RESPONSIBLE USE OF MEDICINES IN AGRICULTURE ALLIANCE

ruma

GUIDELINES

Responsible use of vaccines and vaccination in poultry production

A farm health planning initiative in partnership with DEFRA

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Background

The Responsible Use of Medicines in Agriculture Alliance (RUMA) is a coalition of organisations including agricultural, veterinary, pharmaceutical and retail interests. This guideline is one of a series of species-specific documents developed by RUMA. Initially RUMA came together to address issues of the use of antimicrobials in agriculture, and has published a summary and detailed guidance aimed at promoting responsible use of antimicrobials (available at www.ruma.org.uk). This guidance advised that farmers should regard therapeutic antimicrobial products as complementing good management, vaccination, and site hygiene. It went on to repeatedly refer to the role of vaccination in reducing the need for antimicrobial medication. It is logical, therefore that we should, in this document, go on to consider vaccines and vaccination in more detail.

Vaccines are the most commonly administered veterinary medicines in poultry production. In fact, vaccines and vaccination have had a major impact on the development of the poultry industry, allowing economic and effective control of diseases that had previously limited its development. They are not, however, panaceas for all problems of infectious disease, but should be looked on as useful tools as part of an overall programme of poultry health maintenance.

The Immune System and its Response to Infection

All vertebrates have mechanisms for controlling pathogens – those organisms which are capable of causing disease (see RUMA Guideline *Responsible use of vaccines and vaccination in Farm Animal Production*). There are 2 fundamental parts :

1. Innate mechanisms 2. Adaptive mechanisms

1. Innate mechanisms. Innate mechanisms require no previous exposure to the particular agent – this includes physical barriers such as the mucosal surfaces and mucus layers, specialised cells such as macrophages and natural killer cells and particular soluble molecules such as complement, interferon and cytokines. Some of the elements of the innate defence mechanisms interact extensively with the adaptive mechanisms, which, though present in most vertebrates, are particularly well developed in mammals and birds.

2. Adaptive mechanisms. When a bird is vaccinated, or exposed to a viral or bacterial infection, a complex biological mechanism is set in motion that normally results in the elevation of the bird's specific defences against the disease in question. Sometimes this process also raises non-specifically its defences against other infections by activating components of the innate immune system. The immune response is generated by a complex system of specialised cells, the lymphocytes.

The serological tests measure only one component of the immune response, the antibodies circulating in the blood. Antibodies are proteins with one or more binding sites which attach to a specific site on a pathogen. The other main components of the immune system, which are not measured by standard serological tests, are antibodies produced and secreted locally (in tears, tracheal mucus, on the intestinal mucosa etc.), and the cellular immune response or delayed hypersensitivity.

Hieronymus Fabricius described the location and structure of a diverticulum of the avian cloaca in the late 16th century. It took almost another four centuries before the real significance of the bursa for the development of immunity in birds was recognized, and work on the chicken was fundamental to this understanding. It was found that cells developing in the bursa and those developing in the thymus had different functions in the immune response – the B and T lymphocytes. Both thymus and bursa have a role in producing or controlling the production of the antibody which we measure in serological tests. The separation of the two central maturing organs which is present in the fowl has led to its use as a model for the investigation of many basic immunological phenomena .

How the Immune System Defends the Body

The process involved is complicated and is briefly summarised in summarised in the RUMA Guideline *Responsible use of vaccines and vaccination in farm animal production*.

In embryonic development, birds produce a massive array of lymphocyte populations with varying receptor structures. Those that bind with the normal proteins of the body are selected out so that they do not react with the normal proteins of the body. Those that remain are available to react to foreign proteins, or antigens, when they are encountered in later life. Normally the first stage in the process is that cells such as macrophages ingest the foreign protein, break them into chunks, bind them to specialised proteins of the 'major histocompatibility complex" (MHC) and present them on their surface. The particular population of T lymphocytes with the specific receptor to recognise the specific antigen/MHC complex, binds to it and activates the immune reaction. This involves the secretion of chemical signals, called **lymphokines**. These stimulate the multiplication of specific populations of B and T cells. The **B lymphocytes** also have receptor molecules but can react to free antigen. Their activation leads to the production of a population of plasma cells that secrete **antibody** proteins, which are a soluble form of their receptors. Once the initial challenge has been dealt with, a group of cells (the so-called "memory" cells) that have the required genetic make-up to produce antibody against the specific antigen, remain. Five days or so are generally required for the immune system to respond to the initial challenge but these cells allow a much more rapid and vigorous response to the secondary stimulus. This is known as an "anamnestic" reaction.

The antibodies which are secreted at mucosal surfaces are designated IgA, while IgM and IgG circulate in blood and lymph. IgY is the bird equivalent to the IgG molecules found in mammals. They have the same general structure and function but some biochemical differences. They were designated IgY because they were originally isolated from egg yolk. The adult egg-laying chicken has a prodigious capacity for antibody production. It has been calculated that its weekly production is equivalent to the antibody content of 90-100ml of serum. The classes of antibody have varying chemical structures and numbers of attachment sites per molecule. Serological tests also vary in their ability to detect the different antibody classes. Once the initial challenge has been dealt with, a group of cells remain (so-called "memory" cells) which have the required genetic make-up to produce antibody against the specific antigen.

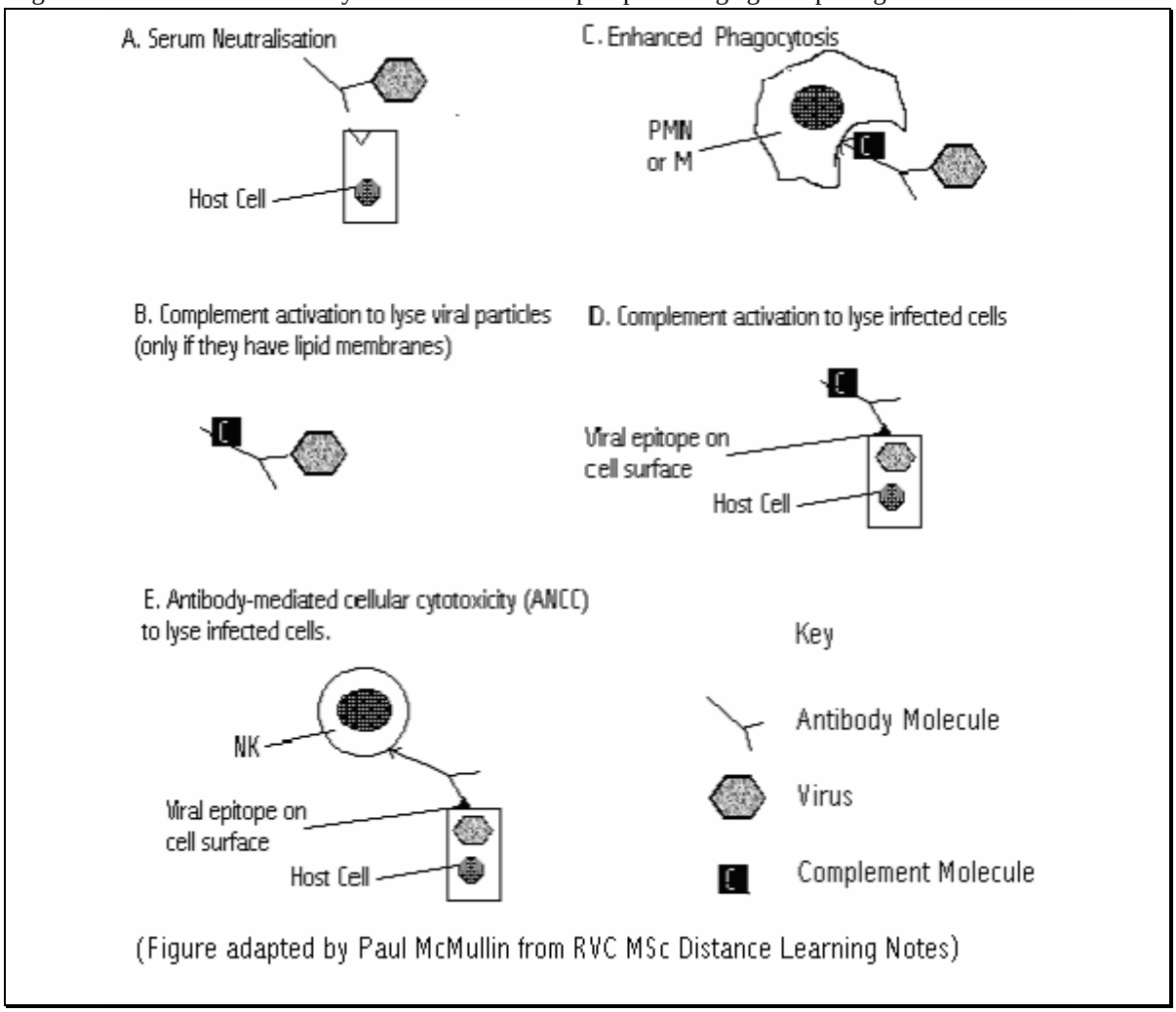
Antibodies work closely with other components of the innate and acquired immune systems to help protect against pathogens. They act by a range of mechanisms, the relative importance of which can vary with the species and pathogen. Figure 1 summarises the main mechanisms.

A. Neutralisation. The function of some of the surface structures (or epitopes) of the pathogen (e.g. those of the haemagglutinin antigen of Newcastle disease virus) is to attach the agent to the cell membrane of a target cell to allow insertion of the viral nucleic acid within the cell. Virus neutralising antibodies can combine with such epitopes and prevent infection of cells. Since viruses, unlike most bacteria, need to be able to infect cells in order to multiply, this is a potentially important way of limiting viral multiplication. The greater the period of exposure of the infecting virus to antibody the greater the effect. For this reason this mechanism is more effective for viruses which have to travel long distances in the body in order to reach target cells.

B. Lysis. Some large viruses with lipid membranes may be broken down when antibodies attach to the membranes then bind and activate complement. This mechanism is also effective with some bacteria and parasites

C. Opsonisation. Many cells of the innate immunity system (e.g. polymorphonuclear cells and macrophages) have receptors for the Fc area of antibody molecules. Virus is more readily phagocytosed when it is bound to antibody because the antibody can bind with the membrane receptors on these cells. Once phagocytosed the viral particles may be broken down by enzymes.

Figure 1 Various mechanisms by which antibodies help in protecting against pathogens



D. Complement activation to destroy infected cells. Antibody binds to components of antigens expressed on the surface of infected cells. This can initiate complement activation to destroy the infected cell. In the case of viral infection,, many of the particles released in destroying the cell will be incomplete, hence non-infective, and easily removed by phagocytosis.

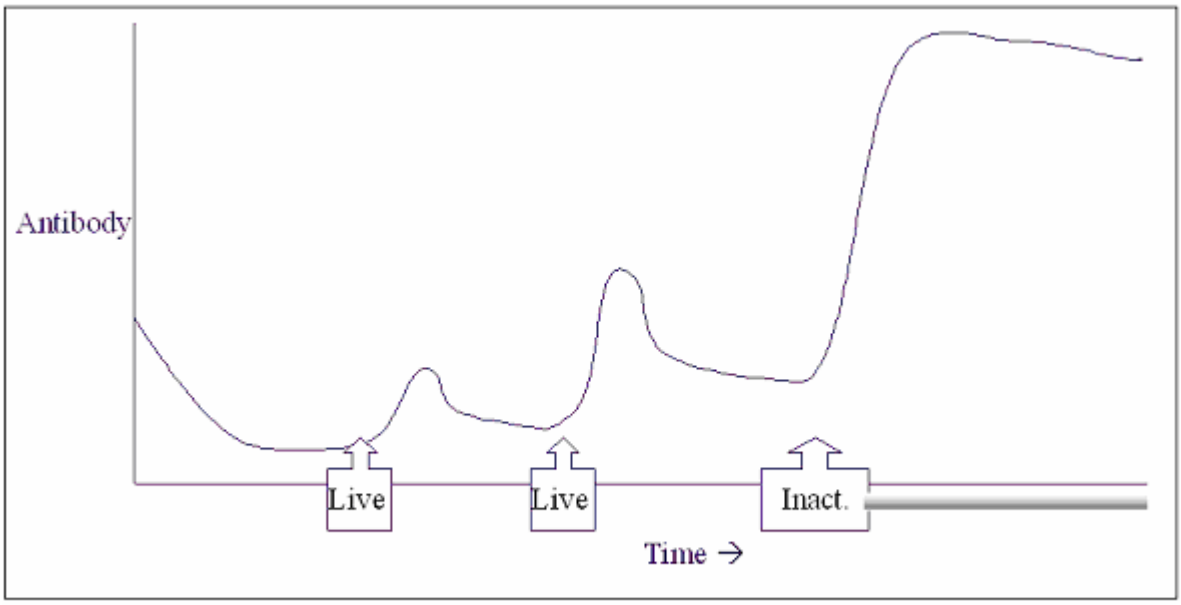
E. Natural killer cell activation to destroy virus-infected cells. In addition to activating complement as described in the previous paragraph , the Fc chains may bind to receptors on NK lymphocytes and activate them to kill virus infected cells (through local secretion of enzymes).

The relative importance of the different mechanisms varies with the type of pathogen. For parasites such as coccidiosis, circulating antibody has relatively little impact on immunity and the major mechanisms of local immunity are those designated as B, C and E in the figure above.

The net effect of all of the above mechanisms acting in immune animals is that infecting viruses have greater difficulty infecting target cells (due to neutralisation, phagocytosis and lysis) and in replicating in target cells (due to their lysis as mediated by killer cells or complement). This should not be taken to imply that cellular immunity is of no importance. In the intact animal both antibody-based and cellular immunity work in close harmony to control infection. While we tend to use the circulating antibody response to vaccination to visualize and understand the immunological response, we need to keep in mind that it is only one facet of what we are achieving with vaccination.

The response to any particular disease challenge or vaccine depends to a very large extent o previous exposure to the same micro-organism or a closely-related one. Figure 2 below shows an idealised representation of the antibody response to a particular, if fairly typical, vaccination programme, representing the rearing period of, for instance, a parent chicken. The high antibody at the left hand side, representing day-old, is a result of the antibody transmitted in the yolk from the parent of the breeding chicks. A live vaccine administered after the antibody level falls off results in a small and transient rise in antibody levels. When the same or a similar live vaccine is given some weeks later the response is more rapid, and higher, because the immune system ‘remembers’ the previous infection (the ‘anamnestic reaction’. However, if the vaccinal infection is very uniform and does not recirculate in the flock, this response can also fall off. When an oil-based inactivated vaccine is given prior to lay then an even higher response is achieved. Because these vaccines result in a long-lasting deposit of antigen in the tissues this response tends to remain a long time, only falling off very gradually as the flock ages. Not all vaccines and infections behave to this ‘norm’ – some, chick anaemia virus, for instance, normally induces high levels of antibody for long periods, even without the use of an inactivated vaccine.

Figure 2 – A typical vaccination programme and serological response. The immune response is 'primed' by the administration of live vaccines, and boosted with an inactivated vaccine.



(Figure by PaulMcMullin)

Objectives of vaccination

The main objective of vaccination is to increase the specific immunity to infections to which the vaccinated poultry are likely to be exposed so that, when challenged, they either do not suffer the disease, or suffer to a much lesser extent than if they had not been vaccinated.

This general objective applies to the individuals of a vaccinated population, just as it does to whole populations, pens, houses, farms, and companies. The associated economic objective is to ensure that, on average, the cost of the vaccines purchased, their application, and any loss of productivity caused by their application, is less than the cost of the disease if vaccines are not used.

In order to achieve the general objective a series of component objectives may be identified. These may vary to some extent with the particular type of production, and disease.

- The appropriate vaccine should have been tested and confirmed to be efficacious when properly administered
- It should be available on the market in the required amounts and of consistent quality
- It should be sufficiently stable in normal storage and application
- Practical methods of administration should be available, and any required equipment procured and properly maintained.
- Farmers, farm staff or contractors should have been properly trained in their application
- The stock should not be suffering an immuno-suppressive disease capable of blocking the response to vaccination

- The timing, dose, repeat administration, should have been reviewed and chosen to avoid adverse interaction with other vaccines and management activities, and optimise the response.
- A system of monitoring response to vaccination, where practical and appropriate, should have been implemented.
- Appropriate biosecurity should have been implemented to reduce the risk of the immunity being overwhelmed by excessive challenge.

In poultry production vaccination is most commonly applied in order to protect the stock on the particular farm being vaccinated. However it may be applied for the benefit of the future owner of the stock. Examples of this are vaccinations of the day-old chick in the hatchery, or pullets being reared for sale to a third party. It may even be applied for the benefit of a future generation when, for instance, breeding chickens are vaccinated in order to confer immunity to their progeny during the first few weeks of life. In all such circumstances it is important to maintain a dialogue among the interested parties to ensure that the required vaccinations are applied.

Types of diseases controlled with vaccination

Vaccines are used in poultry production to control clinical disease (in which there is obvious illness and/or mortality) or sub-clinical disease (in which the birds may appear on inspection to be normal but are not producing eggs or meat as normal birds do).

The occurrence of clinical disease is the usual trigger for the introduction of a vaccine in a programme, and the perceived benefit in reduction of clinical disease (number of cases, proportion of birds affected, level of mortality) will usually be the basis on which the maintenance of the vaccine in the programme is decided. However some poultry infections (mycoplasmosis for example) can have significant economic impact through their sub-clinical effects. In other cases many factors may be involved – here the objective is to determine the measures (which may include vaccination) which produce the optimal economic response.

Control of diseases that affect the immune system is particularly critical if we are to reduce the impact of other diseases, and ensure a satisfactory response to vaccination. Examples of such diseases are Marek's disease, infectious bursal disease, chick anaemia infection and avian leucosis. The poultry industry has appreciated the importance of controlling such diseases for the last 30 years.

Vaccines may be directed at diseases caused by viruses, mycoplasma, bacteria or parasites. Table 1 below summarises diseases of poultry for which there are currently vaccines approved in the U.K. The reader is referred to the link to the National Office for Animal Health in the section on further reading for up-to-date information. In effect all infectious and parasitic diseases are potential targets for vaccination. Whether or not vaccines are developed, marketed and used will depend partly on the technical feasibility of vaccine development and then on whether the disease is sufficiently common and of sufficient impact to justify the cost of the vaccine and its application.

Table 1. Disease for which licensed vaccines are available in the UK. (L) indicates live vaccines while (D) those which are inactivated, or, dead.

	Chicken	**Turkey**	**Waterfowl**
Bacteria	E.coli (D) Erysipelas(D) *Mycoplasma gallisepticum (D)* *Pasteurella multocida (D)* *Salmonella enteritidis (L/D)* *Salmonella typhimurium (L/D)*	Erysipelas(D) *Pasteurella multocida(D)*	Erysipelas(D) *Reimerella (D)* *Pasteurella (D)* *Salmonella enteritidis (L/D)*
Parasites	Coccidiosis (L)		
Viruses	Avian encephalomyelitis (L) Avian reovirus (D) Avian rhinotracheitis (L/D) Chick anaemia disease (L) Egg drop syndrome 76 (D) Infectious bronchitis (L/D) Infectious bronchitis variants (L/D) Infectious bursal disease (L/D) Infectious laryngotracheitis (L) Marek's disease (L) Newcastle disease (L/D)	Avian rhinotracheitis (L/D) Haemorrhagic enteritis Newcastle disease (L/D) Paramyxovirus 3 (D)	Duck virus hepatitis (L) Goose parvovirus (L)

Types of vaccines

It is possible to classify vaccines according to the nature of the pathogen (as shown in Table 1) – viral, bacterial or parasitic. However this does not really further our understanding of how vaccines work or should be used.

It is more useful to categorise vaccines into:

- Live
- Inactivated
- Recombinant
- Nucleic Acid

Until recently only the first two categories were available.

1. **Live Vaccines**. These contain live viruses, bacteria or parasites. They are nearly always weakened (or 'attenuated') in some way to ensure that they do not induce significant disease when administered. They can sometimes be found as naturally weak strains in poultry populations. Sometimes a related pathogen, even from another species, may be used to vaccinate. Jenner discovered that cowpox infection prevented smallpox in man in the 17th century – in fact this is where 'vaccination' comes from – vacca is latin for cow. The same technique is still used today when we apply herpesvirus of turkeys (HVT) to protect chickens from Marek's disease. However, more commonly they are grown through multiple generations in an artificial culture system (such as cell cultures, embryos, or artificial media) so that they become poorly adapted to grow in the target host. The approach was actually developed in the 18th century by Pasteur – amongst other diseases, he used old, possibly live, cultures of *Pasteurella multocida* to protect chickens against fowl cholera. Live vaccines cause infection with living organisms, which then, to a greater or lesser extent, multiply in the host and the resulting infection induces an immune response. This ability to multiply in the host means that effective live

vaccines can contain a very low dose of the agent, making them less expensive to produce than some other vaccines. Some live vaccines are capable of lateral, bird-to-bird, spread and can, thus achieve some protection even in those birds which do not receive an adequate dose initially. Only live vaccines can currently be administered by so-called mass-administration – by drinking water or as aerosols or sprays.

2. **Inactivated Vaccines**. These are also often described as 'dead' vaccines – as their name implies, they do not contain live organisms. To manufacture these the pathogen must be grown in large amounts in the laboratory then inactivated, usually by a chemical treatment. Because they contain no live organisms, they do not multiply in vaccinated birds or spread between birds in the flock. They therefore must be applied to each individual bird by injection. They nearly always contain something to stimulate the immune system locally at the site of injection. These compounds are called 'adjuvants' and the two most common types are mineral oils and aluminium hydroxide. Oil-based inactivated vaccines are usually formulated as an emulsion (either oil-in-water or water-in-oil). Because of the need to have a high content of the antigen, inactivated vaccines tend to be expensive. Uniformity of application (both in terms of % of birds injected and volume injected in each) is critical to a successful outcome, because they do not spread between birds,.
3. **Recombinant Vaccines.** These are actually a sub-set of the category 'live vaccine'. They are created as a mix of two different organisms by artificial means. Nucleic acid from one organism is artificially grafted into the nucleic acid of another in such a way that, when the carrier organism multiplies in the body it also expresses the protein to induce immunity to the second one (without inducing an infection of the second organism) Development of this type of vaccine is highly complex as it is necessary to ensure that the modification does not damage the ability of the carrier organism to infect and multiply. In addition the chosen antigen for the second organism must be the correct protein (in structure and conformation) to achieve protection. For some infections it is necessary to provide immunity to multiple antigens for full immune efficacy to be achieved. In principle, recombinant vaccines share the same features as other live vaccines – they can contain small numbers of organisms, sometimes they can be spread bird-to-bird and be applied by mass routes. However the features of a particular recombinant vaccine will very much depend on the nature of the carrier organism. To date the more common carriers for viral recombinants have been fowlpox virus and Marek's disease herpevirus (or HVT). These particular vaccines do not spread well from bird to bird and so they must be individually injected. They may also suffer greater regulatory hurdles and therefore are more likely to be developed for conditions in which the market is perceived to be large and multi-national.
4. **Nucleic Acid Vaccines.** This is a relatively new approach in which the naked nucleic acid (usually DNA) of a pathogen is injected into the target bird. The mechanism whereby injection of DNA induces immunity is still poorly understood. This has been an area of active research for a number of years but at the time of writing few if any commercial products have been produced based on this technology. While such products would need to be individually administered, there are now techniques to rapidly produce large amounts of DNA in a consistent fashion. Because only the nucleic acid is injected the vaccine is not infectious and does not spread between vaccinated birds.

Development of vaccines

A great deal of development is required in order to produce a safe and efficacious vaccine.

The detail and course of this varies greatly in accordance with the type of disease, and the nature of the vaccine and target stock. In essence there are a number of identifiable steps:

- Isolation and identification of the causal micro-organism
- (For live vaccines – identification of a naturally weak or attenuated strain, or adaptation of a virulent strain so that it no longer causes disease)
- Culture of the micro-organism itself or of the target antigen in some other way
- (For inactivated vaccines – inactivation to kill the micro-organisms)
- Formulation of the vaccine in an appropriate diluent, carrier, with or without adjuvant, and in a package to facilitate storage
- Confirmation that the vaccine is free of extraneous agents
- Confirmation that the vaccine is safe for the target species
- Confirmation that the vaccine is effective in preventing or at least reducing the effects of the target disease.

The time taken to get through all of these steps to registration will vary, but for a fully-licensed commercial product this is unlikely to be less than five years. In order for a product to fully meet all the regulatory requirements for safety, quality and efficacy, the development process needs to generate a complete dossier to satisfy the assessor.

There is, however, a class of vaccines, denominated 'emergency vaccines' which are allowed under current legislation, which allow the development cycle to be much shorter than the normal, often taking as little as three to four months, when using well known organisms for which there is good experience in their culture and inactivation. These vaccines are licensed on the basis that they are manufactured to a recognised standard of quality, they are tested for safety in a small number of the target species before final release, but they are not tested for efficacy. It is up to the attending veterinarian and farmer to assess their efficacy as part of the overall vaccination programme.

Registration of vaccines, regulation of distribution and use, including Special Import Certificates

The requirements for registration and the legal categories of vaccines used in poultry have been summarised in Part 1 of these guidelines.

The registration of all veterinary medicines is regulated under common EU Directives (Directive 2001/82/EC as amended by Directive 2004/28/EC) and implemented in each member state with local regulations (in the UK the Veterinary Medicines Regulations 2005 and subsequent amendments). Registration and other aspects of the regulation of veterinary medicines are the responsibility of the Veterinary Medicines Directorate (VMD), an executive agency of DEFRA. The main definition of a veterinary medicine is "any substance or combination of substances presented as having properties for treating or preventing disease in animals". Thus, the great majority of vaccines used in poultry are defined and regulated in a similar manner to other veterinary medicines. However, because of the biological nature of vaccines there are a range of requirements which are specific to this class of medicine – test results must, for instance, be supplied for each batch of product to the regulator prior to its release for sale. In addition to the normal requirements to demonstrate safety, quality and efficacy, vaccine manufacturers are required to show that the production process can consistently deliver these attributes.

The Veterinary Medicines Regulations also control the distribution, and use of all medicines, as well as record keeping requirements and fees levied by VMD for various approvals and other activities. All veterinary medicines used in food animals must now be classified as Prescription-Only Medicines (POM). Vaccines approved for use in poultry are typically in one of two categories:

(a) Prescription Only Medicine–Veterinarian (abbreviated to POM-V);
(b) Prescription Only Medicine–Veterinarian, Pharmacist, Suitably Qualified Person (abbreviated to POM-VPS);

The category affects how the products may be supplied and purchased. Products in the first category may only be supplied by veterinarians or pharmacists against a prescription issued by a veterinary surgeon. Veterinarians are only permitted to issue prescriptions for animals under their own care in this case. Products in the second category (broadly equivalent the previous PML category) are not subject to the same degree of control – they may be supplied by any of the people mentioned, to a prescription issued by such a person.

The general rule is that for a product to be used in poultry in the UK it must have a UK or an EU-wide licence or marketing authorisation (MA). UK marketing authorisation numbers begin with the letters Vm. However, under a process known as the 'cascade', a veterinarian may, when a suitable product is not licensed or available locally, make an application to use a product licensed in another country. If the product is licensed in another EU country the document is a 'Special Import Certificate' (SIC), if from another country it is a 'Special Treatment Certificate' (STC). Application must be made to the VMD in the prescribed format and a fee is payable for each certificate requested. This initiative has substantially improved access to vaccines which have small markets in different countries, and also been a great help in dealing with periods of inadequate supplies of a licensed product in one country.

Another exception to the general rule relates to 'autogenous vaccines', or, more correctly 'emergency vaccines'. These are inactivated products made from micro-organisms originally isolated on a particular property. They are not regulated in the same way as fully licensed vaccines but an authorisation is obtained which restricts their use to birds on the holding from which the organism was isolated or epidemiologically-linked bird populations.

The legislation also allows for the approval of use of products without marketing authorisations in cases of 'serious epidemic disease'. This provision has not yet been used in poultry, though, in the past, products have benefited from a provisional approval for trial use under large-scale 'Animal Test Certificates'.

Methods of vaccine administration

A wide range of methods of administration of poultry vaccines is available, for use both in the hatchery and on farms. All vaccines are approved for use by specific routes and doses, any use of a route not detailed in the product literature, or different dose should be carefully discussed with the attending veterinarian in advance. Regardless of the method of administration, careful planning and preparation, as well as consistent application and attention to detail, are key to a successful outcome. Faults or deficiencies in the administration of vaccines are, by far, the most common cause of poor response to vaccinations. The various routes of administration are summarised in Table 2 below. The

methods applicable for specific vaccines are detailed in the section showing sample vaccination programmes.

Table 2 Methods of Administration

Location	Individual Administration	Mass administration
Hatchery	In-ovo injection Subcutaneous injection (sc)	Coarse spray
Farm	Subcutaneous injection (sc) Intramuscular injection (im) Wing-web puncture Feather-follicle Eye-drop Nasal drop	Drinking water Coarse spray Aerosol On-feed spray

Preparation and Planning

This involves a series of activities which should occur well in advance of the actual vaccination procedure. The detail will vary with the type of stock, vaccine and route of administration, but the basic check list should include:

- ✓ Identification of the product to be used and number of doses (see Veterinary Health Plan)
- ✓ Ordering the product, specifying date of delivery
- ✓ Are there appropriate conditions of vaccine storage and is storage operated properly (temperature monitoring)?
- ✓ Is the correct equipment available, clean, appropriately sanitised?
- ✓ Are there sufficient people to both handle the stock (if required) and administer the vaccine?

Handling and Bird Welfare in Vaccination

Birds may need to be handled for vaccination, or to be exposed to a change in their normal routine (a brief period of water restriction for instance). Such short-term stresses have minimal effect on the response to vaccination. However poor handling practices can cause significant losses, both on the day due to smothering of overcrowded birds, and during the ensuing weeks, due to damaged sustained in handling. Where birds need to be presented for individual administration of vaccine, inconsistent presentation will tend to be associated with inconsistent administration and response. Use of properly trained and supervised staff with ongoing audit of response to vaccination are key measures to avoid such problems. Adequate handling facilities, penning, etc are required to avoid handling problems and to ensure that all birds are vaccinated.

Storage of vaccines and record keeping

Adequate storage space will be provided for the maximal volume of product to be stored. Space will be sufficient to allow easy circulation of air around all of the stored material. The target temperature for vaccine storage is usually 4-8 °C, but always check the manufacturer's instructions. Temperatures in the storage area need to be monitored either by an appropriate manual or automatic monitoring system which provides records of minimum and maximum temperatures. Low temperatures can be as damaging as high – coccidiosis vaccine in particular is very sensitive to freezing. Any facility that stores vaccines should have a person with designated responsibility for compliance with storage and record keeping procedures, with a designated alternate in his absence. All deliveries of vaccine should be recorded in a book or computer system. Minimum records which should

be maintained are: Product, type of unit, number of units, batch number and expiry date. Such records should include the total units in stock. Received materials should be unpacked and stacked in the storage area, in such a manner as to ensure that stock is used in rotation. A stock check of stored material should be carried out at least monthly. Usage of all vaccines should be in accordance with an agreed programme. Deviations from programme should be described and justified in the written record of vaccination. On withdrawing the required product check that it is the right product by reading the label. Very different products may appear very similar. Record the date of removal, number of units withdrawn, the site on which they will be used, the batch number, expiry date and remaining stock.

Reconsituting freeze-dried vaccines

The great majority of live poultry vaccines are lyophilised or freeze-dried. This greatly improves their stability when stored at 4-8 °C. The vials contain a powdery pellet. The size of the pellet has no bearing on the potency of the product. Regardless of the actual method of administration, freeze-dried vaccines need to be re-constituted. Some vaccines may require a specific diluent for this but distilled water is suitable for most vaccines. If a chlorine inactivator is to be used in the actual vaccination and non-distilled water is to be used for constitution then the water for reconstitution must also contain the inactivator (see section on drinking water administration). If using skimmed milk or powder, do not allow contact with vaccine until at least 20 minutes after its addition and ensure that it is first of all made into a smooth paste and gradually diluted to avoid lumps. Take care to avoid contamination of any utensils and hands with any disinfectant. Utensils used in vaccine preparation should be dedicated for this purpose.

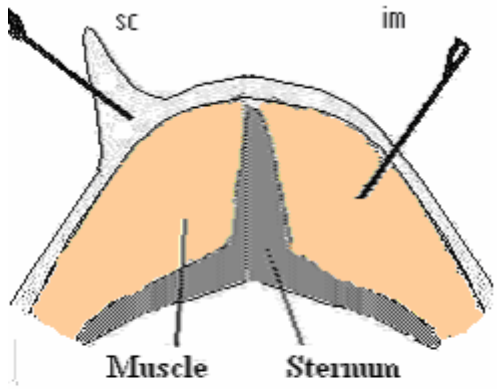
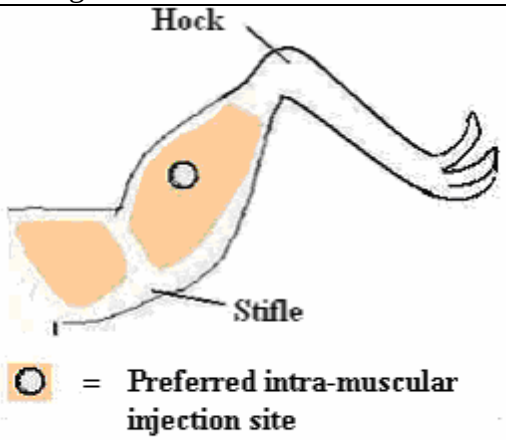
Reconstitution works best when two containers are used, one for reconstituted vaccine and the other for the diluent. The diluent may be split between the two containers at the start. Such containers should have no traces of sanitizer and should be dedicated for this use. Avoid exposing the vials or reconstituted vaccine to direct sunlight or temperatures above 20 °C. Remove all aluminium seals from the vaccine vials. Allow each vial to fill (at least 2/3rd full) with fresh diluent by cracking the seal while holding it under the surface of the clean diluent. Shake vigorously and allow to sit until all vials have been processed. Carefully dispense diluted vaccine into the second container. Rinse each vial and lid by filling it once more from the fresh diluent - this can be immediately dispensed to the second container. The remaining fresh diluent in the first container can be used to make up the diluted vaccine to the required total volume. Mix this thoroughly before application. The rinsed empty vials must be sanitised by putting them in a strong bleach solution before disposal.

Routes for Individual Administration of Vaccines

In-ovo Injection.
This technique was developed initially for the administration of Marek's disease vaccine into broiler chick eggs at transfer (17.5 to 19 days of incubation). It is, in fact, a form of mass-administration, but it achieves this by mechanically replicating individual administration. The equipment in its typical configuration moves a tray of incubated eggs into an injection area, then the eggs are held in position and punched over the air cell. The injection needle extends through the punch into the embryo, before being removed and sanitised by passing a sanitizer between the punch and needle. The eggs are then transferred into a hatcher basket. The equipment should be regularly checked to ensure that no needles are blocked, and carefully sanitised at the end of each day. As punched holes in the injected eggs are not sealed, hatcheries and egg supply farms must operate to a very high standard of hygiene, in particular to avoid problems with aspergillosis.

Subcutaneous (sc) Injection
This involves the use of a hypodermic (literally – under skin) syringe to inject a liquid vaccine through a hollow needle into the space between the skin and underlying tissues. Typically the site of application used in poultry in the loose skin at the back of the neck. For Marek's disease vaccine in day-olds the upper neck is used, for inactivated vaccines in older birds the middle third of the neck is used. In both sites, injection into the muscle must be avoided. Needle length and direction of insertion are used to help control the site of vaccine deposition. Greater care is necessary to avoid accidental self injection with this technique than with intramuscular administration. The product should be deposited 5-10 mm away from the point of skin puncture to reduce the risk of vaccine leakage and facilitate healing of the puncture. As with any injection technique it is important to ensure that all equipment used is properly cleaned, sanitised and maintained to avoid contamination of the product and accurately administer the required dosage. If the product to be administered is a live vaccine, it is also important to ensure that there is no residue of a chemical sanitiser in the equipment which might damage it.

Intramuscular (im) Injection
This is very similar to the previous route – the difference is that it is the intention to deposit the vaccine within a mass of muscle. Typically either the breast muscle or the thigh muscle is used for this purpose. Figure 3 below illustrates the difference between sc and im injection. This technique requires all of the same care as for sc vaccination. Because the aim is to place the vaccine more deeply in the bird's body, there is a greater potential for damage. This may be due to the needle damaging structures such as joints, tendons, blood vessels and nerves (particularly with in-leg vaccination (Figure 4)), or to the depositing of the vaccine where is not meant to be present.

Figure 3 – A cross section of the breast area.	Figure 4. Site of intramuscular injection in the leg
 sc = sub-cutaneous im=intra-muscular (Figure by Paul McMullin)	 (Figure by Paul McMullin)

Needles of 12.5mm (1/2"), 19 gauge needle are usually suitable and should be changed regularly to ensure that they do not become burred and spread contamination. Changing every 2000 birds may be suitable for some classes of birds, but needles should always be changed when moving to a new group (pen or house) of birds, or if the needle becomes at all damaged or slightly blunt. It is possible to use attachments on needles which decontaminate needles between birds. Needle-less injector systems are becoming available for use with some oil-based vaccines. Correct identification of vaccine deposition site is the key element in training staff in the correct use of injectable vaccines. It is helpful to carry out dissections of some birds which have to be culled to ensure that this is achieved. If an oil-based vaccine is in use, it is easy to demonstrate the actual location of the vaccine which has been injected. A range of problems can be encountered with im administration:

- Partial or complete non-injection (look for residue of vaccine in feathers or on equipment nearby)
- Damage to blood vessels, tendons or joints (leg injection)
- Penetrating into the body cavity or liver, liver abscesses or peritonitis (breast injection, especially with poorly developed birds).

Note: Accidental Injection with Oil-based vaccines.
The oil present in these vaccines causes a marked inflammatory response if accidentally injected into an operator. If such injection is in a finger the associated swelling can cause loss of blood supply to the digit and serious health consequences for the operator. For this reason the affected operator should go immediately to an accident and emergency service and present the advisory card relating to adverse reactions (or package inset) to the attending physician. Make sure that the attending physician takes the matter seriously as the initial reaction may appear quite mild.

Wing Web Puncture and Feather Follicles.
These methods are sometimes called 'transcutaneous' They have, in the past, been used to administer live vaccines which, if administered more invasively, are excessively pathogenic. However they are now used almost exclusively for fowlpox vaccination, primarily because the skin is the site of multiplication of this live virus vaccine. Fowlpox vaccination is rarely required in the UK, but the method is included for the sake of completeness.

A double-needle applicator is provided with the vaccine. The needles have depressions near their tips which take up the vaccine when dipped in it. Dip the needles before each bird, spread the wing to expose the under-side of the wing web, and stab through it, avoiding visible blood vessels. Avoid contaminating hands, the feathers or other areas of the birds with the vaccine, in particular the head and eyes to avoid causing lesions in the mouth and eyes. Take particular care to remove vaccine vials and applicators from the house to avoid accidental exposure of birds by non-intended routes.

If using the feather follicle method a few feathers are plucked from the thigh and the vaccine is brushed on the exposed follicles. In either case the 'take' of vaccine is assessed six to ten days after application, by examining the site of application and recording the percentage of birds with small pock and/or scab lesions.

Eye-drop (Conjunctival)

This is one of the most effective ways of administering live respiratory vaccines. The vaccine is reconstituted in a dropper bottle usually with a dye-containing diluent. It has been used mainly for day-old chick administration but, given the labour requirements, its use in the UK has been superceded by coarse spray in the hatchery. Nevertheless, it is the only approved method of application of infectious laryngotracheitis vaccine. Each bird is restrained with its head to one side and a drop of the vaccine is placed in the uppermost eye. Holding the bird in position for a couple of seconds after administration, until it blinks, to ensure full dosage remaining in the eye and draining to the nasal cavity via the tear duct.

Nasal Drop

This is almost identical to the preceding method – instead of dropping in the eye the drop is placed in the uppermost nasal opening. It has similar advantages and limitations to eye-drop. Where a high and early challenge is anticipated, it may be used in conjunction with eye-drop administration.

Routes for Mass Administration of Vaccines

The development of the commercial poultry industry has focussed on delivering what the market requires. Much of the time this results in systems with large numbers of birds (sometimes up to 140,000) in a single house. It is impractical to administer vaccines individually with his scale of production so much effort has been expended in the development of methods of mass vaccine administration. For many vaccines it is perfectly feasible to achieve a high level of protection using the methods described below when they are carefully applied.

Coarse Spray Cabinet (Hatchery)

Hatchery spray cabinets were initially developed to allow early and rapid administration of respiratory vaccines. They may be manually operated by placing a single box of chicks in the hatchery at a time but more commonly in broiler hatcheries they are sited over a roller conveyor and the spray is activated when the box passes through. The later type generally use a flat-fan type spray. Pressure of operation, and nozzle type and maintenance are the main factors which affect performance of these systems. They may be simply monitored by assessing the pattern of spray when a series of empty boxes with dry chick papers is put through. The objective is to achieve a coarse spray of droplets on the down. Chicks should remain moist for 10-15 minutes – this is usually achieved with a volume of application of 200-300mls per thousand chicks, though lower and higher rates of application are sometimes used. Droplets of 100-300µ are appropriate for day-olds and result in visible droplets on the down. Effectively much of the exposure to vaccines is by rubbing their eyes during this period. Chicks should not be transported until they have dried to reduce the risk of chilling.

Coarse spray systems are also being developed for the administration of coccidiosis vaccines. These are said to work best when chicks are held in a well illuminated area while still damp as this encourages vaccine uptake from themselves and each other.

The careful hygiene and maintenance of hatchery-based spray systems is particularly critical because they are normally operating in areas with relatively high airborne bacterial counts. Care also needs to be taken to ensure that the source of compressed air is not contaminated with bacteria or oil.

Coarse Spray

A range of sprayers is used to apply coarse spray to birds on-farm. This can involve simple hand-held or back-pack sprayer, often to do day-old administration into the chick boxes if not done at the hatchery. Day-old administration aims to mimic the effect of hatchery administration – so it is best to do it before releasing chicks into the house.

Spraying can also involve more sophisticated motorised equipment, and, for caged units, trolleys with multiple spray nozzles adjusted to cage tiers. In fact these systems actually generate a broad range of particle sizes (typically from 50 to 1000µ). The larger particle sizes do not travel very far from the nozzle in many systems. Coarse spray tends to be favoured for application to young birds, especially if they have not had prior immunisation. However it must be appreciated that most spray systems actually generate a range of droplet sizes, even when they are predominantly coarse. Some equipment can result in excessive vaccinal reaction, particularly where flocks are stressed by viral challenges, poor ventilation and intercurrent infections such as *Mycoplasma gallisepticum*. Given the potential for spray systems to exacerbate respiratory disease, it is particularly important to obtain the advice of your veterinary surgeon and vaccine manufacturer on the choice and use of such equipment.

Spray vaccination should normally be practised with purified or distilled water. If tap water must be used then a suitable chlorine inactivator should be added before mixing the vaccine. If tap-water is used rather than purified or distilled water, particularly in areas of hard water, it will be more difficult to maintain the spray systems clean and functioning consistently. The volume can be checked in advance by doing a trial-run without vaccine – but typically it will be 500-800ml or more per thousand birds. The ventilation system should normally be closed down during vaccination and for a period of at least 15 minutes afterwards, but the importance of this may vary with the type of sprayer used. If environmental temperatures are unusually high, then it is beneficial to vaccinate early in the morning. Monitor the behaviour of the flock during spraying and thereafter to avoid

smothers. It is usually helpful to turn down the lights during vaccination, although there needs to be sufficient light to allow the operators to clearly see the area being covered. The whole flock needs to be covered by following a consistent path. This is particularly important with coarse spray as the majority of the particles will precipitate very quickly. All operators must be provided with personal protective equipment as recommended by the manufacturers.

Aerosol or Controlled Droplet Administration (CDA).

Aerosol generators or foggers have been used for poultry vaccination for many years. They tend to produce a finer, and more uniform, particle size (e.g. 80-100µ). These fine particles are readily inhaled by the birds and, particularly in conditions of low humidity, the aerosol will tend to dry out and remain in suspension for a period after administration. In recent years there has been an increase in use of sprayers originally developed for horticultural use which have a much more uniform particle size (Controlled Droplet Administration – CDA). These utilize a spinning disk that throws off particles from its edge, and a fan to disperse it over a wide area. These sprayers readily distribute the fog over an area about one metre wide and three to four metres long allowing the operator to rapidly vaccinate a large number of birds. With the small particle size much less water is used – typically 50-80mls per thousand birds – though the particular machine should be checked in advance. Once again, the ventilation system should normally be switched off and the lights turned down. The vaccine is applied by systematically moving down the house covering the entire floor area, but aiming the nozzle above bird height.

Drinking Water

The drinking water route of administration is used mainly for vaccines such as infectious bursal disease and avian encephalomyelitis where the target organ is the gut. Drinking water may also be used for respiratory system vaccines due, in part, to the choanal cleft in the roof of the mouth which allows contamination of the nasal cavity, but also because of the spraying which occurs naturally when birds are drinking intensively, particularly from bell-type drinkers, as this helps vaccine get into the eyes of other birds. In preparing for water-based vaccination it is important to understand the details of the plumbing system, and to have water lines and drinkers as clean as possible. Mild acidification of water ahead of vaccination may be helpful in removing bio-film but should cease 24 hours prior to vaccination. It is usual to wash bell drinkers on the day of vaccination – however the water used should not contain a disinfectant and should be of neutral pH..

The strategy used in drinking water vaccination may be adapted slightly in accordance with the type of vaccine, but, in essence, the aim is to rapidly distribute the vaccine throughout the house, and maintain it constantly available for a period. The dilution rate should be altered to the expected water intake of the flock – this will be modified by the type and weight of birds, time of day, and ambient temperature. Use of one litre per thousand birds per day of age is a useful rule of thumb however. The aim is to ensure that there is sufficient water to ensure that the vaccine remains in the system for 1.5 to 2.5 hours and that all birds drink during this time. Various tools may be used to encourage water intake while vaccinating – choice of time of day, controlling light and/or presentation of feed and withdrawing water for a short period. Water deprivation can be useful but should not be excessive to avoid stressing the flock and inducing too rapid water intake in a proportion of the flock. In practice, a period of water restriction of one to1.5 hours has been found to be suitable for commercial broilers when environmental temperatures are comfortable for the

birds. In most production systems drinking water application is best carried out in the morning to coincide with maximum bird activity.

The vaccinal viruses are equally susceptible to disinfectants as are field viruses so it is very important to ensure that they are not exposed to disinfectant residues, for instance on the hands of the operators, in mixing buckets, dosing systems and drinker lines. It is normal to mix an additive in the water used for vaccination to bind with and inactivate any residue of chlorine in the water. A bonus of doing this is that it provides a colour marker to monitor that the vaccine is distributed throughout the house. The traditional additive used for this is skimmed milk powder, used at a rate of 2g per litre. This is an effective approach if it is added to the water supply 20-30 minutes prior to the addition of the vaccine. However it is not suitable for dosing systems in which a concentrate of vaccine is made up and then administered into the stream of drinking water. It also delivers nutrients into drinker system which can contribute to the build up of bio-film . To address these problems a range of proprietary products have been developed which contain a dye and a rapidly-acting chlorine neutralizer. Examples of such products available in the UK are:

- Avi-blue – Lohmann Animal Health
- Cevamune – Ceva
- Vac-Pac Plus – Merial

The main purpose of the dye in such products is to allow simple verification of effective vaccine distribution by direct observation of the colour of water sampled at different locations. Some such products may be used at a concentration which results in an intense colour in the water which allows detection of the percentage uptake of vaccine by observing the number of birds with staining of the tongue and the intensity of staining.

The details of the method of application need to be tailored to the particular type of drinker, plumbing system, proportioner etc in use. There are four basic approaches

- Mixing the vaccine in a reservoir and distributing directly into bell drinkers with a watering can (really only appropriate for smaller flock sizes).
- Mixing vaccine in a header tank allowing gravity feed
- Mixing vaccine in a dedicated reservoir with coupled pump to inject into or circulate within the drinker system.
- Mixing vaccine as a concentrate and administration into the line with a proportioner

When setting up a new farm or vaccination programme it is advisable to carry out a mock-vaccination ahead of the actual vaccination to identify and correct any problems. If the amount of water required for the period of vaccination is recorded then this will help confirm the appropriate dilution rate to use when actually vaccinating. For instance, if using bell drinkers in young birds it may be advisable to supply supplementary drinkers when vaccinating. If using in-line water sanitation systems these should be switched off the day before vaccination. Manufacturers of vaccine recommend that in-line filters are also by-passed when vaccinating. Once the vaccine is re-constituted (as described above) it should be thoroughly mixed in the required volume either of the concentrate to be dosed or in the reservoir used.. The source of fresh water should be turned off until the vaccine is consumed. On opening the valve to the drinker system in the house it is highly recommended that the water in each line is drained until the dye- or milk-stained water appears. If bell drinkers are in use and they still contain water it is advisable to ‘tip’ the contents to ensure rapid distribution of the full concentration of vaccine. With the vaccine

present in the water it is a good time to carry out a flock inspection, encouraging birds to move from the side of the house and otherwise encourage flock activity with increased lighting and activating feeders.

Drinking Water Application of Coccidiosis Vaccines – Special Considerations

The basic guidance given above is also relevant to these vaccines, but they do have some features which set them apart from other vaccines used. These mainly relate to the fact that live coccidiosis vaccines are composed of coccidial oocysts that are thousands of times larger and heavier than bacteria and viruses. The result is that they tend to settle to the bottom of drinker lines and drinkers. It is certainly perfectly feasible to administer these vaccines into bell drinker systems – the products used in layers and parents include a component to reduce settling and are usually administered directly into the drinkers by the use of a calibrated syringe. If administering in this way be sure to swirl the drinker to thoroughly mix it. Nipple systems are more difficult, particularly those in which the outflow from the pipe into the nipple is above the centre of the pipe rather than at the bottom. To get over these problems, alternative methods of application have been devised and tested (spray on feed, day-old spray).

S**pray on Feed**

It is, perhaps, surprising that feed-based administration of vaccines is not used more frequently. This is probably because of the difficulty in ensuring adequate stability and distribution of the vaccine on a feed base (given the wide variety of feed types and additives). A heat-stable strain of Newcastle disease virus has been developed for feed-based application in some developing countries. Feed-based administration is, however, an effective means of vaccinating poultry against coccidiosis. It is normally applied by using a mechanical sprayer to provide a coarse spray over the total surface area of the feed (on paper or pans) just before the chicks are placed. As with other forms of vaccination, it is helpful to adjust the dose to the required volume of water by carrying out a test-spray of an equivalent area in advance. If the amount of liquid used is slightly excessive simply continue to spray as evenly as possible throughout the house until it is all used up. Sprayed feed rapidly dries out at brooding house temperatures.

Development of vaccination programmes: Beneficial and adverse interactions among vaccines and other medicines

The development of an immunisation programme should be based on knowledge of the diseases to which the birds are likely to be exposed and then incorporating it into the management system of the flock. It requires knowledge of the presence and level of passive immunity in the birds so that immunisation can be properly timed. Timing is also important so that vaccines do not detract from each other's responses or exacerbate their clinical effects.

Vaccines should not be administered when other stressors are acting on the flock. Immunisation is never a substitute for proper sanitation and biosecurity and programmes cannot totally protect birds which are stressed or in unhygienic conditions. Over-reliance on vaccination to the detriment of other disease control measures can lead to a false sense of security and poor disease control. Vaccines should be purchased and utilised only after full

consultation with a poultry veterinary surgeon. Where monitoring tests are available, e.g. serology, these should be routinely utilised to ensure that vaccine responses have taken place.

Detailed health plans can be a very powerful tool to provide a framework for all health-related decisions and records. The health plan should be a collaborative exercise between the company or farmer and their veterinarian and it should summarise the key activities relating to health promotion. As with any commercial activities we should be clear as to the objectives of this:

1. To avoid misunderstanding or miscommunication as to what activities should occur and when
2. To facilitate recording of events as they occur
3. To facilitate the documentation of these activities to other interested parties such as customers and assurance scheme auditors.
4. To reduce the risk of adverse interactions among the different parts of the vaccination programme.

Poultry vaccination programmes are often very intense, with a large number of vaccines in use. While the immune system has the inherent ability to respond to a very large number of pathogens there can still be the risk of adverse interaction. The most common problem relates to live viral vaccines. These rely on multiplication in the bird if they are to establish or boost immunity. Prior vaccination with the same or another vaccine for the same disease can make it more difficult for this to happen, but even vaccines against different disease can result in an activation of the innate immune system so that vaccine organism replication is reduced in the bird. This is the reason for the general recommendation that live viral vaccines should either be administered together or separated by about two weeks. This is particularly important if the different vaccines replicate in the same tissues (e.g. respiratory tract). It is increasingly common to find warnings on product data sheets to avoid using other vaccines within a specific, often prolonged, time period. Some such warnings are based on known or theoretical compatibility issues – others are simply because the compatibility studies required for their removal have not been carried out. Consult your veterinary surgeon if in any doubt as to compatibility.

Vaccines may also have incompatibilities with other programmed, *ad hoc* treatments, or accidental contaminants. Live bacterial vaccines are likely to substantially affected by the use of many antibiotics. Live coccidiosis vaccines are readily inactivated by accidental inclusion or contamination of feeds with coccidiostats or treatment of the flock with anti-coccidials. Even some anti-microbial products, particularly potentiated sulphonamides, can be expected to have an adverse effect on coccidiosis vaccines.

There is one other phenomenon which can result in unexpected effects in vaccination programmes. This tends to be associated with poor uptake of a live vaccine, either due to interference with another vaccine, poor administration, or, perhaps inadequate care in its storage. Regardless of the initial cause, if too small a proportion of the flock are protected by the initial vaccine, there is the risk that the vaccinal virus will spread in successive waves to other birds in the same group. The greater the number of 'waves' the greater the risk that the vaccinal virus will become better adapted to the host and 'hot up' in terms of its clinical effects on the bird. This may be perceived as a 'rolling vaccinal reaction' which continues for a number of weeks, or, sometimes, simply as an unusual serological result with a higher, more variable or more persistent response.

Sample vaccination programmes for breeding chickens, broilers, commercial layers, breeding turkeys and waterfowl

This section provides some sample vaccination programmes for different classes of stock. It must be emphasised that these are in no way recommended by RUMA but are presented to illustrate a range of approaches and provide the opportunity to briefly review the varying objectives of different programmes. The need to adapt programmes to deal with the particular disease challenges in the particular area and farm has been emphasised already and must be re-emphasised in the context of these sample programmes. Given that disease challenges are unlikely to remain static this implies that both programme and challenge micro-organisms will tend to evolve over time. While there are usually good reasons to add new vaccines into a programme (e.g. the confirmation of a disease challenge), it is much more difficult to assess when and if existing vaccines may be dropped. Nevertheless this option should always be kept under review, the more so, the more 'crowded' the vaccination programme becomes. Vaccination programmes should be a key part of farm veterinary health plans for poultry.

1. Breeding Chickens

This is an intensive breeding-chicken programme which has live vaccines for infectious bronchitis (IB) both the conventional Massachusetts strains and various variants, Newcastle disease(ND), infectious bursal/Gumboro disease, avian rhinotracheitis (ART), chicken anaemia virus (CAV), infectious laryngotracheitis (ILT) and avian encephalomyelitis (AE).. Note that the report header has spaces to record the company, farm, house, the date effective and the programme which this replaces, as well as a brief description of any changes made. This format can be used to record the date on which the birds were vaccinated and the batch numbers used. The age of administration inactivated vaccine would be influenced by the age of transfer from rearing to laying farm if it is wished to keep handling to a minimum. Some breeders receive live IB vaccines shortly after transfer. The benefit or otherwise of repeated live vaccination in lay is controversial but is likely to be determined by the frequency and type of natural challenge or re-circulation of challenge strains within flocks. This programme also includes routine blood sampling at nine and fourteen weeks to confirm lack of mycoplasma infection in the rearing period and assess the response to the live vaccination programme. Reovirus serology is checked at fourteen weeks to confirm natural exposure to this infection in rear, as two doses of inactivated vaccine would be recommended if this had not occurred. There is further testing at twenty weeks to confirm a satisfactory response to the inactivated vaccines. Parent-level meat-type chickens would not normally have ILT vaccination but would have a live or inactivated Salmonella vaccination programme.

Company: Effective:1/JAN/6 Bird type:Parent Replaces programme :XXXXXXXXXX Comments/changes:			Farm	
			House	
			Date Placed	
Week	**Type**	**Details**	**Date Done**	**Batch No**
0.1	V	Rispens/HVT : sc		
0.1	V	IB H120 Vaccine: Coarse spray on farm		
1	V	Live 8 strain Coccidiosis Vaccine: Water between 6 and 10 days of age		
2.4	V	Gumboro Intermediate Strain live: Drinking water		
3	V	IB H120 Vaccine Nobilis: Aerosol		
3	V	ND HB1 Vaccine Nobilis: Aerosol		
3.4	V	Gumboro Intermediate Strain live: Drinking water		
4.2	V	Gumboro Intermediate Strain live: Drinking water		
5.5	V	IB variant 4/91/CR88 live Vaccine: Aerosol		
5.5	V	IB Mass +ND Live: Aerosol		
6	V	CAV Vaccine Oral - Drinking water		
7	V	ART - type B chicken strain live: Aerosol		
8	V	ILT Vaccine		
9	B	Blood Sampling: M.g.,M.s.,IBD ELISA,NDV-HI,IB-HI,Storage ,		
10	V	IB variant D274 + Mass: Ulva-fan		
13	V	A.E. Vaccine (Live): Drinking water		
14	B	Blood Sampling :M.g.,M.s.,IBD ELISA,CAV ELISA, ND-HI,IB-HI,Storage,Reovirus ELISA		
16	V	Inactivated Vaccine:ART +IBD+IB+ND. Inactivated Vaccine (may also contain a variant IB strain):REO Inactivated. im		
20	B	Blood Sampling :M.g.,M.s.,IBD ELISA,CAV ELISA, ND-HI,IB-HI,ART ELISA, AE ELISA, Reovirus ELISA,Storage,		

Key: V= vaccination B=blood sampling
AE- Avian encephalomyelitis ART= avian rhinotracheitis CAV= chicken anaemia virus ELISA= Enzyme-linked immunorbent assay HVT=Herpesvirus of Turkeys HI= haemagglutination inhibition IB= infectious bronchitis IBD=infectious bursal disease ILT= avian laryngotracheitis Mass.= Massachusetts M.g.= *Mycoplasma gallisepticum* M.s.= *Mycoplasma synoviae* ND= Newcastle Disease REO=Reovirus

2. Broilers

Broiler vaccination programmes are very simple, given the short life and period of protection required. Longer-lived birds such as free-range and roasters may require slightly more vaccination. Much effort is expended in vaccinating the breeding birds to ensure that chicks have broad-spectrum maternal antibody that is as uniform as possible. There is a special emphasis in broiler programmes in preventing the adverse effects of infectious bursal disease as it is capable of influencing various other diseases through immuno-suppression. Intermediate or 'hot' IBD vaccines may be used depending on the expected intensity and timing of challenge. The optimal timing for vaccination may be affected by the level and uniformity of maternal antibody.

Company:XXXXXXXXXXXManager Resp.: XXXXXXXXXXXXXDate Effective:01/Jan/06 Bird type:Broilers Replaces programme :XXXXXXXXX				Farm	
				House	
				Date Placed	
Day	**Note**	**Type**	**Details**	**Date Done**	**Batch No**
1		V	Marek's Vaccine HVT sc in hatchery (usually only free-range or roasters)		
1		V	IB Mass. vaccine : Spray		
1		V	ND Live mild: Spray (optional)		
1 - 5		V	Live 5 strain coccidiosis vaccine on feed or drinking water (Free Range)		
16-18		V	Intermediate strain IBD/Gumboro (Live): Drinking water		
20-25		V	IB Mass and/or IB 793B/CR88 variant: Aerosol		

Key: V= vaccination B=blood sampling
HVT=Herpesvirus of Turkeys IB= infectious bronchitis IBD= infectious bursal disease Mass= Massachusetts ND= Newcastle Disease

3. Commercial Layers

Commercial layers follow a similar vaccination pattern to breeding chickens. There is a particular emphasis in achieving good protection against both standard and variant strains of infectious bronchitis. Marek's disease challenge is also likely to start earlier than in breeding flocks so some producers have a second vaccination in addition to the combined Rispens and HVT strains. Because there are no progeny of these birds there is no requirement for inactivated Gumboro/IBD vaccine. However it is normal to include, instead egg drop syndrome (EDS) in the inactivated vaccine. As with breeding birds, some producers will repeat one or more live vaccines shortly after transfer, and they may also repeat live IB vaccines during lay, though not all live IB vaccines are approved for this purpose. In recent years *Mycoplasma gallisepticum* (M.g.) has become more common in the commercial layer industry, so an increasing proportion of birds have a live attenuated M.g. vaccine by aerosol once or twice during rearing. Nearly all commercial layers will also have a programme for *Salmonella enteritidis*, many also for *Salmonella typhimurium*. This may be achieved by two or three live vaccines given in drinking water during the rearing period, or by two injections of an inactivated product given, typically at ten and sixteen weeks of age. Vaccination for *Salmonella* is a key component of the "Lion" Assurance scheme operated by the British Egg Industry Council, so members of this scheme need to ensure that their programme complies with the recommendations for use of their chosen product.

Company:XXXXXXXXXX Manager Resp.: XXXXXXXX Date Effective:1/Jan/06 Bird type:Commercial Layer Replaces programme :XXXXXXXXXX Comments/changes:.				Farm	
				House	
				Date Placed	
Week	**Note**	**Type**	**Details**	**Date Done**	**Batch No**
0		V	Rispens/HVT: sc in hatchery		
0.1		V	IB Mass+D274 variant: Coarse spray		
0.5		V	8 Strain Coccidiosis Vaccine: Drinking water		
2		V	Gumboro Intermediate (Live): Drinking water		
2.4		V	IB 793B/CR88 Variant: Coarse spray		
4		V	Gumboro Intermediate (live): Drinking water		
5		V	IB Mass +ND : Spray		
7		V	Type B Chicken ART : Spray:Aerosol		
8		V	ILT Vaccine		
10		V	IB 793b/CR88 Variant: Aerosol		
10		V	ND HB1: Spray: Aerosol		
12		B	Blood Sampling :M.g. M.s. ND-HI,IB-HI,IB 793B Variant HI,Storage		
13		V	A.E. Vaccine: Drinking Water		
16		V	Inactivated ART + IB Mass + ND+EDS: im (may also include an IB strain)		
20		B	Blood Sampling ND-HI,IB-HI,EDS-HI,Storage (16),		

Key: V= vaccination B=blood sampling
AE- Avian encephalomyelitis ART= avian rhinotracheitis EDS=egg drop syndrome ELISA= Enzyme-linked immunorbent assay HI= haemagglutination inhibition HVT=Herpesvirus of Turkeys IB= infectious bronchitis ILT= avian laryngotracheitis Mass.= Massachusetts M.g.= *Mycoplasma gallisepticum* M.s.= *Mycoplasma synoviae* ND= Newcastle Disease

4. Breeding Turkeys

This follows a similar pattern to the chicken programme with live vaccines used to prime the response in the early stages of rearing followed by inactivated vaccines later. The programme is less crowded partly because there are fewer vaccines available for turkeys and partly because the rearing phase continues to about twenty eight weeks of age. Turkey rhinotracheitis (TRT)/ avian rhinotracheitis is a more serious disease in turkeys than in chickens. Inactivated paramyxovirus-3 (PMV-3) vaccines are also routinely used in turkeys.

Company:XXXXXXXXXXX Manager Resp.: XXXXXXXXXXXXXDate Effective:01/JAN/06 Bird type:Turkey Parent Replaces programme :XXXXXXXXX				Farm	
				House	
				Date Placed	
Week	**Note**	**Type**	**Details**	**Date Done**	**Batch No**
0.1		V	TRT Live Vaccine : Spray in boxes		
3		V	ND HB1 Vaccine: Spray		
7		V	ND Clone 30 : Spray		
11		V	ND Clone 30 Aerosol		
12		V	A.E. Vaccine (Live): Drinking water		
15		V	TRT Type B Live vaccine: Aerosol		
17		B	Blood Sampling: M.g.,M.s.,M.m., TRT ELISA, Storage ,		
20		V	Inactivated TRT + ND + PMV3: im		
20		V	Pasteurella Vaccine: im		
22		V	AE Vaccine (Live): Drinking water		
26		B	Blood Sampling: M.g.,M.s.,M.m., TRT ELISA ORT ELISA, Storage		
26		V	Pasteurella Vaccine: im		
26		V	Inactivated TRT + ND + PMV3: im		
32		B	Blood Sampling: M.g.,M.s.,M.m., TRT ELISA, ORT ELISA, Storage		

Key: V= vaccination B=blood sampling
AE- Avian encephalomyelitis ELISA= Enzyme-linked immunorbent assay M.g.= *Mycoplasma gallisepticum* M.s.= *Mycoplasma synoviae* M.m.= *Mycoplasma meleagridis* ND= Newcastle Disease ORT= *Ornithobacterium rhinotracheale* PMV3= Paramyxovirus type 3 TRT= turkey rhinotracheitis

5. Waterfowl

Vaccination programmes for waterfowl are generally less intensive than for other poultry species and vary widely in accordance with the class of stock and circumstances. The programmes tend to be along the lines shown in the following paragraphs.

Breeding birds

Geese - large flocks may have Parvovirus vaccine. The first dose is given at around three weeks of age and the second dose one to two prior to breeding season. A booster vaccination is given each year.

Ducks (Pekin)- *Salmonella* vaccination is usually practised. Either two doses of an inactivated vaccine or 2-3 doses of live vaccine. The timings of these vaccinations are similar to chickens and depend on previous site history and risk. Emergency vaccines may be used for any bacteria considered a risk - *Reimerella* most commonly. Some flocks will have Duck Virus Hepatitis vaccine - two doses in rearing period, with a booster prior to the second laying period if being kept on.

Meat production generation

Geese - mostly no vaccination but may give *Pasteurella* and/or erysipelas vaccination if site history suggests a risk. Timings are similar to the age used for turkeys at a younger age.

Ducks - Single age commercial meat duck sites may have no vaccination at all, and multi-age sites may have emergency *Reimerella* vaccine.

Monitoring response to vaccination, and practical assessment of the benefits of vaccination

The complexity of the immune response as described above suggests that no single test (with the possible exception of artificial challenge) will accurately assess the response to vaccination. In practice, what must first be considered are the simple techniques of directly assessing whether vaccines are being applied properly. Vaccine manufacturers and poultry veterinarians are able to independently audit vaccination. It is preferable, where possible, that such audits are done against a written procedure which has been put in place, and adapted as required to the particular situation of the farm. The details of the audit process will vary with the particular route of administration but will typically include assessments of :

- Likely vaccine viability – correct storage, avoidance of contact with inactivators in handling and preparation
- Equipment and set-up – maintenance, preparation, use
- Operation – distribution of spray or drinking water, speed of injection, evidence of leakage

Specific tools are available to provide more detailed information :

- Dye addition to drinking water – counts of birds with tongue staining
- Water-sensitive papers – to assess droplet distribution
- Post-mortem examination of injection sites – for oil-based vaccines

It is often convenient and effective to combine practical training with a flock audit.

The second main approach to practical assessment of response to vaccination is serological testing. This should begin with consideration of an appropriate time to take the samples and appropriate sample numbers. The timing should take into account the vaccination programme and allow sufficient time for a response (typically two weeks after vaccination where it is a re-vaccination). Larger numbers of samples improves the reliability of the results and any interpretation based on them. Groups of less than 20 samples/flock are difficult to interpret reliably. The samples must be selected randomly from the flock being assessed – including all pens, where present, and not targeting particular birds. Each bird in the flock should have an equal chance of being sampled. The laboratory should present the individual results as well as a mean of all results in the group and a measure of the Dispersion or Variability of the results (expressed as Standard Deviation or Coefficient of Variation). The laboratory should be able to interpret the results against the background of ‘normal’ results for the age and class of poultry for that laboratory. However, great care must be taken in attempting to compare results from different laboratories – they are often not directly comparable. Assessments of vaccination programmes should concentrate on a significant number of flocks sampled and tested in a consistent fashion

The final assessment of whether a vaccination programme is working is the occurrence, or

lack of occurrence of clinical disease and satisfactory productivity. Effective vaccination, does not, of course guarantee good performance, as it may be affected by other factors and even diseases against which no vaccine is currently available.

Particular issues with respect to the use of vaccines against notifiable diseases

The two most important diseases of poultry are Newcastle disease and avian influenza. They are causes of high mortality and production losses, but they also result in considerable disruption to normal poultry production as a result of various official controls. Whether or not vaccine is to be permitted, or even mandatory, in the control of these diseases is constantly under consideration by the relevant authorities. Vaccination has been very important in the effective control of Newcastle disease in many countries, particularly where effective live vaccines which may be applied by mass administration are available. The main 'down-side' to use of vaccines relates to the risk of creating apparently healthy, yet infected, flocks which can then be a source of infection for other flocks.

Vaccination of backyard poultry

The broad principles outlined here apply equally well to back-yard or fancy fowl production. The requirement for vaccination is likely to vary with the particular circumstances. Small groups of mature birds which are kept in isolation have less need for vaccination than large groups to which new birds are constantly being added, or which come in contact with other groups directly or indirectly (as during visits to exhibitions). Where possible, flocks should be started with young healthy point-of-lay pullets which have had a full vaccination programme, with subsequent replacement of birds from the same source and vaccinated in the same way. Small closed populations may be used for breeding for periods without significant disease but some diseases are almost inevitable:

Marek's disease: Chicks need to be vaccinated as soon as possible after hatching by injecting sc. They should be kept in a clean isolated area for as long as possible to allow the vaccine to work. As for most poultry vaccines only 1000 dose vials are available it makes sense to set as many eggs as possible in one go.
Coccidiosis: It is possible to have small vaccine packs dispensed (typically 100 doses) and, for small groups of birds it is practical to administer this by drops directly in the mouth. For full immunity the birds require exposure to their own faeces so, if moving them from an isolated brooding area at three to four weeks it may be helpful to move some of the litter as well.

Other live viral vaccines can be obtained, but usually only in 1000 dose packs. If dealing with small numbers of birds these are best made up and dispensed using an eye-dropper using the eye-drop method described above. For all live vaccines any unused product must be carefully inactivated – strong bleach solution is appropriate for this and the container should then be disposed of correctly.

Further Reading

NOAH Compendium of Data Sheets for Animal Medicines, published by NOAH and online at http://www.noahcompendium.co.uk

Vaccine Administration
http://www.poultryindustrycouncil.ca/compendium-vaccine_admin.html

Atomisers
http://www.micron.co.uk/cda_for_poultry_vaccination

Vaccination by Injection – The Do's and Don'ts
http://www.intervet.co.uk/binaries/92_98493.pdf

Vaccine administration techniques – Drinking Water
http://www.intervet.co.uk/binaries/92_56674.pdf

Auditing Vaccine Application Procedures in Poultry
http://www.thepoultrysite.com/articles/341/auditing-vaccine-application-procedures-in-poultry

Veterinary Medicines Regulations 2005 SI 2745 (and subsequent years)
http://www.opsi.gov.uk/si/si2005/20052745.htm

Unofficial Draft Consolidate Directives on Veterinary Medicinal Products
http://www.vmd.gov.uk/General/VMR/200428ec.pdf

Article published in Vaccination at Work in Commercial Broilers, a Merial publication. Authored by P.W. Cargill, BVet.Med, Cert PMP, MRCVS, Merial Avian Business Unit, United Kingdom and Joey Johnston, Merial Avian Business Unit, Gainesville, GA, USA

Preventative Medicine for Backyard Poultry Flocks
http://elkhorn.unl.edu/epublic/pages/publicationD.jsp?publicationId=438

B.Glick (1978) Poult Science. The immune response in the chicken: lymphoid development of the bursa of Fabricius and thymus and an immune response role for the gland of Harder.**157**(5):1441-4.

The Responsible Use of Medicines in Agriculture Alliance (RUMA) was established in November 1997 to promote the highest standards of food safety, animal health and animal welfare in British livestock farming.

A unique initiative involving organisations representing every stage of the food chain, RUMA aims to promote a co-ordinated and integrated approach to best practice in the use of animal medicines.

RUMA membership spans the food chain and includes organisations representing interests in agriculture, veterinary practice, the pharmaceutical industry, farm assurance, training, retailers, consumers and animal welfare interests.

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RUMA is made up of the following organisations:

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Animal Health Distributors Association (AHDA)

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Linking Environment and Farming (LEAF)

Meat and Livestock Commission (MLC)

National Beef Association (NBA)

National Consumer Council (NCC)

National Farmers Union (NFU)

National Office of Animal Health (NOAH)

National Pig Association (NPA)

National Proficiency Test Council (NPTC)

National Sheep Association (NSA)

The Royal Association of British Dairy Farmers (RABDF)

Royal Pharmaceutical Society of Great Britain (RPSGB)

Royal Society for the Prevention of Cruelty to Animals (RSPCA)

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