# **Module 9: Disease Control and Prevention**

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**Key Concept**

1. Use epidemiologic evidence to control and prevent disease.

## **Use epidemiologic evidence to control and prevent disease**

### **Epidemiology and Clinical Decision-Making**

Many concepts in epidemiology including disease measures and test characteristics inform veterinary clinical decisions and patient/population management on a daily basis. Animal exposures and risk combined with surveillance data can guide decisions regarding vaccination and other preventive measures. Routine disease monitoring can alert the clinician to disease outbreaks and prompt infection control actions in the clinic setting or within an animal population.

### **Disease control programs**

Important animal diseases are managed through prevention, control, or eradication programs depending on the situation, including whether the disease occurs as an endemic, emerging, or transboundary disease. When these programs are developed, their need must be clearly justified, including development of clear objectives and expected impacts.

Depending on the type of disease and objectives of the program, different management interventions may be considered (vaccination, movement control, cull of positive animals, vector and reservoir control, etc.).

#### **Disease control concepts** (Use epidemiology concepts learned in class)

* Consider sources of infection (reservoirs), transmission pathways, and susceptible populations
* Consider agent-host-environment determinants of disease in individuals, while evaluating time, location, and individual aspects of disease across populations.
* Characterize the disease
  1. Measure disease in defined populations (where it is and where it isn’t) using available tests.
  2. Evaluate the predictive value of results from tests.
* Identify factors associated with disease and evaluate which factors may be causal.
* Have a Good Management Practices (GMPs) tool-box available for disease control and prevention (See **Figure** below)
  1. Disease disinfection
  2. Segregation
  3. Vaccination
  4. Hygiene
  5. Depopulation
  6. Treatment

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### **Case 9.1. Colic in horses**

Colic can be defined as acute disease of the equine abdomen associated with signs of pain, and lesions associated with colic may be categorized as obstruction, strangulation, nonstrangulating infarction, enteritis, peritonitis, ulceration, or ileus. Case fatality risk has been reported to vary from 6-84%.

Due to this high case fatality risk, efforts to control the incidence of colic through preventive practices seem warranted. Many have hypothesized that certain nutritional practices predispose to colic, but which practices? Or perhaps is increased risk associated with a previous nutritional change (rather than specific changes) as one of the components of a sufficient cause (a risk factor) leading to colic.

In an attempt to control colic in an equine population, 1427 horses on 31 farms were followed for up to 1 year. These data indicated that the incidence of colic was 104 colic cases / 358,991 horse-days at risk (10.6 colic cases / 100 horse-years at risk). Source: Tinker. 1997. Equine Vet J. Risk factors for equine colic. 29:454-458.

**How strong is the association between nutritional change in the previous year and colic incidence?** Records showed the following:

|  | **Colic developed** | **No colic developed** | **Total** |
| --- | --- | --- | --- |
| **Nutritional change** | 70 | 370 | 440 |
| **No nutritional change** | 34 | 509 | 543 |
| **Total** | 104 | 879 | 983 |

The incidence of colic in horses:

· With nutritional change in previous year = 70 colic cases / 440 horse-years at risk.

· Without nutritional change in previous year = 34 colic cases / 543 horse-years at risk.

Relative Risk (RR) = (70/440) / (34/543) = 2.54

Interpretation: If a horse has a nutritional change in previous year, it was 2.54 times more likely to develop colic compared to horses without nutritional change.

Nutritional change in horses seems to predispose to colic development. **Is this association statistically significant?**

One way to evaluate statistical significance is through use of **p-values from hypothesis testing**. For example, p=0.01 provides a 1% probability that the observed difference between 2 groups was due to chance alone. P-values can be generated through use of statistical hypothesis testing (for example the **Chi-square test of independence**).

**Null hypothesis (HO):** There is no difference in the incidence of colic between horses with or without nutritional change.

**Alternative hypothesis (HA):** there is a difference … (two sided)

**Is this apparent association statistically significant?**

If risk factor has no effect, then we expect (blue values in table, compared to the observed values in black):

|  | **Colic developed** | **No colic developed** | **Total** |
| --- | --- | --- | --- |
| **Nutritional change** | **70**  **47** | **370**  **393** | **440** |
| **No nutritional change** | **34**  **57** | **509**  **486** | **543** |
| **Total** | **104** | **879** | **983** |

Chi-square test statistic = 23.9 with 1 df. Since 23.9 > 3.84, the p-value < 0.05.

Therefore, reject the HO and accept HA. The authors concluded that there was a statistically significant association between nutritional change and incidence of equine colic.

Note: A second way to evaluate statistical significance is through use of **confidence intervals (eg., 95% CI).** These are usually calculated using a computer software program since are laborious by hand.

In this case, with a RR=2.54, the 95% CI = (1.7 – 3.8). This is interpreted as the following: If the study were repeated many times, we expect 95% of the RR estimates to lie between 1.7 and 3.8. Since 1.0 (the no association level) is not included in the interval, we conclude there is a significant difference in the incidence risk between the 2 groups beyond that due to chance.

Further, the **Risk difference** between the groups with and without nutritional change in the previous year:

= (70 / 440) – (34 / 543)

**= 0.159 - 0.063 = 0.096**

This indicates there was a 9.6% additional incidence of disease in the sample attributable to nutritional change in the previous year.

The **Population attributable risk** for nutritional change in the previous year for causing colic

= 0.096 x (440/983) = 0.96 x 0.45 = 0.043

This indicates that the incidence of colic in population attributable to nutritional change in the previous year was 4.3 / 100 horse-years at risk.

Finally, the **Population attributable fraction**

= 0.043 / (104/983) = 0.043 x 0.11 = 0.39

Indicating that 39% of colic in this population was attributable to nutritional change in the previous year.

In summary, this example shows the critical role that nutritional changes can play in the incidence of colic in horses, and the value of minimizing nutritional changes to control disease incidence.

### **Surveillance**

In managing diseases, there is nearly always a surveillance component involved, which can have a variety of objectives.

**Animal health surveillance** can be defined as the ongoing systematic collection, collation, analysis, and interpretation of data and dissemination of information to those who need to know so that disease control actions can be taken when needed.

Surveillance activities can have multiple objectives, such as:

* Establish the baseline situation or magnitude of a problem.
* Investigate the geographic and demographic extent of an outbreak and predict possible spread.
* Identify unusual clusters of disease that would allow its early detection.
* Generate hypotheses that can be further investigated.
* Detect changes in health practices, risk factors, or exposures.
* Monitor disease agents or isolation activities.
* Evaluate control measures and intervention efforts.

Depending on how the data is collected, surveillance can be classified as passive or active.

* **Passive surveillance** is based on the analysis of compiled records accumulated through existing programs, such as veterinary diagnostic laboratory records and veterinary clinical records). This type of surveillance typically does not allow calculation of accurate measures of disease occurrence (prevalence or incidence) since information on the population at risk (denominator) is usually missing. It is based on the cooperation of the involved places of data entry (laboratories, veterinary hospitals, slaughter plants) and it does not involve active search for cases, and therefore it is may be difficult to obtain timely diagnosis of emerging diseases through this type of surveillance.
* **Active surveillance** involves the pro-active sampling and testing of animals at different points. For food animals in the production chain, this could include the farm, the market, or the slaughter plant. If adequately conducted, active surveillance provides scientifically valid information on the disease status of a population at a given time, but it is much more costly than passive surveillance, particularly in the case of rare diseases that require large sample sizes for its detection.

The purposes of surveillance are rapid detection of introduced diseases and emerging issues, monitoring and providing actionable information for endemic diseases, and measuring regional prevalence of trade-significant diseases. When a disease is considered foreign, the main purpose of surveillance is its rapid detection on domestic soil and monitoring the risks associated with domestic outbreaks, as well as to document disease free-status. If the disease is present in a country or region, surveillance systems will allow assessment of the progress in eradication and control efforts. In any case, outbreak detection is usually one of the expected outcomes of surveillance activities.

**Syndromic surveillance** uses existing data in real time to monitor the frequency of illness with a specified set of clinical features. This type of surveillance often allows for the identification of disease clusters prior to a confirmed diagnosis.

When evaluating a surveillance system and its applicability, one should assess multiple factors, including: the type of surveillance, how data is acquired, objectives of the surveillance system, stakeholders, resources, limitations and biases, usefulness, and information that can be gained from the system.

### **Outbreak investigation**

When an outbreak is suspected, the first step is to **verify that there is in fact an increase in the occurrence of a certain disease** in a defined space and time (cluster of cases in space and time above what is expected).

In order to do this, it is critical to work with a well-established **case definition** that should define simultaneously:

* The characteristics of the population at risk (the denominator, the population from which cases originate), and
* The specific traits that distinguish the cases from the other members of the population at risk (the numerator, what makes cases stand out).

Therefore, a good **case definition** should include criteria for:

* **Individual factors** (“non-vaccinated dogs below 6 months”),
* **Place factors** (“in the Twin Cities area”),
* **Time factors** (“showing symptoms in the last 2 months”), and
* **Clinical signs** (exhibiting 2 or more clinical signs of the following: high temperature, coughing, sneezing and nasal/ocular discharge) features.

Once the case definition has been established, it will be possible to **describe the outbreak in space and time** depending on the level at which the investigation is being carried out (i.e., at the premises level vs. the regional level). The observation of how disease has evolved will allow the **development of hypotheses** about the likely source(s) of the outbreak. For example, all the diseased animals were vaccinated last week, or were housed with animals that just entered the farm; or all the positive farms had sent animals to the state fair that took place the previous month.

If there is enough information available, **data analysis** can be conducted to test the hypotheses formulated in the previous step (for example, verify if there is a biologically and statistically significant association between becoming diseased and being vaccinated last week) so that risk factors can be effectively identified. If the evidence is strong enough, this can lead to the implementation of prevention or mitigation measures to control, restrict, or terminate the outbreak.

#### **Steps in Outbreak Investigation** (Stevenson, 2008)

1. Verify the outbreak
   * What is the illness observed?
   * Is there a true excess of disease?
2. Investigating an outbreak
   * Establish a case definition
     1. Specify characteristics of the population at risk.
     2. Specify what distinguishes cases from other members of the population.
3. Enhance surveillance to identify additional cases
4. Describe outbreak according to individual, place and time
   * Record the physical layout of the premises.
   * Record the animal `calendar' intended by management for the relevant animals.
   * Record the policy that determines when or why animals are routinely moved from one group to another during normal operation.
   * Obtain specific information on practices used.
   * Collect historical, clinical and productivity data on those individuals that are affected (cases) and those that are not affected (non-cases).
   * Plot an epidemic curve by identifying the first detected case (index case) and then graphing subsequent numbers of cases through time from the index case through to the end of the outbreak. Does the epidemic show common source or propagated properties?
5. Develop hypotheses about the nature of the exposure to identify potential risk factors.
6. Conduct analysis to identify risk factors associated with the disease.
   * Calculate the risk ratio (RR) of disease for each exposure.
7. Implement disease control interventions.
   * Provide written and verbal instructions to your client detailing your approach to controlling the outbreak.
   * Ensure appropriate measures are taken to monitor the response to interventions.