



ANIMAL TRANSPORT: ADDRESSING DISEASE SPREAD AND ANTIMICROBIAL RESISTANCE THROUGH ONE HEALTH PERSPECTIVE

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What this session covers

1

See transport as a health & welfare issue

Recognize animal transport as a determinant of welfare outcomes, not just a logistics step – and understand the physiological mechanism behind it.

2

Connect transport to disease spread and AMR

Understand how movement, mixing and stress link to disease transmission and antimicrobial resistance.

3

Apply a One Health approach

Looking how animal, human and environment health perspectives, are interconnected to strengthen transport systems.

The scale of the problem

Live-animal transport is not a marginal activity.

- Chickens are the most-traded species by volume (1.3B+/yr), followed by turkeys, pigs and ducks.
- Buffalo trade is growing fastest (+26%/yr), ahead of geese, chickens and ducks.
- Europe is the largest overall trader; Asia dominates buffalo, goat, sheep and camel imports.
- Intercontinental trade is widespread — 8 of 12 species had 10%+ of trade cross-continent in 2021.

Source: Warne RK, Cleaveland S, Chaber AL. From barnyard to boarding pass: Exploring livestock's world tour. JSFA Reports. 2025; 5(4): 149–186.

**1.5
billion+**
live farmed animals
traded across borders
every year, worldwide

FAO / Faunalytics, 2025

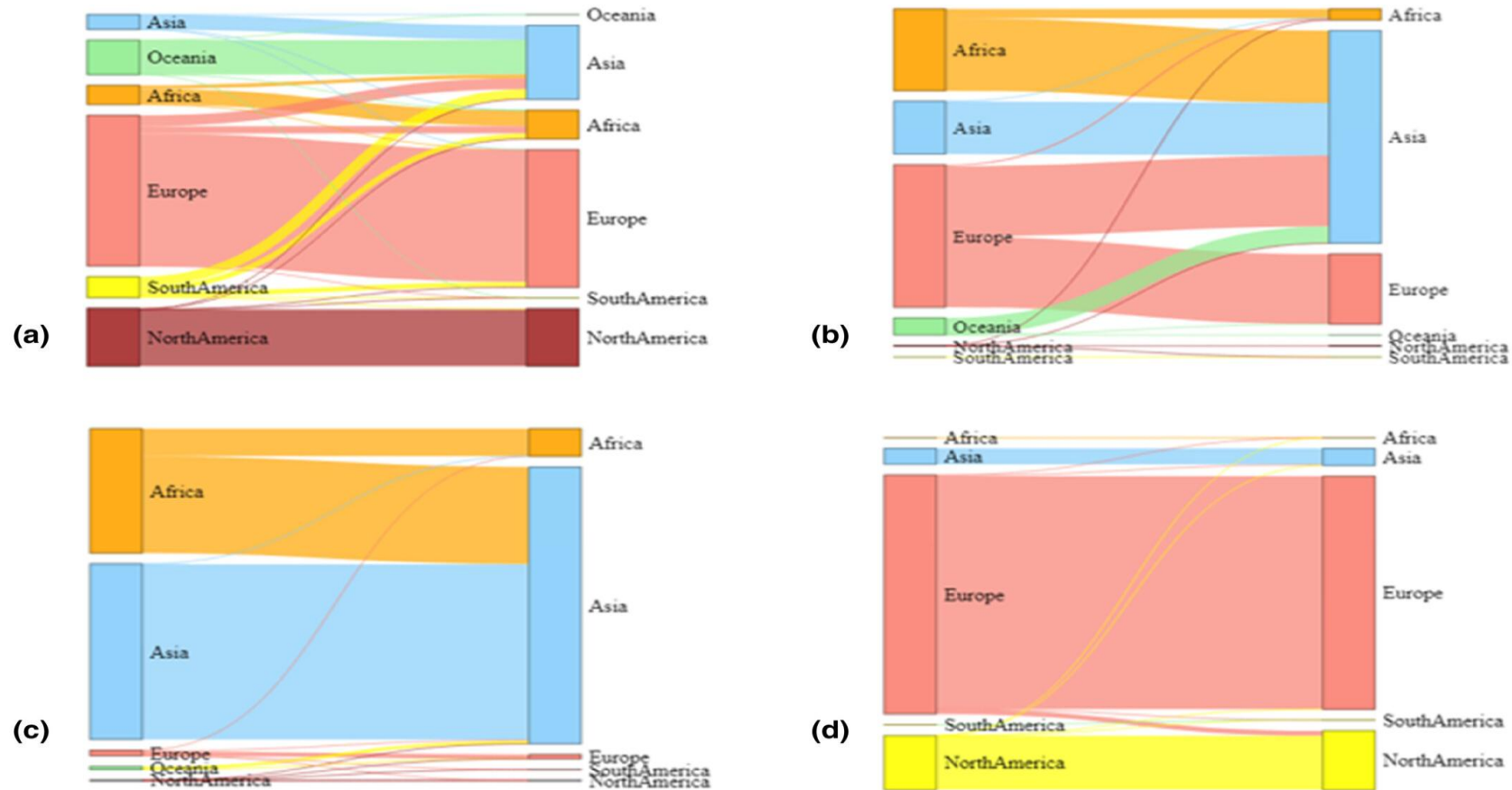
~9 million
live sheep & goats
projected to be
imported into SWANA
by 2028

Meat & Livestock Australia, 2024

Live-animal movement across SWANA is large, growing, and directly exposed to global AMR and transboundary-disease trends — which is exactly why transport sits at the centre of a One Health approach.

Species trade flows, 2021

Direction of international trade for cattle, sheep, goats and pigs — exporting continent (left) to importing continent (right).



Source: Warne RK, Cleaveland S, Chaber AL. From barnyard to boarding pass: Exploring livestock's world tour. JSFA Reports. 2025; 5(4): 149–186.

Regional logistics & volume

Massive regional volume

An estimated 15–20 million animals are transported annually into and within the SWANA region via maritime and overland corridors.

The East African pipeline

Somalia and the Horn of Africa are the highest-volume suppliers, moving millions of sheep and goats across the Red Sea to Jeddah, Saudi Arabia.

Long-haul maritime routes

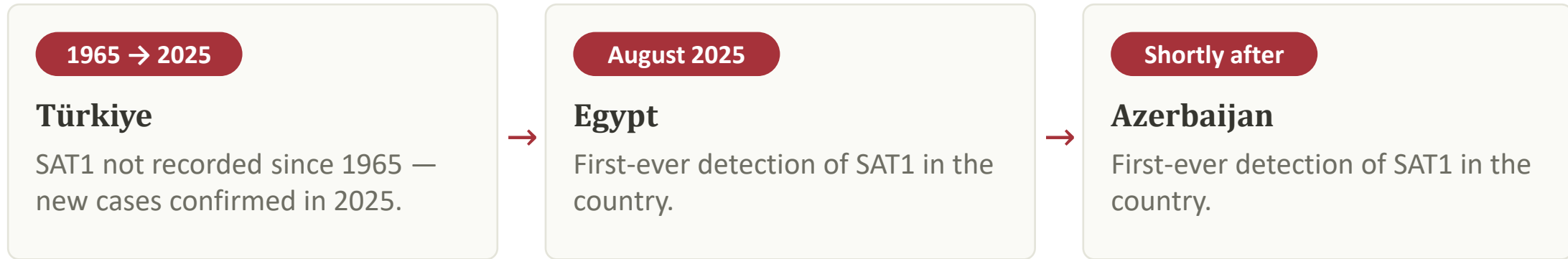
Australia, Brazil and Uruguay supply sheep and cattle via multi-week sea voyages — though Australia's sea-freight sheep ban by 2028 is depressing historical volumes.

European RoRo traffic

Romania, Spain and France transport millions of live cattle and sheep across the Mediterranean directly into North African ports (Morocco, Egypt, Libya).

Source: Warne RK, Cleaveland S, Chaber AL. From barnyard to boarding pass: Exploring livestock's world tour. JSFA Reports. 2025; 5(4): 149–186.

Transboundary disease: FMD serotype SAT1



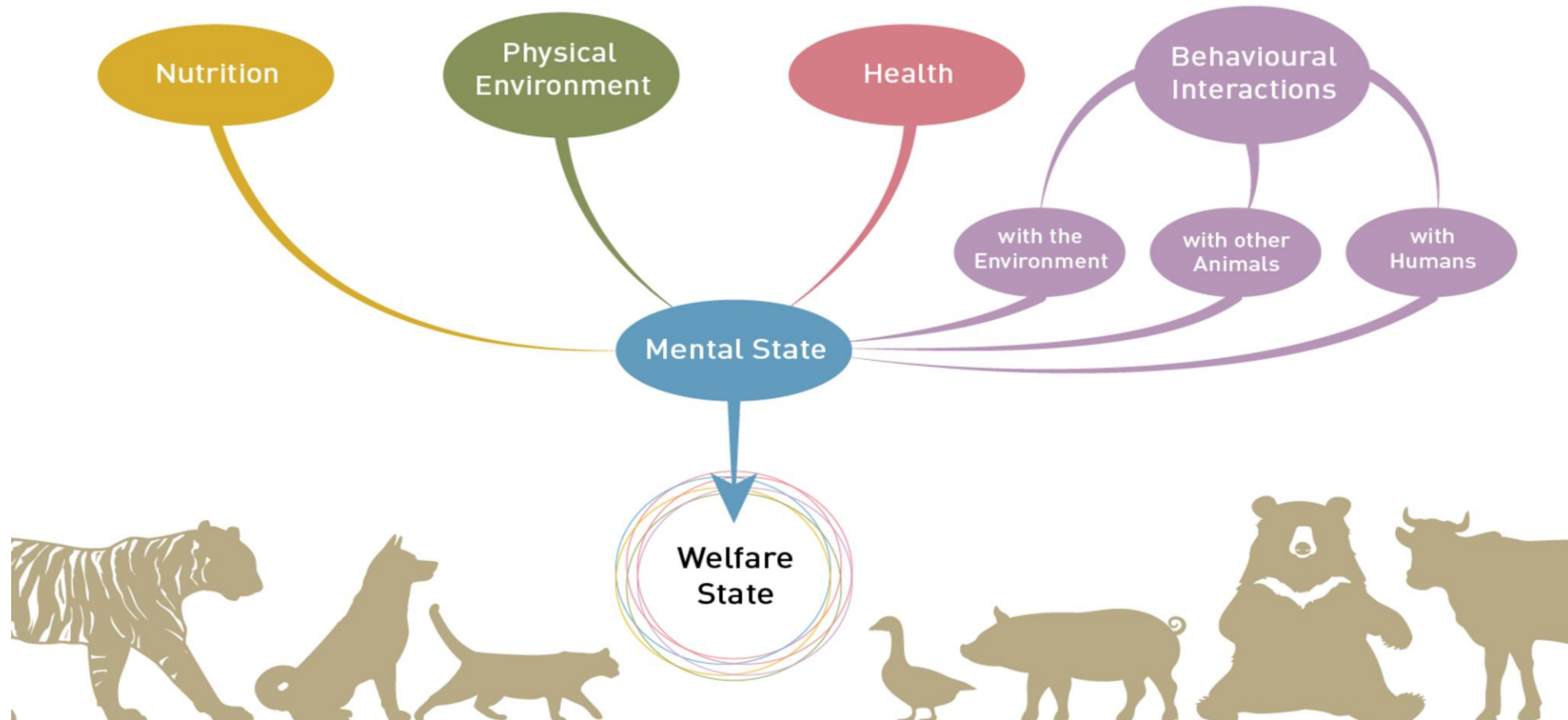
Spread could be attributed to transboundary livestock movement into populations with no pre-existing immunity to this serotype.

Ongoing exposure:

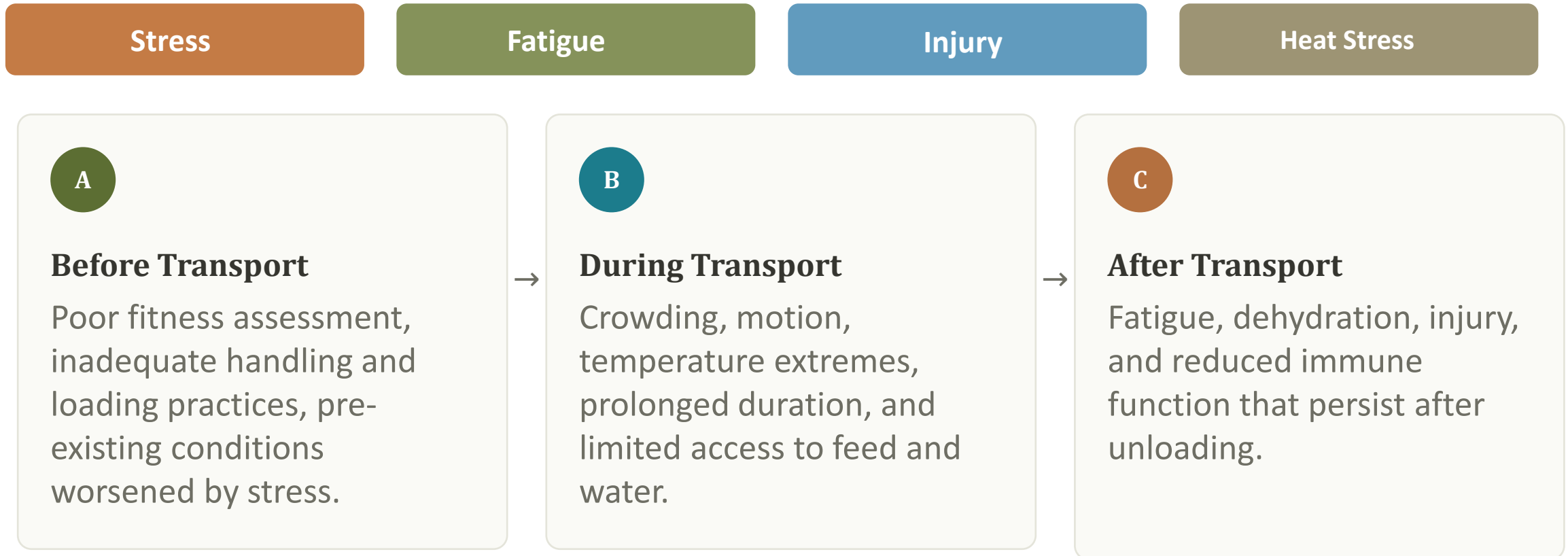
90+ WOA member countries currently lack officially recognised FMD-free status; the disease remains endemic across large parts of Africa, Asia and the Middle East.

A multidimensional concept

Welfare state is shaped by the interplay between nutrition, physical environment, health and behavioural interactions — all converging on the animal's mental state.

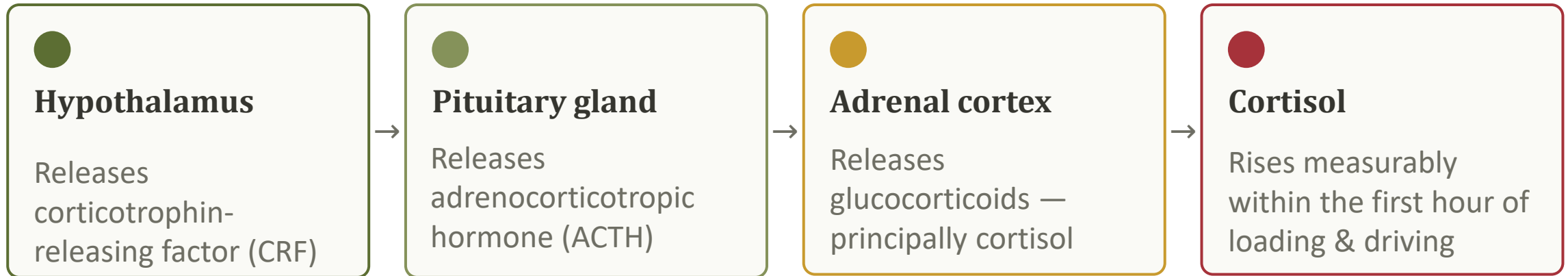


Welfare consequences occur across the full journey



The stress–immunity pathway: the HPA axis

The mechanism behind the welfare and AMR pathways: how a stressful journey becomes a weaker immune system.



Alongside cortisol: a broader stress signature

- Elevated heart rate and altered respiration
- Shifts in adrenaline / noradrenaline
- Changes in white blood cell counts
- Acute-phase proteins (haptoglobin, serum amyloid A) on longer journeys — signalling active inflammation

Cortisol is the physiological bridge between welfare consequences and the AMR pathway — the mechanism, not just a correlation. “Reduce stress” is a legitimate AMR-mitigation measure, not only a welfare one.

How cortisol suppresses immune function

Cortisol is immunosuppressive by design — it limits inflammation and conserves energy for an immediate physical challenge. In transported animals, three specific effects are documented:



Blunted antibody-T-cell coordination

Reduced expression of Fc receptors and T-cell growth factor production weakens the link between antibody responses and T-cell activity.



Impaired first-responder cells

Altered neutrophil gene expression changes apoptosis, tissue remodeling, margination and antibacterial killing — neutrophils become less effective at reaching and destroying bacteria.



Narrower adaptive response

Reduced lymphocyte responsiveness limits the animal's capacity to mount an effective response to a pathogen encountered during or after the journey.

Stress changes immune function in ways that raise disease risk.

From stress to illness: two documented pictures

Beef & stocker cattle — respiratory disease

- Transport stress suppresses respiratory-tract defences at the same time commingling exposes animals to new pathogens — letting bacteria and viruses establish in the lower airway.
- Result: Bovine Respiratory Disease (BRD), historically called “shipping fever” — the best-documented clinical consequence of transport stress in cattle.
- Recent nuance: some studies find increased inflammatory gene activity in the airway shortly after transport/auction stress — even before a pathogen is detected — the picture is shifting from “immunity switches off” to “immunity is dysregulated.”

Lactating dairy cows — a production-relevant twist

- The same cortisol-driven cascade applies — but in transported lactating cows it shows up directly in production data.
- A rise in circulating white blood cells occurs alongside a measurable increase in milk somatic cell count (SCC) — the standard indicator of udder inflammation and subclinical mastitis risk.
- Milk yield drops in parallel. Transport stress is not only a welfare abstraction — it shows up in a bulk-tank quality parameter within hours.

Stress changes immune function in ways that raise disease risk and the use of antimicrobials.

Fitness-for-transport is animal-specific

Unweaned calves

- Immunological gap: maternal (colostrum) immunity is waning while active immunity is not yet mature
- Underdeveloped herding instinct makes loading and handling harder
- Feeding-related digestive risk if loaded soon after milk feeding
- Guidance: ≥ 5 weeks old and $\geq \sim 50$ kg before long journeys

Animals under 12 weeks old lack the body fat and physical stamina required to cope with fluctuating temperatures inside transport vehicles

Between 33% and 96% of young calves are treated with antimicrobial during the first weeks after the transport

Mortality rates range from 0.06 to 0.7 % during the 24-30 h after arrival

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Pregnant animals

- Last 10% of gestation (or calved within a week) = unfit for transport under current guidance
- 1.5-hour transport of late-pregnant cows raised cortisol — 1 in 10 subsequently aborted
- **Dairy-specific:** a missed milking schedule raises udder pressure and mastitis risk

After **40% gestation**, the total weight of the uterus, placental fluids, and fetus increases dramatically

Pregnant animals face a significantly higher risk of losing their balance, falling, and suffering severe bruising or joint injuries.

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Old & cull animals — esp. dairy cull cows

- Most often culled for reproductive disease, lameness or mastitis — conditions that already limit mobility
- Highest probability of any cattle category of becoming non-ambulatory, going lame, or dying on long hauls
- Slaughter studies find poor body condition, bruising and untreated disease — many were not fit to leave the farm

Common thread: different specific causes, same underlying mechanism — reduced physiological reserve at the exact moment the HPA-axis stress response is most active.

Three pathways, one movement event



Direct transmission

Close contact between animals during loading, transit and unloading spreads pathogens directly.



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Mixing of sources

Animals from multiple origins and health statuses are combined at assembly points and markets.



Cross-border risk

Movement across jurisdictions can introduce or spread disease beyond a single country's control

Foodborne pathogen risk: stress, shedding, contamination

Salmonella and Shiga-toxin-producing *E. coli* (e.g. O157:H7) are often carried in the gut of healthy cattle without visible disease. The public-health risk arises at slaughter, when hide/faecal contamination reaches the carcass.

6% → 89%

Salmonella prevalence on hides,
farm to packing plant arrival

18% → 46%

Faecal Salmonella prevalence
over the same transport chain

- Transport and the pre-slaughter lairage period are consistently identified as shedding risk points — with transport trailers themselves testing positive at high rates, **implicating the vehicle as a cross-contamination site.**
- **Mechanism:** feed withdrawal, dietary change and transport stress increase recoverable *E. coli* and *Salmonella* from rumen and faeces — the same stress physiology as the HPA-axis pathway.
- Transportation may be **a potential stressor** for cattle as evidence by increasing shedding and cross-contamination risk of *Salmonella* spp.

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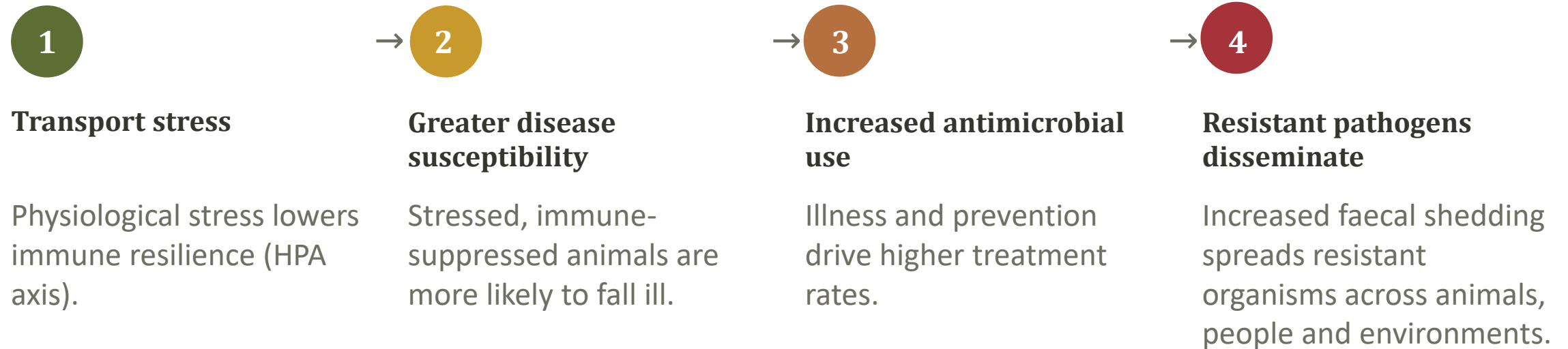
Where this connects to AMR

EFSA's 2022 scientific opinion names “increased faecal shedding” as a main risk factor for spreading resistant bacteria and resistance genes during transport.

If shed pathogens already carry resistance genes from prior on-farm antimicrobial use, the same hide-to-carcass pathway spreads resistant strains into the food chain — closing the loop between immune suppression, shedding and AMR.

From stress to resistant pathogens

Key point: cortisol via the HPA axis is the mechanism linking welfare consequences to the AMR pathway — not merely a correlation.



The full pathway, end to end

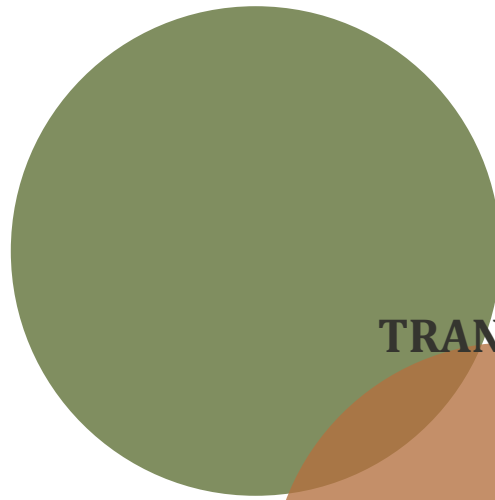
- 1 HPA axis activates → cortisol & stress hormones rise
- 2 Cortisol suppresses and dysregulates immunity (neutrophils, lymphocytes, mucosal defences)
- 3 Vulnerable animals (calves, late-gestation, cull cows) show a larger relative effect
- 4 Weakened defences raise disease susceptibility (e.g. BRD) and faecal shedding of resistant strains
- 5 Illness drives antimicrobial use; shedding & contamination spread pathogens into the food chain
- 6 Movement and mixing separately spread transboundary disease (e.g. FMD) across borders

Every step above is a point where veterinary action — fitness assessment, reduced journey duration, hygiene, rest, and prudent antimicrobial use — can interrupt the chain.

Transport sits at the intersection

Animal health

Welfare, disease exposure and productivity of transported animals.



Human health

Zoonotic spillover risk and exposure of handlers, traders and communities.

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Environment health

Spread of pathogens and resistant organisms via waste, water and shared spaces.

Transport sits at the intersection — decisions made there ripple across all three health domains.

Along the journey

A weakness at any single point can undermine welfare, biosecurity and antimicrobial stewardship for the whole journey.



Each control point maps to a step in the stress–immunity pathway — fitness assessment limits who is exposed to stress at all; loading, transit and rest stops limit how much cortisol rises; unloading assessment catches what got through.

Four responsibilities across the journey

1 Fitness Assessment

Determine whether each animal is fit to travel before the journey begins.

2 Biosecurity Advice

Guide loading density, hygiene, and cleaning/disinfection of vehicles and facilities.

3 Disease Surveillance

Monitor for signs of illness before, during and after transport, and report findings.

4 Antimicrobial Stewardship

Promote prudent, evidence-based use of antimicrobials to limit AMR selection pressure.

Three organising principles

1

Prevention-Focused

Standards emphasize preventing welfare, disease and AMR problems before they occur, not only reacting to them.

2

Risk-Based Management

Measures are proportionate to the disease and welfare risk of the species, route and journey conditions.

3

Shared Responsibilities

Competent authorities, veterinarians, transporters and handlers each hold a defined role across the journey.

Reflected across WOAH's Terrestrial Animal Health Code chapters on animal welfare during transport and on AMR/antimicrobial use.

Five actions across the journey

1

Improve fitness assessment

Standardize pre-transport veterinary checks, and vulnerable animals not be transport

2

Strengthen biosecurity

Enforce cleaning, disinfection and separation of sources.

3

Reduce stressors

Reduce transport duration, manage density, heat and improve handling.

4

Enhance surveillance

Track illness and outbreaks across the journey.

5

Promote prudent antimicrobial use

Reserve treatment for justified clinical need.

Together, these five actions target every stage of the transport journey — from fitness assessment to arrival.

The chain, restated simply



A One Health approach strengthens animal, human and environment outcomes together.

Every fitness check, biosecurity measure and prudent antimicrobial decision along the journey is a One Health decision.



Animal Welfare.
Worldwide.



THANK YOU FOR YOUR ATTENTION!

FOUR PAWS is the global animal welfare organisation for animals under direct human influence, which reveals suffering, rescues animals in need and protects them. Founded in 1988 in Vienna by Heli Dugler and friends, the organisation advocates for a world where humans treat animals with respect, empathy and understanding. The sustainable campaigns and projects of FOUR PAWS focus on companion animals including stray dogs and cats, farm animals and wild animals – such as bears, big cats and orangutans – kept in inappropriate conditions as well as in disaster and conflict zones. With offices in Australia, Austria, Belgium, Bulgaria, Cambodia, France, Germany, Kosovo, the Netherlands, Switzerland, South Africa, Thailand, Ukraine, the UK, the USA and Vietnam as well as 13 wild animal sanctuaries and cooperation projects across the globe, FOUR PAWS provides rapid help and long-term solutions.

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