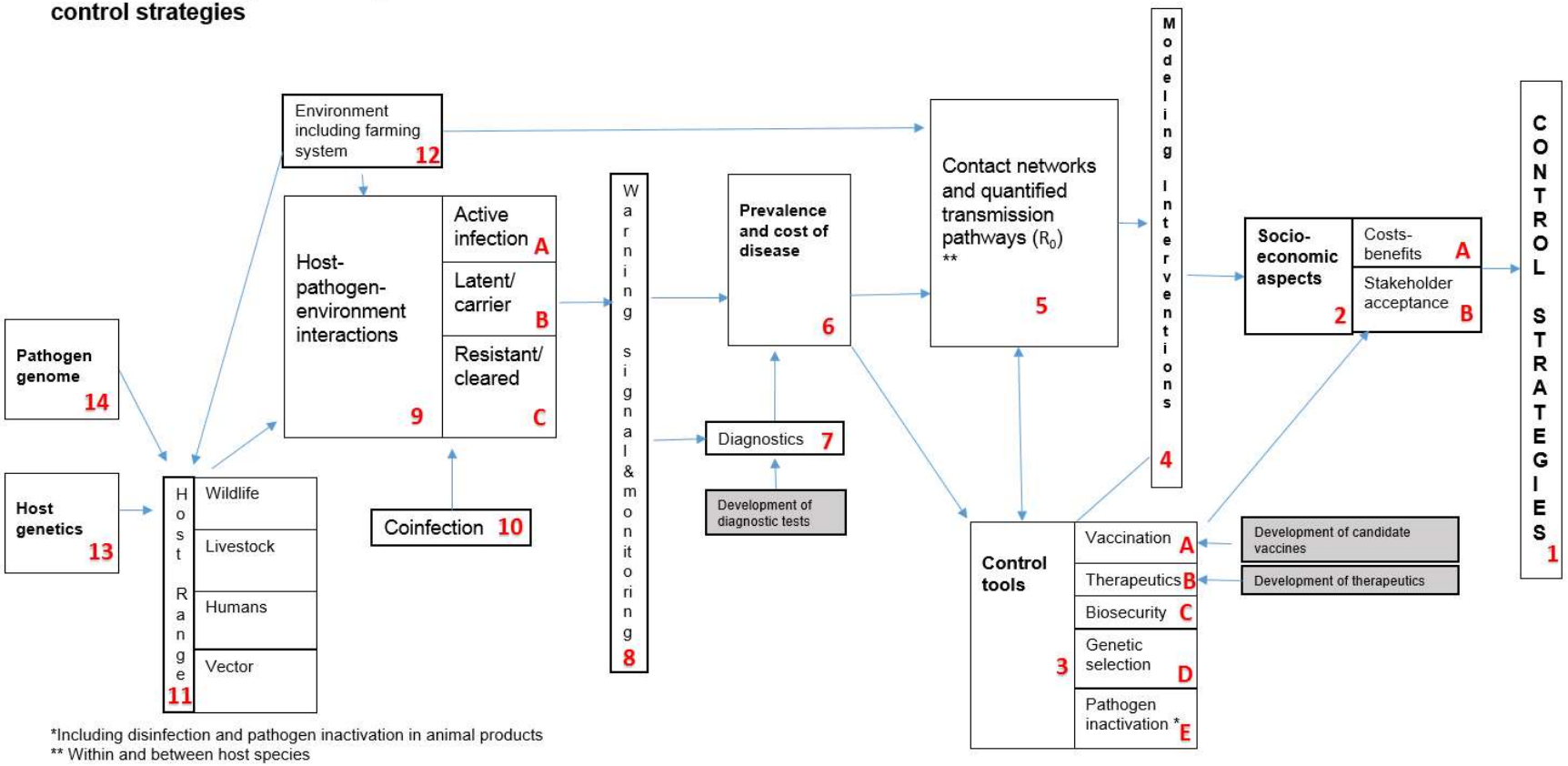
STAR-IDAZ
International Research
Consortium on Animal Health

Roadmap Lead Summaries

Disease/pathogen						
Roadmap type	Influenza Control Strategies					
Version: Date	v1	22/03/2023				

Research roadmap for development of disease control strategies



Please note: Lead summaries are not required for the grey boxes above as they have their own dedicated roadmaps

Lead Summary [1] - Control strategies

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Prevention of outbreaks and their rapid containment when outbreaks do occur

Prevention of multiplication of pathogen subtypes and clades resulting from weaker implementation of control measures

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Development of effective and sustainable control strategies for influenza outbreaks

Prevention of outbreaks requires very strong international collaboration and alignment of approaches – should it be reinforced?

Diversity of contexts

Field work not always scientifically prepared & described – how to make sure results can be scientifically extrapolated and shared?

Engagement of all stakeholders who determine control strategy inputs (regulators, poultry industry) and are affected by outcomes

Consideration of varied restraints/concerns: heritage breeds, value, environment, social concerns, food security, cost, supplies

Solution Routes

What approaches could/should be taken to address the research question?

Develop models to evaluate control strategy inputs and outcomes

Good vaccine that can be delivered via mass application method

All inclusive multi-stakeholder plan of action to deliver control options

Encourage international experience and data sharing

Education on biosecurity measures to poor resource settings

Collect data on control strategy inputs and outcomes

Contextualising control options to different geographies and socio-economic platforms

Dependencies

What else needs to be done before we can solve this need?

Social science studies to understand trust among key players

State of the Art

Existing knowledge including successes and failures

Some data on vaccination already available

Projects

What activities are planned or underway?

Lead Summary [2]- Socio-economic aspects

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Reduce socio-economic impacts of influenza outbreaks

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Alternative methods to depopulation in case of outbreaks
Lack of trust of farmers
Humane treatment of animals, societal animal welfare concerns
Control strategies that preserve food security and livelihoods
Lack of people and material during mass outbreaks
Effective compensation strategies
Swine flu is very impactful on the pig industry but not much prevented and at the farmer's expenses while the big risk stands with human infections and emergence of a pandemic – should the farmers really bear all costs of this prevention?

Solution Routes

What approaches could/should be taken to address the research question?

Social sciences studies to understand human behaviours and produce applicable guidelines that could reduce influenza spread and to describe level of acceptance of various measures
Human-animal interface studies at critical sites, including social and behavioural sciences
Social studies that evaluate the cost of influenza outbreaks on various communities: rural communities, consumers, regulatory agencies, poultry production and processing, all stakeholders.
Economic models of outbreaks which can be used to evaluate the costs of control strategies
Quantifying losses comprehensively to convince policy makers and leaders of thoughts on need for investment in controls
Plan proper communications plans for farmers and for the general public
Engagement of social scientists to gather data
Development of communication strategies

Dependencies

What else needs to be done before we can solve this need?

State of the Art

Existing knowledge including successes and failures

In France an exercitation was done to calculate costs of outbreaks and of costs of vaccination and monitoring

Projects

What activities are planned or underway?

Lead Summary [2A] - Costs-benefits

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Support decision-making by cost-benefit analysis of the options

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Assess cost-benefit of different management strategies of outbreaks
Shorten the length of carcass compost time
Ensure that cost-benefit assessment is comprehensive and cover all sectors and types of poultry

Solution Routes

What approaches could/should be taken to address the research question?

Develop rapid methods to assess when virus is inactive in order to optimise compost times (carcasses and eggs)
Cost of diagnostic surveillance compared to stamping out
Compare scenarios with and without vaccination

Dependencies

What else needs to be done before we can solve this need?

Standard and effective sampling method for virus viability on carcasses and eggs
Properly list and describe all options and make sure to have the right methodology to assess the costs

State of the Art

Existing knowledge including successes and failures

In France a study was carried out to calculate costs of outbreaks and of costs of vaccination and monitoring

Projects

What activities are planned or underway?

Lead Summary [2B] - Stakeholder acceptance

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Respond to stakeholders needs for sustainable and safe management of outbreaks
Acceptance of the general public towards outbreak control measures and vaccination policy
What methods prevent stigmatization and have ease of adoption?

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Sustainable management of outbreaks and disposal of carcasses
Acceptability of depopulation for the public, consumers and small flock owners
Lack of public science literacy
Lack of communication between various stakeholders on the way forward best methods
Local suitability/acceptability of the standard solution in different geographical areas
Safe management of outbreaks for the operators
Stigma within the animal owners that the sick birds must be sold immediately and not reporting to local authorities

Solution Routes

What approaches could/should be taken to address the research question?

Alternative methods to killing in outbreaks management
Strategic use of stamping out
Harmonise carcass disposal with 'normal' activities
Bring in local knowledge and acceptable practices to aid acceptance
Establish compensation levels for farmers
Establish consumer acceptance

Dependencies

What else needs to be done before we can solve this need?

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [3] - Control tools

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Development of improved control tools for influenzas virus to minimize losses when infections occur and to prevent spread to other populations

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

To develop vaccine, therapeutics, biosecurity measures, disinfectants and breed selection for controlling influenza virus in targeted species
To develop strategies to use various control tools across various species, ages, and types of production as well as in varied stages of an outbreak,
Lack of knowledge on how dietary/other interventions might be targeted towards eliciting changes in the microbiota that support immunity to influenza and/or improve responses to vaccines

Solution Routes

What approaches could/should be taken to address the research question?

Pre-emptive risk assessment for targeted disease control measures
Strategies for the suppression and local/regional eradication of swine influenza
Assessment of exposure risks for flocks from outdoor composting
Additional composting methods: Above ground, in Ag bag
Increase and improve biosecurity measures (solution useful for controlling several respiratory diseases at once)
Improve compliance and practice among workers. Upper management by-in
Methods to neutralize virus from housing when birds are present
Windbreak gaze (netting efficacy)
Keep animals inside
Risk assessment post outbreak to determine when a site can be declared free of pathogen to prevent subsequent outbreak
Design vaccination strategies that fit species, age, production type and maternal antibody status including priming and boosting with various technologies to optimize protection and duration of immunity

Dependencies

What else needs to be done before we can solve this need?

Understand the risk of outbreak spread with the application of existing strategies and/or when no control is applied

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Action CA20103 - COST

Lead Summary [3A] - Vaccine

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Effective vaccination strategies

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

TRADE barriers need to be overcome which may result in the need to meet specified criteria

Solution Routes

What approaches could/should be taken to address the research question?

Design vaccination strategies that fit species, age, production type and maternal antibody status including priming and boosting with various technologies to optimize protection and duration of immunity

Dependencies

What else needs to be done before we can solve this need?

Lack of a good high throughput way to evaluate protection
Development of vaccines (see dedicated roadmap)

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [3B] - Therapeutics

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

To develop effective and affordable therapeutics for influenza viruses for targeted species
Develop strategies for therapeutics use

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Risk of the emergence and spread of resistance
Identify appropriate uses of antivirals in animal
Residuals in products and environment (withdrawal time and MRL)
Cost of therapeutics for animal production systems
Preservation of therapeutics for human use and possible high value companion animals to reduce antiviral resistance development
Need to have clear definitions on how to determine when a flock/bird is negative
Is there a need/market for therapeutics in controlling outbreaks?

Solution Routes

What approaches could/should be taken to address the research question?

Development of flu antivirals (particularly for horses and companion animals?)—reduce virus shedding while avoiding spread of drug resistance esp. to human/swine flu
Demonstrate safety for animal, human and environment of new therapeutics, defining Withdrawal period and MRL
Explore approaches that might overcome resistance issues like siRNA
Define how to use therapeutics in control: use and depopulate approach or use in animals that don't enter the food chain: Zoo birds, endangered species, hi value breeders, etc.
Decision tool or decision matrix to guide practitioners should be made available
Establish if therapeutics have been implemented/used regionally

Dependencies

What else needs to be done before we can solve this need?

Involve public health side here

State of the Art

Existing knowledge including successes and failures

Currently therapeutics can't be used in production animals as stamping out is applied for biosafety reasons

Projects

What activities are planned or underway?

Lead Summary [3C] - Biosecurity

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Effective and efficient biosecurity protocols

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Cost-effective tools and strategies to improve in farm biosecurity
Contextualize and adapt standard biosecurity measures in local settings?
Education of small-holder farmers (e.g. training on better practices to be used)
Aging and variable poultry housing systems
Getting producer and worker engagement to do biosecurity everyday
Showing that there is value in everyday biosecurity

Solution Routes

What approaches could/should be taken to address the research question?

Assess existing biosecurity measures: their efficiency, their cost-effectiveness, their gaps (what is still missed)
Separate biosecurity into easily understood parts – within farm hygiene/sanitation to reduce between animal spread VS outside the farm entry and exit practices to reduce infection of the farm or other farms
Optimise protocols to clean/disinfect premises in varied settings considering trade-off among safety and environmental/workers impact
Identify potential sources of virus entry or contamination per premises
Targeted measures to prevent introduction of influenza viruses
Biosecurity protocols around composting activities to avoid wildlife scavengers to disseminate virus-evaluate the risk of wildlife infection and spread
Sewage treatment protocols, impact on diseases control
Practical and effective DPI for workers
Tools for removal and killing virus in the ventilation systems
Tests for farm-workers (carrier state in humans)
Operational biosecurity competency evaluations
Effective disinfectants for wide use without adverse effects on human health
Quantitative measure of mitigating impacts of various biosecurity protocols
Economics of biosecurity- both in routine production to reduce incursions of endemic pathogens and during outbreaks to prevent spread and reduce duration of outbreak
Structural biosecurity that overcomes on farm operational biosecurity compliance failures
Using scaled-up approach to biosecurity implementation in smallholder farms
Alternative biosecurity protocols for low resource areas
Standardized questionnaires to be able to compare and analyse biosecurity measures
Modelling with biosecurity measures

Dependencies *What else needs to be done before we can solve this need?*
Increased surveillance to avoid secondary outbreaks Getting stakeholders buying in Case studies to define cost-benefit of biosecurity in different settings

State of the Art *Existing knowledge including successes and failures*

Projects *What activities are planned or underway?*
Action CA20103 - COST

Lead Summary [3D] - Genetic selection

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

To breed animals more resistant to infections

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Improve resistance to infection by selective breeding or genetic modification

Solution Routes

What approaches could/should be taken to address the research question?

Application of immunogenetic study findings to generating more resistant commercial poultry species

Translation of recent findings on possible innate immune determinants of susceptibility in avian species into generation of more resistant breeds

Dependencies

What else needs to be done before we can solve this need?

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [3E] - Pathogen Inactivation

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Determine how long the virus remain viable in the carcasses and the environment
Ways to inactivate pathogens under various conditions

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Maximum length of time to compost based on environmental temperature and initial viral load
Determine the optimal waiting time for operational safety before rendering
Cost effectiveness of methods: definition for each virus strain and matrix

Solution Routes

What approaches could/should be taken to address the research question?

Determine the best method to compost
Methods to measure viral inactivation
Models to evaluate the efficacy of pathogen inactivation using various strategies
Virus strain and matrix: can we find easier ways?
Models to reduce environmental contamination and track reduction

Dependencies

What else needs to be done before we can solve this need?

Ways to study pathogens in field conditions without select agent issues or spread

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [4] - Modelling interventions

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Mathematical models that can improve prevention and control measures for influenza viruses
Geo-epidemiologic models that can improve prevention and control measures for influenza viruses

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Mathematical/computational modelling of outbreak dynamics to inform public policy
Need for data as early as possible to populate the model
What are the specific datasets necessary as basic minimum for a good model?
Models to include climate change data that affects wild bird migration
Difficulty to track different vectors movements,
Diverse strains and clades

Solution Routes

What approaches could/should be taken to address the research question?

Impact of airborne transmission (wind or ventilation system)
Improvement of current modelling systems with new knowledge on transmissions routes, epidemiological and environmental data
Inclusion of epidemiological, environmental, and socioeconomic data into comprehensive viral prediction systems
Computational risk modelling based on epidemiological and surveillance data, including diverse strains and clades
Preset/well defined data fields to ease data movement and collection
Models taking into account vaccinated/unvaccinated populations and vaccines' /(incl. R_0)
Determination of the population (bird or animal number) sampled with environmental samples.
Models contextualising real-life scenarios

Dependencies

What else needs to be done before we can solve this need?

Target surveillance efforts and disease control strategies
Data availability to populate models.
Possibility of Data sharing between countries and from private companies.
Data collection from populations that are difficult to capture like upland gamebirds.
Duck population data. Mortality, production parameters, antibodies, virological.
Availability of socio-economics and livelihoods data

State of the Art

Existing knowledge including successes and failures

Projects *What activities are planned or underway?*

Lead Summary [5] - Contact networks and quantified transmission pathways (R_0)

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Identify and quantify transmission pathways inter and intra-species

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Establishing the Inter- and intra-species transmission dynamics
Model systems or non-invasive ways to study intraspecies transmission

Solution Routes

What approaches could/should be taken to address the research question?

Transmission dynamics of influenza across major interfaces (e.g. wild, domestic, human, and environment), particularly between pigs and humans
Interaction pathways between wild birds and poultry, and computational models of such pathways
Increasing understanding of live poultry markets and related viral transmission dynamics
Routes and patterns of avian influenza incursion into poultry holdings
Factors that influence the spread/risk of HPAI along new bird migratory routes
Propagation pathways of swine influenza between herds (e.g. live pig transport, airborne transmission, etc.)

Dependencies

What else needs to be done before we can solve this need?

Virus datasets from various settings and conditions along with metadata

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [6] - Prevalence and cost of disease

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Assess the global burden of influenza viruses

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Cost-benefit of wildlife network surveillance vs human-interface surveillance network
Standard methods for cost-benefit analysis
Effective systems for monitoring influenza at the human/animal interface
Development of efficient sampling methods for rapid detection of emerging strains
Integration of diagnostic and surveillance data systems
Standardization of international surveillance programs for avian and swine influenza
Improvement of surveillance systems in wild birds
Develop innovative surveillance methods

Solution Routes

What approaches could/should be taken to address the research question?

Develop a global Ag cartography
Assessment of high-risk areas to target limited surveillance resources for maximum impact
Rapid characterization and pathotyping of variants circulating in the field (high throughput point-of-use technology

Dependencies

What else needs to be done before we can solve this need?

Socio-economic studies
Improve surveillance systems – incl. In vaccinated populations
Early detection systems for influenza A virus in turkeys and pigs

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [7] - Diagnostics

Research Question
What are we trying to achieve and why? What is the problem we are trying to solve?

Optimal strategies for early detection

Challenge(s)
What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Early detection

Solution Routes
What approaches could/should be taken to address the research question?

Standardise sampling protocols for diagnostic sampling
Develop diagnostic test (see dedicated roadmap)

Dependencies
What else needs to be done before we can solve this need?

Engagement of public and private sectors

State of the Art
Existing knowledge including successes and failures

Projects
What activities are planned or underway?

Lead Summary [8] - Warning Signal & monitoring

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Develop cost-effective early warning systems for influenza viruses – both on-farm and in wildlife

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Cost and feasibility of wildlife surveillance systems
New methods for anticipating/detecting potentially dangerous viral subtypes prior to major outbreak events
Early-warning risk-based surveillance systems designed for emerging events in both wild and domestic hosts
Syndromic surveillance
Accessible information system: current systems can only be accessed by certain stakeholders
Increase trust of farmers in institutions

Solution Routes

What approaches could/should be taken to address the research question?

Socio-economic studies to assess cost-benefit of different wildlife surveillance systems
Remote sensors and artificial intelligence for early warning linked with official sampling protocols
Early detection systems for influenza A virus in turkeys and pigs
Mortality triggers for livestock species under varied conditions
Easily accessible information system by all stakeholders.
Information regarding animal diseases and outbreaks is constantly updated, ease to access and understand.
Monitoring wildlife predators/scavengers for seroconversion

Dependencies

What else needs to be done before we can solve this need?

Develop cost-effective surveillance systems

State of the Art

Existing knowledge including successes and failures

The information system is available unfortunately it can only be accessed by the authorities

Projects

What activities are planned or underway?

Lead Summary [9] - Host-pathogen-environment interactions

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Improved understanding of the host-pathogen-environmental interactions

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Understanding the mechanisms behind increased pathogenicity observed with some H9N2 and H5N2 LPAI strains
Clades and strain and subtype differences complicated a single way to address the issues
Potential role of the vasculature in HPAI pathogenesis
Consequences for disease ecology in wild bird species of the wide range of avian species susceptibility of H5N1
Understanding why some duck species are resistant to infection and disease compared to terrestrial poultry
Are there better ways to cluster groups of viruses that behave similarly to have groups of solution?
Role of maternal immunity and vaccination in disease transmission
Role of scavengers (dogs, cats, birds) and carriers like rats in infected premises

Solution Routes

What approaches could/should be taken to address the research question?

Increasing understanding of potential reservoir species at the human/animal interface
Monitoring of point-of-entry into high-risk areas (introduction of HPAI from Asia/Europe to Nigeria) via migratory waterfowl
Viral, host, and environmental factors that influence the risk of acquiring an HA multibasic cleavage site
Transmission experimental models for complex biological systems e.g., live bird markets, ponds where wild birds gather, bird feeders, sow barns.
Quantify the transmission role of scavengers (dogs, cats, birds) and carriers like rats in infected premises

Dependencies

What else needs to be done before we can solve this need?

Standardization of pathogenesis/transmission models and experimental influenza delivery routes

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [9A] - Active Infection

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Duration (and quantification?) of infectious windows for various subtypes
Windows of susceptibility (species, physiological status, age, presence of MDAs, etc) and shedding

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Effect of mutations at receptor binding site on viral replication and bird/mammalian species adaptation
Determinants of viral shedding from respiratory vs. intestinal tracts
Role of unregulated cytokine expression in production of vaccine-associated enhanced respiratory disease of swine (important also for other different species and virus strains)

Solution Routes

What approaches could/should be taken to address the research question?

Comparative studies of pathogenesis with different influenza viruses in the swine host
Virus shedding patterns at the individual and flock level and age group level
Replication and transmission efficiency studies: compare similar studies e.g. using Mexican lineage H5N2 LPAIV and / or Asian H9N2
Studies on the state of active infection in hosts with varying levels of immunity

Dependencies

What else needs to be done before we can solve this need?

Challenge studies with various hosts/ages/immunity/viral strains

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [9B] - Low level circulation in populations/carrier

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Information on a possible carrier state in some species or immune-suppressed individuals

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Very low level of virus in population at end of acute infection
Impact of suboptimal immunity

Solution Routes

What approaches could/should be taken to address the research question?

Transmissibility of low levels of virus in population, risk to other hosts/populations

Dependencies

What else needs to be done before we can solve this need?

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [9C] - Resistant/cleared

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Information on resistant species (innate mechanisms of resistance to infection) and on immune clearance in susceptible species

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Genetic determinants of resistance to HPAI strains in known reservoir species (e.g. ducks)
Mechanisms (genetic or otherwise) behind duck resistance to HPAI strains
Translation of recent findings on possible innate immune determinants of susceptibility in avian species into generation of more resistant breeds
Understanding avian immunology across 9000 species

Solution Routes

What approaches could/should be taken to address the research question?

Understanding the immune response to influenza viruses and viral clearance with various strains, hosts, ages, states of immune function
The state of influenza A viruses in migrating wild birds.
Role of deltaFcIGY in neutralization/clearance.

Dependencies

What else needs to be done before we can solve this need?

Data on immunity from field settings
Approved tests (better tests) to assess immunity and protection from challenge

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [10] - Coinfection

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Impact of influenza virus infection on co-infection with different viruses or bacteria and vice versa

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Effects of co-infection with different viruses or bacteria
Coinfection often leads to misdiagnosis
Coinfection could lead to reassortment, increase shedding and increase susceptibility?

Solution Routes

What approaches could/should be taken to address the research question?

Experimental and field studies particularly with representative avian species (wild & poultry species) and for pigs
Assess added value of vaccination against co-infecting pathogens to prevent influenza infections
Models that include coinfection risks/phenotypes/outcomes and
Suitable panel assay for respiratory viruses
Whole genome sequencing in co-infected populations to identify the possible pathogens that could dampen the immune system and result in persistent low-level infections
Investigate regional approach instead of country-level approach in territories with similar trade systems
Understanding market system and role in co-infection and vice versa
Penside tests for co-infections to improve field actions

Dependencies

What else needs to be done before we can solve this need?

Knowledge of/studies of the potential coinfectors across the globe
Good differential diagnosis protocols
Improved tests to inform/predict protection
Well developed and integrated vaccination programs

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

INFLUOMA (NEIKER) (LINK: INFLUOMA – Neiker I)

Lead Summary [11] - Host range

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Knowledge on patterns of host susceptibility

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Understanding patterns of host susceptibility based on molecular markers and on host ecology
Molecular determinants of viral adaptation/restriction to different species/tissues
Determinants of host adaptation beyond the HA and NA proteins
Mechanisms of intra-host virus evolution

Solution Routes

What approaches could/should be taken to address the research question?

Increasing understanding of potential reservoir species at the human/animal interface
Investigate what are the main species involved in maintaining the virus in wild bird metapopulation, particularly for HPAI clade 2.3.4.4b
To grow knowledge beyond the polybasic cleavage site on HA
Identify determinants of virus shedding in respiratory and / or digestive tracts

Do species behave differently to the virus in different geographies? And production systems? Are there environmental factors? And stress factors?
Understanding transmissibility in ostriches/ducks and the resistance to highly pathogenic viruses resulting in potential transmission to wild birds due to farming practices

Dependencies

What else needs to be done before we can solve this need?

Surveillance in locations where multiple species are exposed to influenza A viruses.

State of the Art

Existing knowledge including successes and failures

Infection in Spain in minks, nice work about change in genome and danger for humans

Projects

What activities are planned or underway?

Lead Summary [11A] - Wildlife

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Prevent spill-over of HPAI from poultry to wildlife.
Reduction of population impacts of HPAI on wild bird and wild mammal species.

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Identification of the most important reservoir species within wild bird populations
How high or low is the host species barrier?
Dynamic of exchange between migratory wild migratory birds and resident wildbirds – reservoir persistence

Solution Routes

What approaches could/should be taken to address the research question?

Molecular signatures of adaptation to poultry of wild bird LPAI virus
Evaluation of poultry systems that provide good poultry health and welfare and reduce contact with relevant wildlife.
Study wildlife species at the interface with domestic animal/humans
Study wildbirds and wild boars raised and released into the wild by hunting activities
Direction of infection: From domestic to wildlife or vice versa

Dependencies

What else needs to be done before we can solve this need?

Longitudinal wild bird surveillance studies
True costs and benefits of poultry production need to be implemented in order to allow changing poultry systems for both improved poultry health and welfare and reduced risk of spill-over of HPAI to wildlife.

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [11B]- Livestock

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Host range of different subtypes in livestock
What is the species-specific risk of HPAIV developing in a poultry farm.

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Cross-species infectivity including wild birds and domestic birds to wild mammals.
Novel subtypes in avians, pigs and equine
Knowledge on bird species and tissues within the host which are involved in the genesis of HPAIV H5 / H7
Impact of Influenza D virus (often associated with bovine respiratory disease complex)
Mixed farming contribution to the spread of influenza

Solution Routes

What approaches could/should be taken to address the research question?

Study why turkeys are highly susceptible and not young broilers
Predictive approaches for understanding the level of risk posed by new isolates
Risks related to farms raising several species (e.g. turkeys and pigs)
Pigs should be monitored for H5 infections

Dependencies

What else needs to be done before we can solve this need?

Broad surveillance across livestock species

State of the Art

Existing knowledge including successes and failures

Minks in Spain showed an infection with a dangerous mutation for humans

Projects

What activities are planned or underway?

Lead Summary [11C] - Humans

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Mitigate the potential for influenza pandemics from animal origins

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Potential of zoonotic/reverse zoonotic impact of swine, equine and companion animals influenza
Risk of feeding or food/preparing infected material to human and livestock

Solution Routes

What approaches could/should be taken to address the research question?

Identification of critical reservoir species at the human interface
Epidemiological studies
Studies of molecular determinants of human adaptation
Determine viral and host factors that contribute to the successful transmission of swine influenza virus to other species

Consistent, longitudinal virological surveillance of human populations exposed to animal hosts
Identify high-reassortment strains could improve pandemic preparedness or reveal new treatments

Dependencies

What else needs to be done before we can solve this need?

Consistent, longitudinal virological surveillance of human populations exposed to animal hosts

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [11D] - Vectors

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Role of mechanical vectors (rodents, house flies -Musca domestica, other insects) in premise-to-premise transmission

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Lack of knowledge of the level of importance of vector transmission

Vectors flow freely between farms and wild areas and among farms

Different types of vectors have different mechanisms of spread and varied roles in transmission/persistence/outbreak spread

Solution Routes

What approaches could/should be taken to address the research question?

Ecology studies of farming systems to identify potential vectors (insects, vermin, etc.) under varied stressors like during normal times and when there is an outbreak

Surveillance of various potential vectors

Challenge and transmission studies on various hosts

Transmission studies from specific vectors to poultry

Dependencies

What else needs to be done before we can solve this need?

Include vector control in all biosecurity plans

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [12] - Environment including farming systems

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Role of environmental and ecological variables in virus transmission patterns

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Mode of environmental transmission
Wildlife reservoirs in avian viruses
Constantly changing virus
Risks of exposure in various farming systems
How can we limit transboundary risk associated with shared ecology?
Farming near houses (like using manure, like cleaning the waterways)

Solution Routes

What approaches could/should be taken to address the research question?

Identification of the most critical environmental interfaces
Identification of critical reservoir species, particularly within wild bird populations and understanding transmission within the different species
Dynamics of influenza transmission in various population settings in swine
Role of wind/dust in transmission patterns
Study the changes in virus ecology/epidemiology (avian & 2.3.4.4.b clade /swine and endemic farm infections)
Evaluation of farm size and animal density exposure risk factors.
Identification of farm/environment risk factors for HPAIV incursions
Study how much do open market and free-range birds contribute to spread
Increase knowledge on precursor viruses and/or signals to indicate any changes in ecology and enable anticipation
Determine the variables of 'risky' ecosystems in order to determine where poultry holdings should or should not be established

Dependencies

What else needs to be done before we can solve this need?

Data transparency across nations and private companies
Data collection harmonization so that there is consistency
Shared data and protocols across countries
Monitor wildlife at strategic points

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Lead Summary [13] - Host genetics

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Improve knowledge of host genetics in relation to susceptibility

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

How to manipulate bird genetics and / or anti - viral state responses without vaccine use?

Any new genetic improvement has a cost on the physiology (e.g. birds will grow more slowly)

Understanding the genetic behind the host immune systems of resistant animals (e.g. ducks/ostriches)

Solution Routes

What approaches could/should be taken to address the research question?

Identify molecular markers of host range in different birds (we know a lot more about what it takes for a virus to transmit from birds to humans than the same about different bird species)

NGS , variant analysis bioinformatics tools , combined with experimental in vivo studies in different bird species - Host / virus risk assessment matrix

Study of host genomes for identifying factors contributing to resistance

Improve the immune responses of hosts to vaccination (turkeys especially)

Transgenomic studies of infected ostriches/ducks to determine the resistant genes and how they can be bred into poultry

Evaluate the impact of developing more resistant hosts that will live among humans and wildlife that are still susceptible

Study immunization capacities of vaccination and genetics modification combined

Dependencies

What else needs to be done before we can solve this need?

Better understanding of avian immunology

Acceptance of consumers in case of GM

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

INFLUOMA-IRTA (Link: INFLUOMA - Searching the molecular mechanisms of avian influenza virus infection outcome in the avian host by using a multi-omic approach. ~ IRTA)

Lead Summary [14] - Pathogen genome

Research Question

What are we trying to achieve and why? What is the problem we are trying to solve?

Understand the influenza genome (pathogenicity, immune suppression, adaptation to new species, ecology, impact of interventions such as vaccination on evolution, etc.)
What allows LPAIV to switch to HPAIV in H5 and H7 and not in other subtypes.
What makes the AI to change into a strain dangerous for humans

Challenge(s)

What are the scientific and technological challenges (knowledge gaps needing to be addressed)?

Reassortment and continuing spread of H5N8 (goose Guandong lineage H5 viruses)
Rate of genetic change and factors affecting
Mechanisms of gene reassortment between virus subtypes

Solution Routes

What approaches could/should be taken to address the research question?

Continuing development of NGS-based whole genome sequencing
Effective deployment of 3rd -gen sequencing technologies for both wet- and dry-lab protocols, allowing point-of-incidence analysis
Maps of virulence signatures for artificial intelligence / machine learning algorithms that can better link genotype to phenotype
Molecular signatures in viruses associated with improved environmental stability (effect of ammonia , temperature) and vaccination
Sequences and metadata from viruses in a broad variety of hosts and under varied conditions
Sequences from IAV events in which various viral phenotypes are suspected (aerosol transmission, survival in the environment, multi-species infection, etc)

Dependencies

What else needs to be done before we can solve this need?

Improved data sharing of sequences – especially in real time
Mechanisms of intra-host virus evolution

State of the Art

Existing knowledge including successes and failures

Projects

What activities are planned or underway?

Special thanks to the participants to the workshop & (see full report)

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