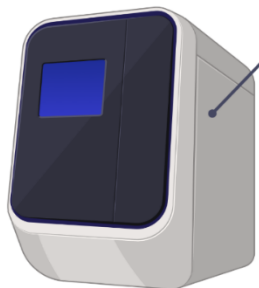
3 RNA extraction ~45 min

Purified RNA is extracted from deactivated virus.



4 RT-qPCR ~1 h per primer set

Purified RNA is reverse transcribed to cDNA and amplified by qPCR.



5' 266 13,468 21,563 29,674 3'

ORF1a ORF1b RdRp E N*

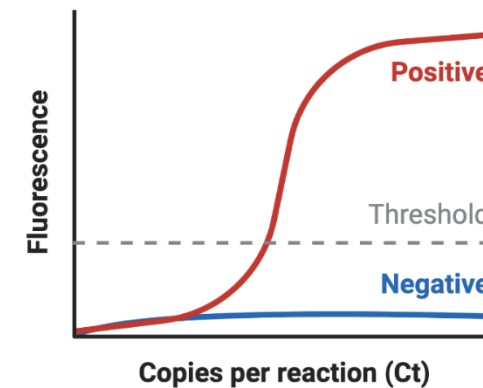
Example primers and probes for screening

E_Forward: ACAGGTACGTTAATAGTTAATAGCGT	E gene First-line screening tool
E_Probe1: FAM-ACACTAGCCATCCTTACTGCGCTTCG-BBQ	
E_Reverse: ATATTGCAGCAGTACGCACACA	
RdRp_Forward: GTGARATGGTCATGTGTGGCGG	RdRp gene Confirmatory testing
RdRp_Probe1: FAM-CCAGGTGGWACRTCATCMGGTGATGC-BBQ	
RdRp_Probe2: FAM-CAGGTGGAACCTCATCAGGAGATGC-BBQ	
RdRp_Reverse: CARATGTTAAASACACTATTAGCATA	

Primer sequences are for *illustrative* purposes only.

5 Test results real-time

Positive SARS-CoV2 patients cross the threshold line within 40.00 cycles (< 40.00 Ct).





A “One-Health” approach for diagnosis and molecular characterization of SARS-CoV-2 in Italy



Alessio Lorusso^{a,*}, Paolo Calistri^a, Maria Teresa Mercante^a, Federica Monaco^a, Ottavio Portanti^a, Maurilia Marcacci^a, Cesare Cammà^a, Antonio Rinaldi^a, Iolanda Mangone^a, Adriano Di Pasquale^a, Marino Iommarini^b, Maria Mattucci^c, Paolo Fazio^d, Pierluigi Tarquini^e, Rinalda Mariani^f, Alessandro Grimaldi^g, Daniela Morelli^a, Giacomo Migliorati^a, Giovanni Savini^a, Silvio Borrello^h, Nicola D'Alterio^a



Article

SARS-CoV-2 RNA Persistence in Naso-Pharyngeal Swabs

Maria Luisa Danzetta^{*}, Laura Amato, Francesca Cito, Alessandra Di Giuseppe, Daniela Morelli, Giovanni Savini, Maria Teresa Mercante, Alessio Lorusso, Ottavio Portanti, Ilaria Puglia, Federica Monaco, Claudia Casaccia, Annapia Di Gennaro, Lilia Testa, Giacomo Migliorati, Nicola D'Alterio and Paolo Calistri

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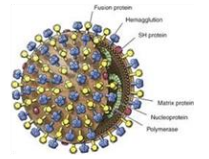
* Correspondence: m.danzetta@izs.it

Received: 19 June 2020; Accepted: 23 July 2020; Published: 26 July 2020

Our interpretation of PCR-based results is based on human samples

Active SARS-CoV-2 infection (mainly with clinical signs)

- CT values in general are very low, which means very high viral titers, likely a source of infectious virus (isolation could be successful)
- Higher viral loads are correlated with longer viral shedding (up to 63 days). Overtime, titers tend to decrease till the negative status is reached.



SARS-CoV-2 in recovered individuals

- Frequently we do observe traces of viral RNA for several days/weeks, likely not a source of infectious virus (isolation very likely to be unsuccessful). Sometimes, this finding is intermittent.

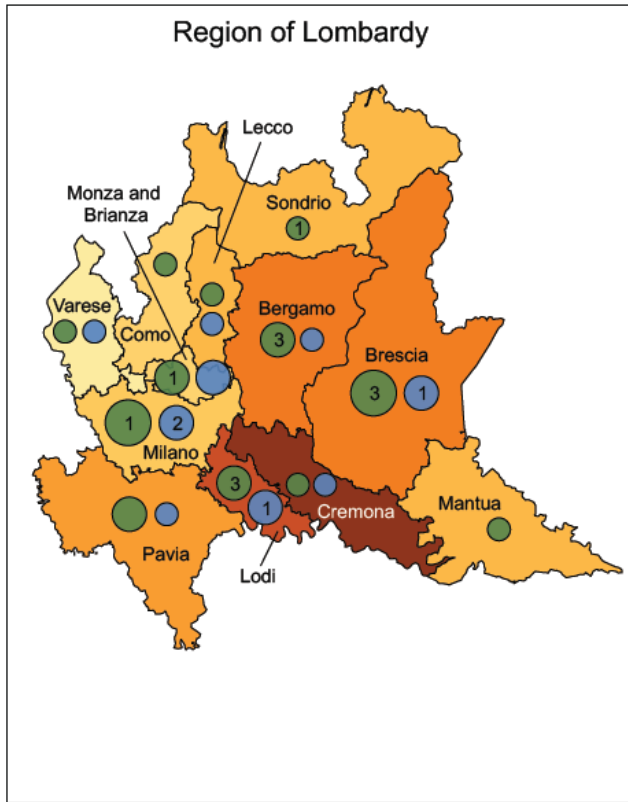
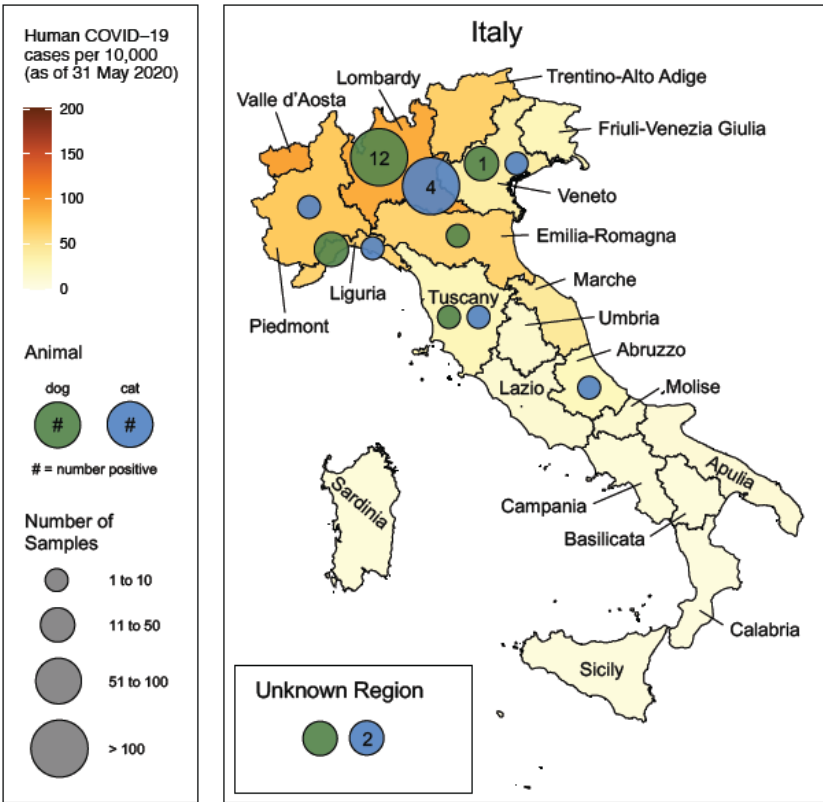


Is COVID-19 the first pandemic that evolves into a panzootic?

Rania Gollakner and Ilaria Capua*

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3,35%

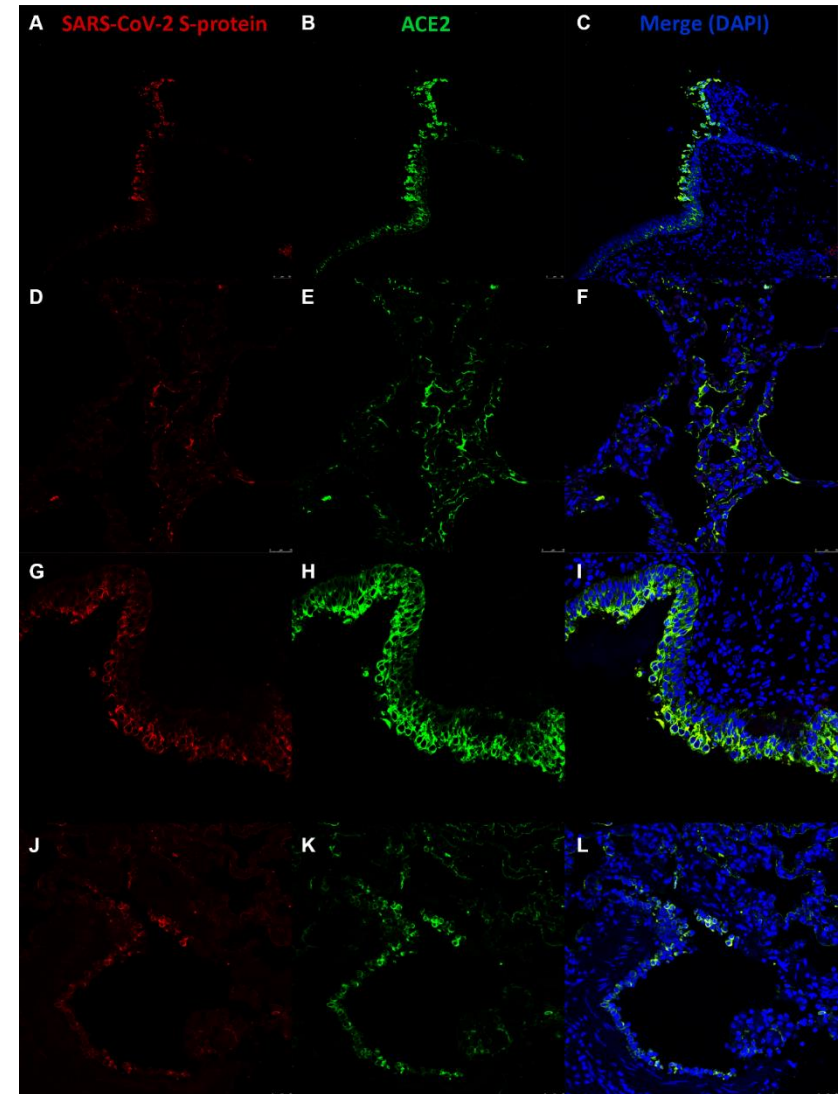
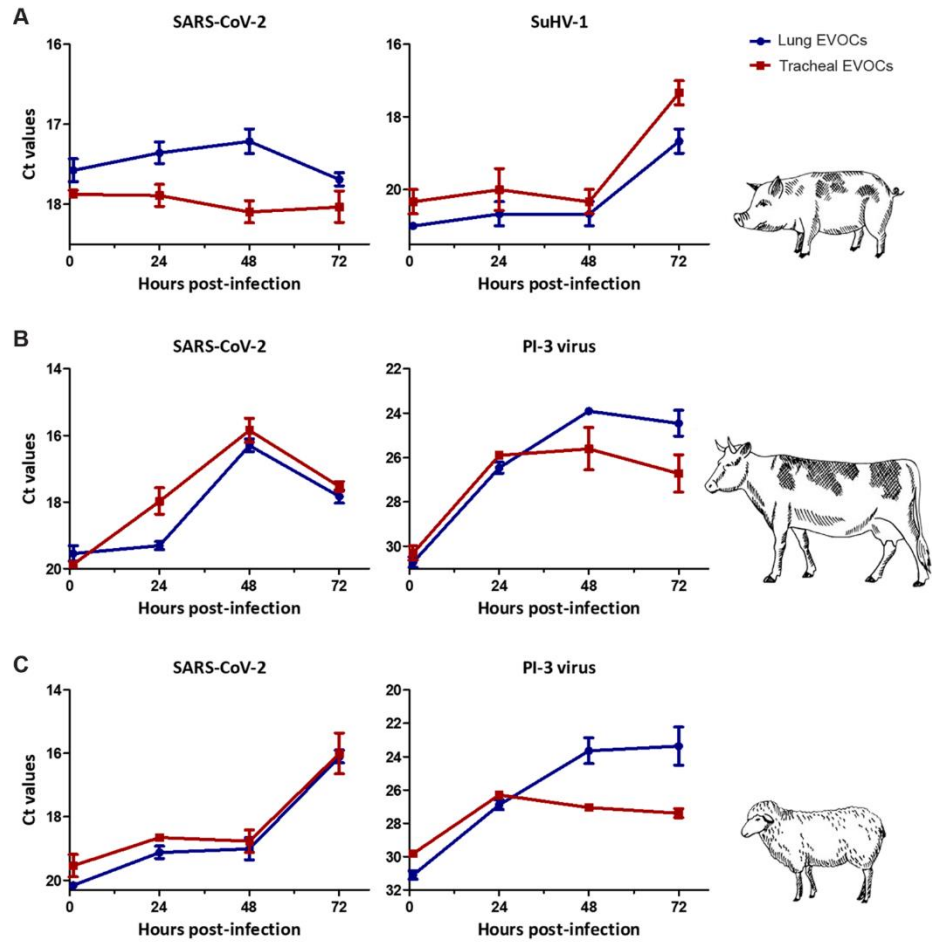


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Key messages of SARS-CoV-2 in animals

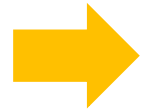


- Data on animals are still scarce
- Dogs and cats, in an intense COVID-19 scenario, can seroconvert.
 - Multiple routes of shedding
- Shedding period seems to be shorter compared to humans
 - Ferrets, cats, and golden Syrian hamsters can be experimentally infected and can spread the infection to other animals of the same species.
- Mice, pigs, chickens, and ducks do not seem to become infected or spread the infection

- In case of PCR positivity: clinical status, titers, isolation, serological status
- Prudent use of SARS-CoV-2 antigens and interpretation of serological results



Additional evidence that an animal species could act as SARS-CoV-2 reservoir or intermediate host includes demonstration of high-level RNA shedding and the detection of SARS-CoV-2 RNA and/or anti-SARS-CoV-2 antibodies in other animals of the same species in their natural habitat or commercial production settings.



Sufficient evidence needs to be accumulated before confirming susceptibility of an animal species; FAO and OIE are taking a leading role in collecting and analyzing such evidence.

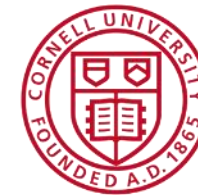


Thank you for your attention

CityU

#48

QS WORLD UNIVERSITY RANKINGS 2021



Jockey Club College of Veterinary
Medicine and Life Sciences

香港城市大學
City University of Hong Kong
in collaboration with Cornell University

From Global to Local Context: Considerations for Country-specific Risk Assessments

Dirk U. Pfeiffer

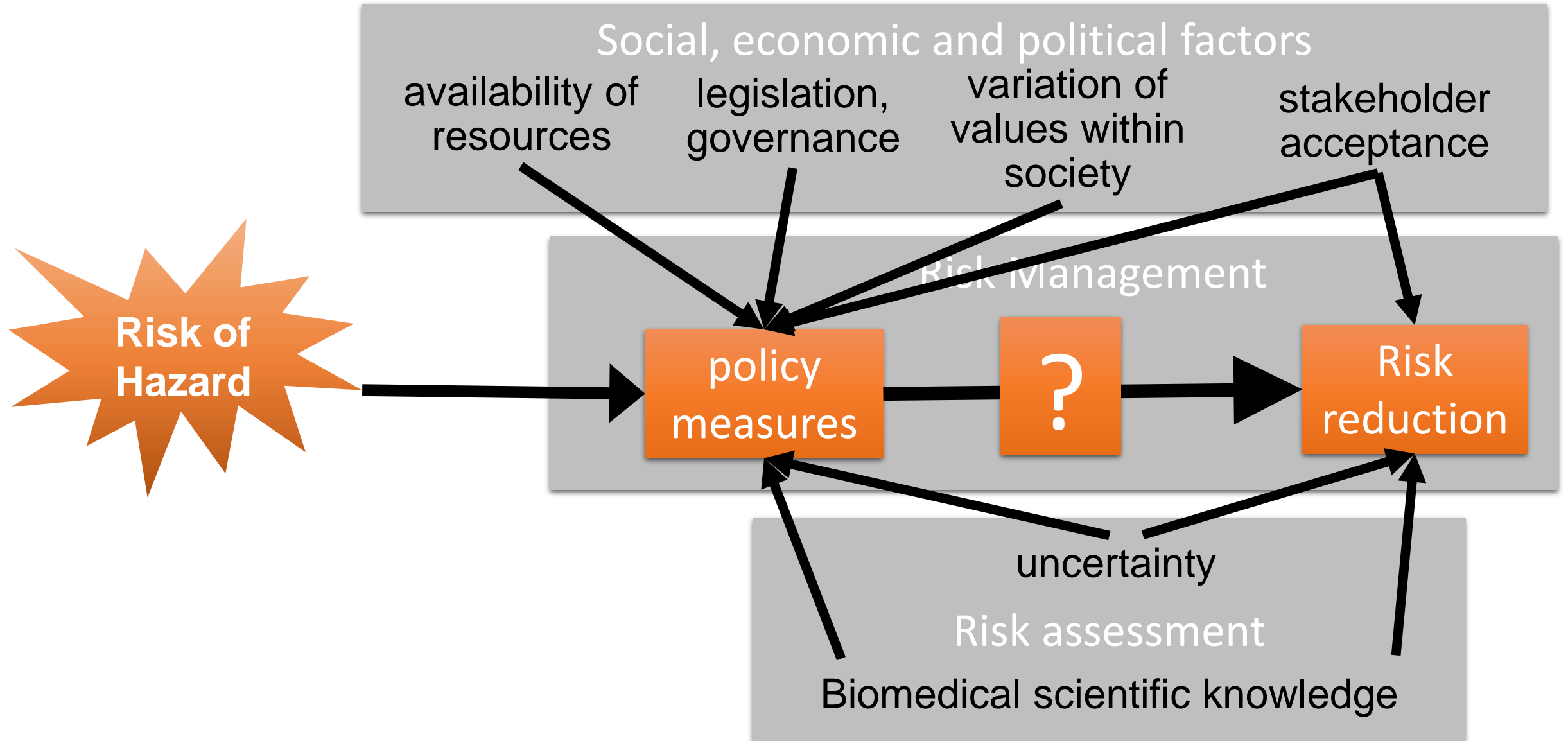
Chow Tak Fung Chair Professor of One Health, City University of Hong Kong
Professor of Veterinary Epidemiology, Royal Veterinary College, University of London
Adjunct Professor at China Animal Health and Epidemiology Centre, Qingdao



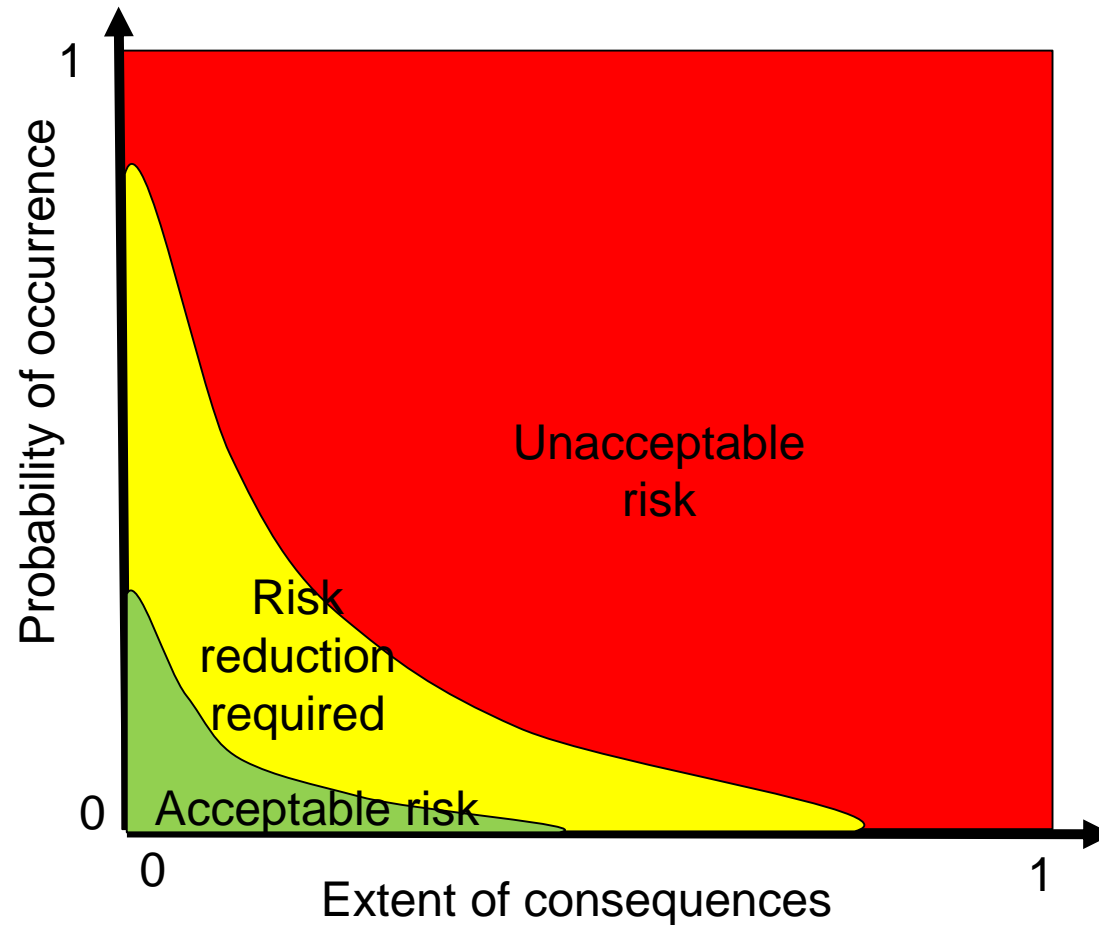
QS World University
Rankings 2021
Veterinary
Science **No. 2**

RVC Royal
Veterinary
College
University of London

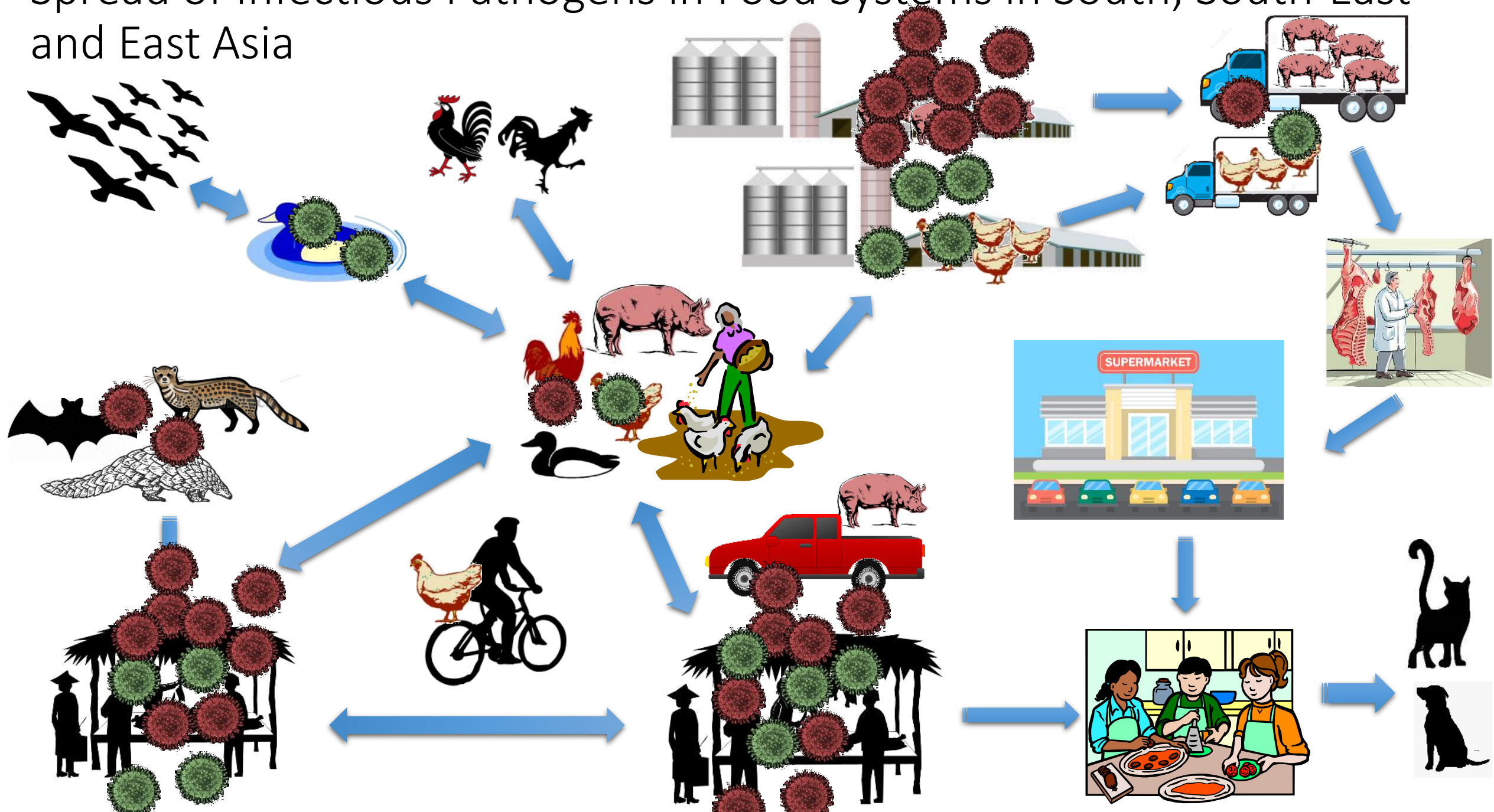
Risk, Risk Assessment and Risk Management



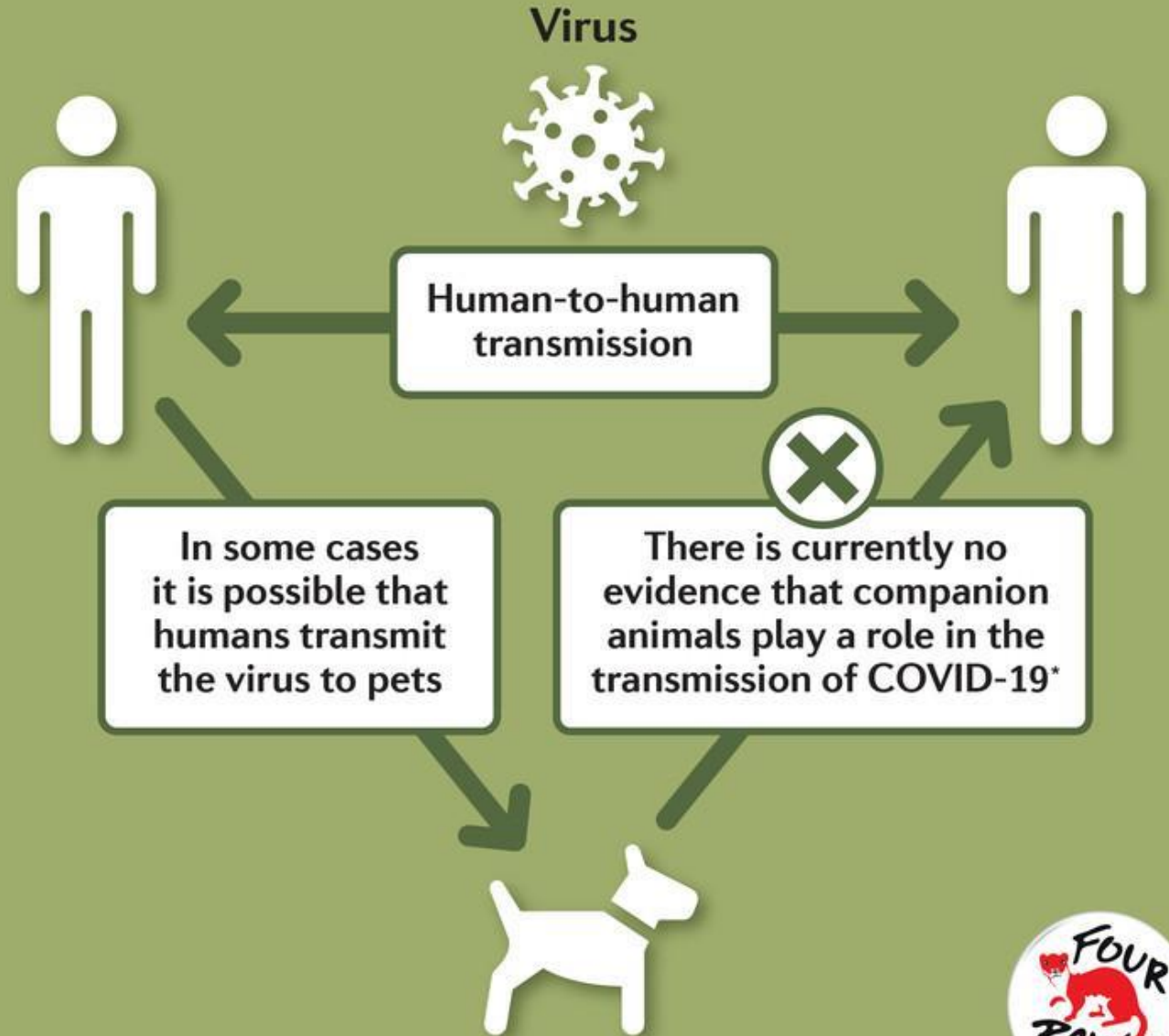
Acceptable Risk, Risk to be Reduced or Unacceptable Risk (adapted from IRGC 2005)



Spread of Infectious Pathogens in Food Systems in South, South-East and East Asia

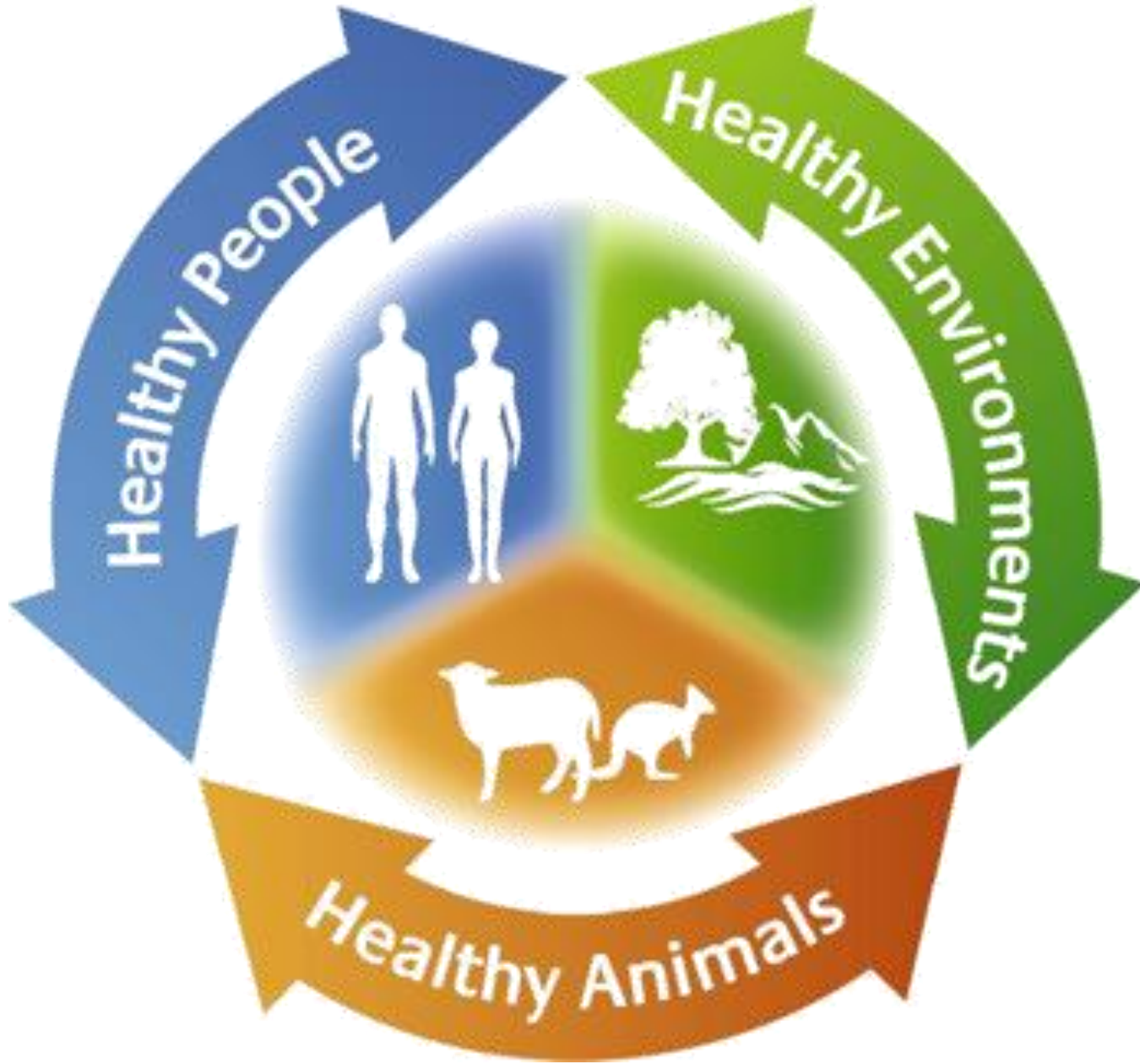


TRANSMISSION OF COVID-19 TO PETS



*Source: <https://www.who.int/news-room/q-a-detail/q-a-coronaviruses>





Taking a Multisectoral, One Health Approach:
**A Tripartite Guide to Addressing
Zoonotic Diseases in Countries**



Image from: <http://barfblog.com/tags/one-health/>



Food and Agriculture Organization
of the United Nations

Application of results from the FAO SARS-CoV-2 Exposure Assessment at country-level



Sophie von Dobschuetz and Ihab El Masry

Surveillance Team, Animal Health Service, ECTAD-HQ, FAO

Application of results from the FAO SARS-CoV-2 Exposure Assessment at country-level

Stage #1

- **Engage One Health partners**

- Veterinary authorities
- Public Health authorities
- Wildlife, Environment, Forestry
- Fisheries
- Research partners/institutions
- Private sector
- Etc.

- Virology
- Epidemiology
- Risk assessment
- Wildlife
- Pets
- Farm animals
- Etc.





Application of results from the FAO SARS-CoV-2 Exposure Assessment at country-level

Stage #2

- **Conduct country-specific risk assessment, taking into account:**
 - Local animal species/products*
 - On the ground realities in provinces/districts
 - Characteristics of value chain nodes
 - Conditions of animal keeping or sale and associated behaviours
 - Etc.

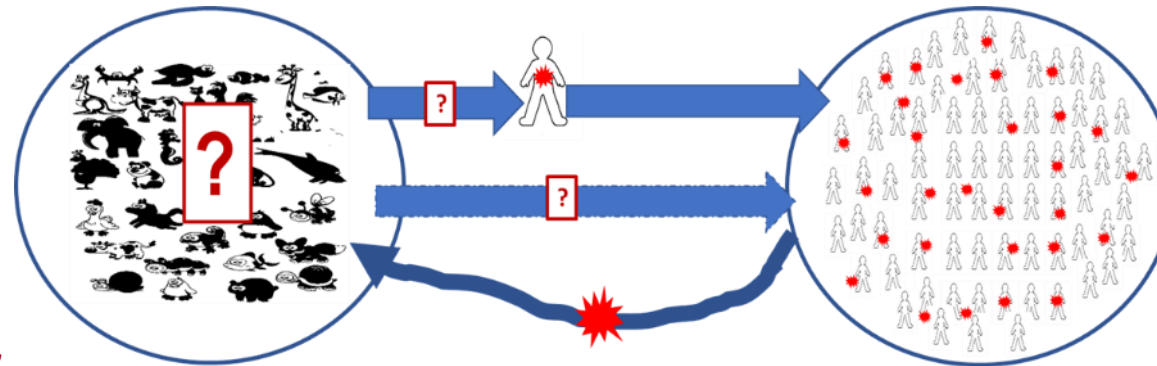
**consider processing methods*

-
-
- Use current knowledge elaborated in FAO's exposure assessment
****unique synthesis****
 - Use additional national resources, information

Apply guidance presented by
Dirk Pfeiffer

Application of results from the FAO Exposure Assessment at country-level

Stage #3



What we don't know

- Convert knowledge gaps to objectives of One Health investigations and research studies.
- Follow a progressive approach.



What we know

- Use known information in the planning of OH investigations and research studies to:
 - Prioritize animal species
 - Target certain areas/conditions/value chain nodes
 - Design laboratory or field studies
 - Etc.
- Disregard species or conditions that have been assessed as 'negligible' (e.g. birds, pigs, aquatic species, thoroughly cooked meat)

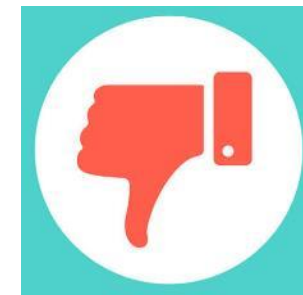


Application of results from the FAO Exposure Assessment at country-level

To note when designing field studies:

At this early stage, when many knowledge gaps remain, FAO

- **encourages** public health, veterinary and wildlife authorities, and forestry and natural resources management to work closely together with a **One Health approach on targeted investigations of SARS-CoV-2 transmission** between animals and humans, provided conditions and resources allow.
- **discourages** sampling surveys as part of **active or random surveillance** for SARS-CoV-2 in animal species that would distract time and resources away from other responsibilities of veterinary services.

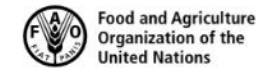




Application of results from the FAO Exposure Assessment at country-level

To note for decision making

- Assessing a low or even moderate exposure risk from certain animal species does not imply they (currently) play a role in the epidemiology of SARS-CoV-2
- Therefore, measures that may subject these species to unnecessary stress, impact their trade or affect their conservation status are not justified at the moment
- Sufficient evidence needs to be gathered from both laboratory and field studies before the susceptibility or epidemiological role of an animal species can be confirmed
- On the other hand, species that have been assessed as 'negligible' can be considered 'not susceptible' (e.g. birds, pigs, aquatic animals)



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Qualitative exposure assessment





Application of results from the FAO Exposure Assessment at country-level

Annex 4: Prioritization of animal species to be investigated further through field surveillance

	Natural infection confirmed*	Experimental infection**		Infectious virus produced in tissue explant	ACE2 affinity to bind RBD	Same family of a susceptible animal	Mammalian predator of susceptible animal	Score	Priority
		High susceptibility	Poor or no susceptibility						
Malayan tiger	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	13	High
Caracal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	4	Medium
Rhesus macaque	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	11	High
Ferret	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9	High
Mink	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	10	High
Pangolin	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9	High
Cat	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	19	High
Dog	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	Medium
Cattle	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3	Low
Pig	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-3	Negligible
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0	

* Natural infection refers to SARS-CoV-2 and other closely related viruses.

** Susceptibility after experimental infection refers to evidenced replication and shedding of infectious virus rather than positive PCR test results alone.



Application of results from the FAO Exposure Assessment at country-level

Annex 3: Progressive approach to investigate SARS-CoV-2 wildlife reservoir(s) or intermediate host(s)

	Objective	Targeted animal species	Sites
Phase 1	Screening to detect SARS-CoV-2 RNA and anti-SARS-CoV-2 antibodies.	Animals classified as high priority (see Annex 4).	Sites of highest animal-animal or human-animal interface intensity (traditional markets and live animal congregation sites/collection points prior to reaching a market) in COVID-19 affected areas, with priority given to Southeast Asia and sub-Saharan Africa for identification of reservoir hosts.
Phase 2		Wildlife species of same family of animals testing positive in phase 1.	
Phase 3		Predators of the wildlife species testing positive in phases 1 and 2 (if applicable), priority to mammalian predators.	
Phase 4	Narrow down investigation to exclude hypothesis of accidental infection.	Species tested positive in phases 1, 2 and 3.	High risk areas (highest density of target species - natural habitat and captive farming).



Application of results from the FAO Exposure Assessment at country-level

Stage #4

- **Update your country-specific risk assessment**

- Should be a living document, our knowledge changes quickly
- To be updated when new results come in (local or global)
- Re-shape your investigation and research studies accordingly



- Keep up to date with information provided by FAO, OIE and WHO!
- Help generating additional information and share timely with the international community
- Help preventing the establishment of the virus in a potential new host species
- Always use the One Health approach!!

Thank you

Authors

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...and all the 47 reviewers!!

Food and Agriculture Organization of the United Nations

Rome, 2020



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