

Chapter 8

The Impact of Disease on Welfare

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8.1 Introduction

Welfare is usually defined in terms either of an animal's ability to cope (Broom, 1986) or of health and behavioural needs. Indeed the very word "dis-ease" implies a state lacking "ease" or well-being. We feel it is important to consider disease holistically: that is to consider the animal's ability to resist stress and the environmental challenges it faces. Whereas the outcome of poor welfare is expressed as disease, the relative contributions of various stressors will vary with each individual. The other chapters consider genetics, nutrition and environment in terms of the welfare of poultry. However, given the same housing, air, feed and water, some birds may become diseased and some remain healthy. Intrinsic biological variation results in a range of nutrient reserves and immune status at hatching, plus differences in genetic make up, social status and behaviour that interact with each other and further factors to provide different outcomes for the individual. In the pragmatic world of farming, flock health status may be frequently chosen as the index of welfare, but it is important not to lose sight of the health and well-being of each individual, even in flocks numbering tens of thousands of birds.

For the individual animal, it matters not whether any disease it suffers from is common or rare, is created by systems it lives in, or by natural susceptibility to the disease. In terms of the impact on the welfare of the global population of poultry, common conditions such as enteritis, footpad lesions, cellulitis, distended crop and respiratory disease have the greatest significance because they are often considered as routine, and if they do not cause significant economic loss, may be accepted as established hazards about which little can be done. By virtue of the numbers of animals affected, these common irritant, non life threatening conditions become very significant.

For example, crop distension might sporadically affect 0.1% of birds in a broiler flock, and sometimes bigger numbers in turkey flocks (Peckham, 1984). This is not

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usually a life threatening condition, but will compromise the bird, and be reflected in reduced growth. A shorter bird may find it harder to access resources in the shed. If the bird is significantly smaller, it may be culled on farm (welfare concerns over on farm slaughter) or be too small to be effectively stunned in the electrical stunning bath at the slaughter plant. This condition is a low level “sporadic” condition of little economic impact, but may, for the individual bird, seriously reduce the quality of its life. If we assume that crop distension is intermittent, but can be found worldwide, then 0.1% of 40 billion meat chicken (estimate for world production) gives 40 million birds a year may have their broader “welfare” compromised by this low level condition. For other common, but economically insignificant, conditions such as pododermatitis, the numbers of poultry affected worldwide can be astounding. In the absence of large-scale surveys of the incidence of foot pad dermatitis (pododermatitis) in chicken, taking assumed figures based on small surveys in Europe, of 25% in broilers and 5% in layers, the number of individual birds affected annually could be some 10 billion plus.

Recognising the complex aetiology of disease, this chapter will outline indicators of disease and microbiological agents of disease, and will attempt to hint at the possible “other factors” and interaction of gene and environment that may contribute to disease. Skeletal and metabolic disorders, by which we mean any condition not caused directly by an infective organism, will be considered in depth because of their widespread occurrence and increasing significance for poultry welfare. *We do not attempt to describe all poultry diseases, but rather to use selected conditions as illustrations of the welfare consequences of ill health.*

8.2 Indicators of Disease

The following signs are all indicative of a bird that is in a state of crisis. From a welfare point of view they are symptomatic of substantial stress, and of a reduced ability to cope with the cumulative and combined effects of current and previous stressors. They reflect strategies that have evolved to conserve and re-direct energy in the body towards combating disease and regaining health. Their presence indicates the need for human intervention to support the recovery of sick birds, and equally importantly to try to prevent the spread of disease, and to recognise possible causes, so that corrective and preventive action may be taken. Birds are seldom treated as individuals (apart from culling) but rather as populations; thus the decision to treat whole groups is generally based on the cost effectiveness of treatment.

8.2.1 Malaise

Typical signs and symptoms of an unhealthy bird include

- **Withdrawal:** the bird isolates itself as far as possible from other members of the flock and from interactions with them, so that the sick bird is to be found under

feeder or drinker lines, or at the edges or corners of houses or cages. The bird also becomes less responsive to most external stimuli.

- Hunched posture: the neck is retracted down towards the body, the tail may droop, the general appearance is more rounded and contracted and the eyes are often closed.
- Dull feathers: the feathers no longer refract the light and particularly in brown-feathered birds look darker. This may be due to the bird's loss of interest in or lack of energy for preening and feather maintenance, but can also be a sign of an inadequate diet or severe parasite infestation.

8.2.2 Pain

In evolutionary terms, a prey animal with manifest signs of pain is more likely to be selected by a predator, thus domestic fowl show few visible signs of pain on visual inspection. However, a bird that is in pain will indicate behavioural distress (including escape behaviour) and may vocalise if handled and the affected area is gently palpated. In poultry there is evidence of pain in several musculoskeletal disorders and infected lesions that will be discussed in the relevant sections below.

8.2.3 Dehydration and Emaciation

These are always symptomatic of poor welfare and a state of disease. As modern systems of poultry husbandry commonly provide adequate feed and water ad libitum, emaciation and dehydration reflect an inability of the individual bird to access these resources. Occasionally this is due to social stress, but more often to lameness or disability due to disease (Butterworth et al., 2002).

8.2.4 Decreased Productivity

Reductions in egg shell quality, egg output or growth rate may indicate that the bird is re-directing nutrients to the repair of damaged tissues. Whereas high productivity does not in itself equate with good health and welfare, reduced productivity (weight gain, or maintenance of weight), in the same thermal conditions is often a sign of disease or distress.

8.2.5 Immunosuppression and Reduced Liveability

Good flock liveability is both a welfare and an economic goal, and there has been much research into nutrients that enhance immune defences. Trace elements such as zinc, iron, copper, selenium and manganese are essential for resistance to disease and normal immune function (Fletcher et al., 1988). The particular importance of

zinc in poultry was reviewed by Kidd et al. (1996). Birds are susceptible to a number of diseases which result in immunosuppression, and these diseases are discussed under the headings Gumboro disease, Chicken Infectious Anaemia, Oncogenic viruses and fungal toxins. The use of intermittent lighting schedules that also reduce daily illumination may improve liveability and reduce mortality in laying hens (Lewis et al., 1996). Immune function was improved in a line of White Leghorn hens that was selected for longevity (Cheng et al., 2001). As well living for longer, the birds' also showed reduced cannibalism and flightiness, plus improved feather score.

8.3 Metabolic and Physiological Disorders

In this section we include those disorders associated with abnormal metabolic function. These usually develop as a result of unbalanced genetic selection by human beings, and frequently affect more than one tissue or organ in the body. Scheele (1997) argues that homeostatic dis-regulation results from an imbalance between production rate and maintenance requirements, which leads to diseases in the organs that supply energy. Thus it is not unusual for several conditions, with essentially the same root metabolic cause, to be manifest in a flock or even a single bird. For example, the review by Sanchez et al. (2000) showed that broilers selected for rapid growth, high breast yield and high feed conversion efficiency can often barely supply their muscles with oxygen and also show a reduced ability to adapt to metabolic stimulation by factors such as altitude, climate or energy/protein-rich diets. This substantial compromise of the health and welfare of very young (under 6 week) birds, compared with slower-growing broiler strains, was attributed by these authors to:

- reduced lung volume: body weight ratio
- decreased ability to fix oxygen in the blood
- higher blood viscosity
- frequent cardiac arrhythmias.

In consequence, many broilers are predisposed to pulmonary hypertension and ascites. Incorporating selection criteria for pulmonary, cardiovascular and haematological characteristics into the genetic selection model and matching these against growth criteria could substantially reduce such problems.

8.3.1 Ascites

Ascites is an accumulation of fluid in the peritoneal cavities, most commonly caused by increased pressure in the blood vessels, which forces out excess fluid and inhibits re-absorption of tissue fluid. Another common cause is right ventricular

failure. Mortality in affected flocks is over 1% and may rise to 20%, although incidence averaged 4.7% in a 1996 international survey (Maxwell and Robertson, 1997). Most aspects of the disease are considered by Julian (1993). The condition may be reduced or prevented by slowing metabolism via genetic, dietary or husbandry measures (such as increased periods of darkness, Gordon, 1997). In their review of causal factors, Decuypere et al. (2000) suggest that a fundamental cause is the imbalance between oxygen supply and the oxygen required to sustain rapid growth rates and high food efficiencies. They also provide evidence for the close association of the quantity, form and quality of the diet and the incidence of ascites.

8.3.2 Cardiovascular Disorders

Whereas cardiomyopathy and ruptured aortas are major causes of mortality in turkeys, they are comparatively rare in broilers. Apart from ascites (above), flip-over or SDS (sudden death syndrome) is the main condition associated with cardiovascular disease in broilers. Mortality levels in affected flocks are typically 0.5–2% with males predominantly affected (Julian, 1996). The absence of clear symptoms on post-mortem, and its occurrence in apparently healthy, fast-growing birds indicates that it is likely to be a metabolic disease, in which an imbalance of electrolytes or metabolites causes ventricular fibrillation. Under research conditions, an imbalance of calcium and phosphorus in the diet can significantly increase SDS (Scheideler et al., 1995). Stress, induced by high stocking density (Imaeda, 2000), bright lights and disturbance by humans may also increase incidence.

8.3.3 Haemorrhagic Fatty Liver Syndrome

In this condition, abnormal accumulation of lipid in the liver, is due primarily to an inappropriate diet, particularly the ad libitum provision of feed high in carbohydrate and low in fat. Such diets are commonly used to increase egg production, but lead to excess storage of fats in the liver. The livers of laying hens become putty coloured owing to contents of up to 70% lipid (mostly triglyceride) and they also haemorrhage. Excessive abdominal fat is seen, and the kidneys are often pale and swollen. Mortality is generally low, but morbidity high and egg production may fall. Scheele (1997) noted that the condition was the most important disease of laying hens in the Netherlands. It is more common in caged layers which cannot exercise to use up the excess energy. When formulating diets for birds it is important to realise that their carbohydrate and lipid metabolism differs from mammals. In particular, the liver rather than the adipose tissue is responsible for lipogenesis. Adding lipase to the diets of laying hens may increase the incidence of liver disease whilst improving the PUFA (polyunsaturated fatty acid) content of yolk fat (Lichovnikova et al., 2002).

8.3.4 Reduced Longevity

An important cause of cellular ageing and reduced lifespan in organisms is oxidative stress. A reduced oxygen supply to body tissues is one way in which improved food conversion efficiency can be achieved. If this occurs in conjunction with increased demands on the metabolism for growth and production, then increased free radical production and damage to DNA is likely. This could in part explain the ever-reducing lifespan of farmed species. Many avian species, however, have a relatively high resistance to oxidative stress (Ogburn et al., 1998) and a stronger antioxidant-defence system than mammals of comparable size (Klandorf et al., 1999). This could help to account for the astonishing increase in productivity of fowl during the past half century. Whereas the ability of birds to cope with a relatively hostile biochemical environment may have enabled them to do this, concurrently it appears to have rapidly advanced the ageing process.

Selective breeding by man has reduced the lifespan of meat-type fowl so dramatically that it is now very difficult to keep parent birds (broiler-breeders) alive for long enough for them to reach sexual maturity and reproduce. If broilers are not slaughtered at their intended market age of around 40 days old, then they begin to die of age-related conditions soon after (Butterworth et al., 2002). Many scientists predict that the lifespan of the modern broiler fed to appetite is about 12 weeks, but for ethical reasons have not run the trials to confirm this. The equivalent in humans would be attaining the body weight of an adult at pre-school age, and living to an average of only 7 years of age.

8.4 Skeletal Disorders

8.4.1 Osteoporosis in Layers

Osteoporosis is rarely an issue in meat-strain birds, or even in broiler-breeders, because their egg output is comparatively low. The unfortunate choice of the term “leg weakness” to describe lameness in meat-strain birds led some to assume that bone strength was reduced, which is not usually the case. Reduced bone strength is however, virtually ubiquitous, to some degree, in modern strains of layers that are managed for high egg output. Osteoporosis is a reduced mineralisation of the main structural bones of the skeleton which weakens them, leading to torsion (particularly of the keel bone) and to fractures. The birds are unable to obtain sufficient calcium from the diet or by release from medullary bones (which act as calcium reservoirs) to form the egg shells and so they mobilise skeletal calcium. The skeleton becomes increasingly weak as lay progresses, and older birds are more likely to suffer “*cage layer fatigue*” in which, as well as widespread bone abnormality, paralysis occurs due to nerve damage from weakened bones in the vertebral column. Caged birds also have insufficient space to exercise, and in particular to perform weight-bearing exercise and therefore are prone to *disuse osteoporosis*.

Osteoporosis is a major welfare issue because millions of birds are affected and may suffer pain from broken bones (see below). The widespread occurrence of this disease indicates that the laying hen cannot adapt its calcium metabolism sufficiently to cope with the stressful demands of modern production and husbandry. An inability to cope is a welfare issue (Broom, 1986). The main changes that place an unreasonable demand on the physiology of the layer are:

- Prolonged and continuous egg laying. Hens evolved to lay in clutches with periods in between that enabled their skeletal reserves to be replenished.
- Advancing the age of sexual maturity. By forcing birds into lay when young, skeletal growth is incomplete even before the demands of egg laying commence. Furthermore, oestrogen activity has a greater effect on skeletal integrity than diet, and thus should not be prematurely stimulated in the immature bird.
- Insufficient weight-bearing exercise in caged birds (see Baxter, 1994).

8.4.2 Lameness in Broilers

Lameness in broilers stems principally from various skeletal disorders, but is so important from a welfare point of view that it is considered under a separate heading. According to one authority (Webster, 1995), lameness in broilers constitutes “in both magnitude and severity, the single most severe, systematic example of man’s inhumanity to another sentient animal.” There is widespread concurrence that it is a major welfare concern, particularly as so many millions of individual animals are affected.

8.4.2.1 Assessment and Prevalence

Lameness is widely assessed using the gait scoring system, devised by Kestin et al. (1992), that assigns a gait score (GS) from 0 (normal, fully mobile and agile) to 5 (incapable of walking) based on visual appraisal by humans of the gait of a broiler that is encouraged to walk. With trained and standardised assessors, and with an appropriate sample of broilers (Kestin and Knowles, 2003), the method can estimate the distribution of gait scores in a commercial flock – or in other words, the magnitude and severity of lameness. The prevalent opinion is that broilers with a gait score of 3, 4 or 5 have increasingly compromised welfare. On this basis, recent surveys have estimated the proportion of broilers affected (GS>2) to be 2.5% (Knowles et al., 2008), 14.8% (Berg and Sanotra, 2001, a pilot study in Sweden of 400 broilers in 8 flocks at 29–33 days of age), 30.1% (Sanotra et al., 2001, a survey in Denmark of 2,800 broilers in 28 flocks at 31–42 days of age). There are a number of possible explanations for such widely differing estimates of the prevalence of lameness in broilers. One is inter-observer reliability, and the inevitable inaccuracies associated with a subjective method of evaluation. This can be overcome to a large degree by training, validation and the use of standards (such as a large reference database on

videotape of the locomotion of broilers of each different gait score). Several other factors that are known to affect lameness are discussed below. Many of these varied between surveys and could account for some of the differences.

To overcome the potential errors associated with subjective methods, a few objective methods of measuring lameness have been developed. Computer analysis using filmed images or pedobarographs has proved to be accurate and reliable in characterising gait (Corr et al., 1998, Reiter, 2002, Savory, 2003, personal communication) but also expensive, time-consuming and not suited to fieldwork. A simple new method based on latency to lie in very shallow water is being developed and has been used in trials on commercial farms (Weeks, 2001, Weeks et al., 2002, Berg and Sanotra, 2003). Results have initially been compared against gait scoring with highly significant correlations. Once fully refined, the test is expected to be used for auditing, breeder selection and accurate field assessments of lameness. From a welfare perspective, the new test has the advantages of being a bird-based assessment requiring no human interpretation, and of the duration of the test decreasing to a few seconds with increasing lameness.

For all methods of assessing prevalence and severity of lameness an appropriate sample of birds needs to be selected. For a given level of precision of the estimate, the number of birds required for the sample will vary according to the proportion of lame birds in the flock (Kestin and Knowles, 2003). In practice, in a commercial broiler house with fittings in the way, it is difficult to select a truly random sample of birds and this affects the accuracy of any estimate.

8.4.2.2 Genetic Influences on Lameness

As discussed in Chapter 7 by Savory, selection for fast growth and increased food conversion efficiency has had an adverse effect on several aspects of broiler welfare. Principal among these is increased susceptibility to lameness, although this varies slightly between genotypes (Kestin et al., 1992, 1999). A survey of leg problems in commercial broiler flocks in Sweden found the proportion of lame broilers (gait scores >2) was significantly greater ($P<0.001$) in Cobb genotypes, at 26.1%, than Ross 208 genotypes, at 14.1% (Sanotra et al., 2003). Several studies have shown that high levels of lameness are significantly associated with high growth rate and precociously heavy body weight, and Kestin et al. (2001) demonstrated this across a particularly wide variety of genotypes (Fig. 8.1). Previous studies (Kestin, 1992, Sorensen et al., 2000) have also shown that both the proportion of broilers affected by lameness, and the severity of lameness, increases with age. As would be expected in growing broilers, weight also generally increases with age, but this only applies to birds that can still walk and have adequate access to feed and water (up to GS 3). Those birds classified as GS 4 or 5 are unable to gain adequate access to feed and water, and in consequence their growth is impaired (Fig. 8.2). Clearly the health and welfare of such very lame broilers is so poor that they should be culled, and good producers will have a thorough culling programme. Leg culls in Northern Ireland were 0.5% of males and 0.4% of females, McNamee et al. (1998).

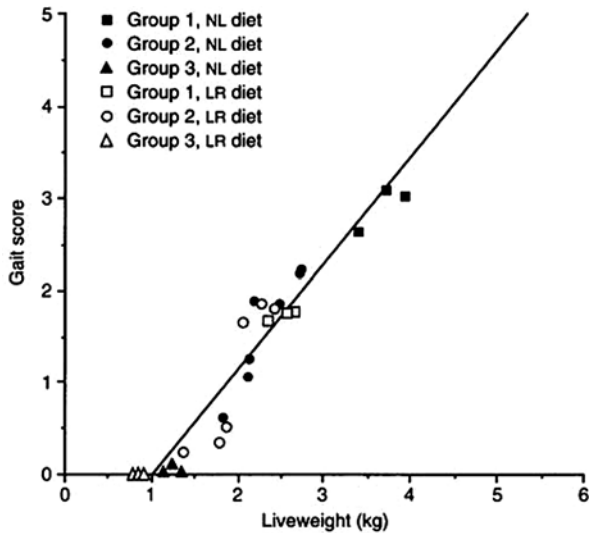


Fig. 8.1 Relationship between lameness (gait score) and liveweight of 3 genotype groupings of 13 genotypes at 54 days of age fed a non-limiting (NL) or Label Rouge (LR) diet. Reproduced with permission, from Kestin et al. (2001). Regression coefficient 1.262 ($P < 0.001$). A similar relationship was found at 81 days of age

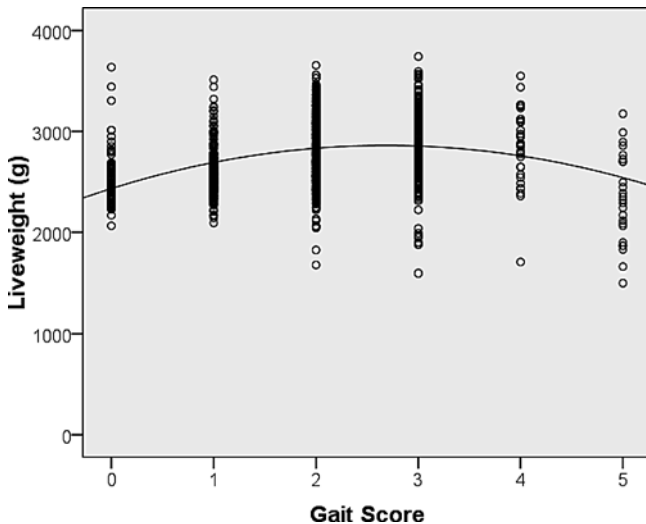


Fig. 8.2 The curvilinear relationship between Gait Score (lameness) and body weight. The lamest birds (GS 4 and 5) cannot access feed and water freely

8.4.2.3 Husbandry Influences on Lameness

Research has shown that several variables can affect the expression of lameness in a flock of broilers. It is important to note that many of these affect liveweight and that often any benefits are due primarily to this weight reduction. Thus, to determine whether changes have a value per se, correction must be made for alterations in body weight. Lameness increases in prevalence and severity with increasing stocking density (Hall, 2001; Sørensen et al., 2000). The free floor space available for exercise decreases with increasing stocking density and could account for some of the increase in lameness. Several studies support the hypothesis that reduced exercise increases leg problems (Reiter and Bessei, 1998; Bizeray et al., 2000). The effects of light on broiler welfare are complex, however certain lighting patterns may reduce the incidence of leg disorders (reviewed by Gordon, 1994; Sorensen et al., 1999). Improvements in leg health may be due both to the stimulation of bouts of activity and also to periods of high quality rest and improved metabolic health (Gordon, 1994). This explanation could equally apply to the reported benefits of providing feed in meals rather than *ad libitum* (Su et al., 1999). To reduce leg problems effectively, feed restriction generally has to be severe enough to cause long-term growth reduction whether applied for short periods at a young age in broilers (e.g. Su et al., 1999) or throughout life in broiler parent stocks. It then becomes difficult to balance the resultant welfare benefits with the welfare problems. In the case of broilers other methods should preferably be employed to improve leg health. Because use of perches by broiler is so low, particularly after about 4 weeks of age, they have no effect on leg health. Most trials using environmental enrichment to stimulate activity also have negligible effect on health although they may alter behaviour.

Recent experiments have begun to examine effects on lameness and other responses to combinations of husbandry measures such as lighting schedules and stocking density (Sanotra et al., 2002). There is now a need for the combined effects of all factors known to affect lameness and other aspects of broiler welfare to be studied in a systematic way in commercial scale trials.

8.4.2.4 Causes of Lameness

In simplistic terms, modern broilers have been selected to have the potential for extremely rapid muscle growth. If this growth of soft tissue occurs at a very young age, then it may exceed the capacity of the skeletal system to support it. Moreover, broilers have been selected for increased breast muscle size. This confers biomechanical disadvantages owing to the width of the breasts in much the same way as the enlarged udders of modern dairy cows force abnormal gait of their hind limbs. Reiter (2002) contrasts the rolling gait of broilers, which need to shift the centre of gravity over each leg in turn with each step, with layers that walk normally because both feet are beneath their centre of gravity.

The principal musculo-skeletal disorders associated with lameness in broilers were reviewed in 1993 by Thorp. Although these are conveniently considered separately from infectious causes, reviewed by Butterworth (1999), there may be overlap. For example, abnormal growth plate development, or wear and tear in

distorted joints, may predispose to colonisation of the synovial fluid and membranes by opportunist infectious agents such as *staphylococci* or *reoviruses*. Following acute infection, chronic conditions such as tenosynovitis and arthritis may develop. The inflammation and pain associated with infectious causes of lameness generally results in a substantially reduced ability and inclination to walk, that is to a gait score classification of 4 or 5 (Jordan, 1996, Kestin et al., 1994). From *post mortem* examination, it estimated that staphylococcal tenosynovitis accounts for 3–4% of cases of lameness (Pattison, 1992, Reece, 1992) and the incidence in broiler breeders is higher, since the disease has longer to develop.

8.4.2.5 Consequences of Lameness

The disabling consequences of lameness have particular significance for broiler welfare if they cause behavioural frustration, prolonged discomfort or pain.

Many studies have shown significantly altered behaviour patterns, particularly reduced activity, in lame and heavy birds (Murphy and Preston, 1988; Newberry et al., 1988; Blokhuis and van der Haar, 1990; Bessei, 1992; Weeks et al., 1994). More recently, Weeks et al. (2000) observed that, on average, lame broilers (GS 3) lay down for 86% of their time, which was significantly longer than the 76% of sound birds (GS 0). Walking declined with age but occupied an average of 3.3% of the time of broilers approaching slaughter weight. Lameness significantly reduced this to a minimal 1.5% in the worst affected birds. For lame birds, the time spent on their feet idling or preening was significantly less than sound birds, and this could indicate a reduced quality of life. More importantly, there was evidence of frustration of normal feeding behaviour. When the feeders were set lower than usual, lame broilers lay down to eat for almost half their feeding time, whereas sound birds predominantly chose the usual standing posture for eating. Moreover, detailed observations using video records revealed that lameness altered the feeding strategy of broilers. The sound birds visited the feeder an average of more than 50 times in 24 h, but the number of visits to the feeder was reduced with increasing lameness to an average of around 30 visits in the lamest broilers. However, meal duration was adjusted to give no overall differences in time spent feeding per day (Fig. 8.3).

The alterations of the time budget, in particular the reductions in activities performed whilst standing, and the different feeding strategies adopted, are consistent with lameness imposing a cost on the affected broilers to the detriment of their welfare. In an experimental study of dustbathing behaviour, Vestergaard and Sanotra (1999), found that lame broilers with tibial dyschondroplasia (TD) dustbathed on significantly fewer days and showed reduced dustbathing behaviour. These birds also had longer periods of tonic immobility when tested at six weeks of age than birds without TD, and the authors suggested that an inability to dustbathe might increase the sense of fear. Their study also indicated that it was the pain associated with lameness that reduced dustbathing behaviour. Very severe lameness may result in reduced ability to access food and, more critically, water drinkers – particularly if nipple and cup drinkers are set at a height which requires that birds have to “stretch” to reach them. Birds with this degree of lameness should always be humanely culled. The consequences of not doing so were revealed in a study carried out in the UK by

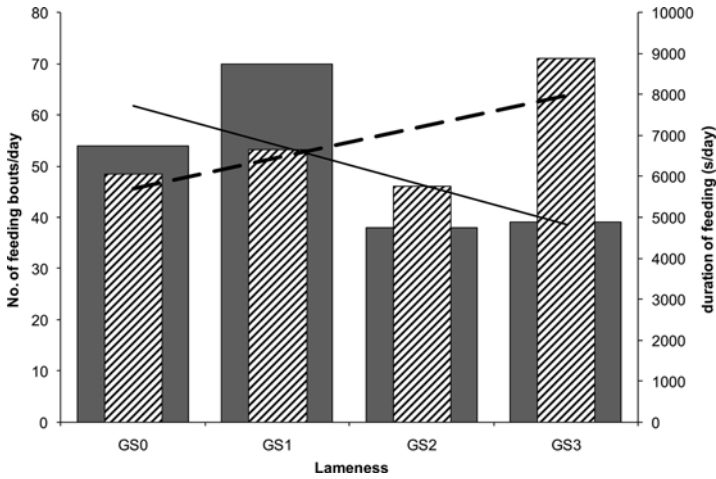


Fig. 8.3 With increasing lameness from none (GS0) to pronounced (GS3), broilers reduce the number of feeding bouts (*solid grey*) but increase the duration of each bout (*hatched*) so that overall time spent feeding remains similar (after Weeks et al., 2000)

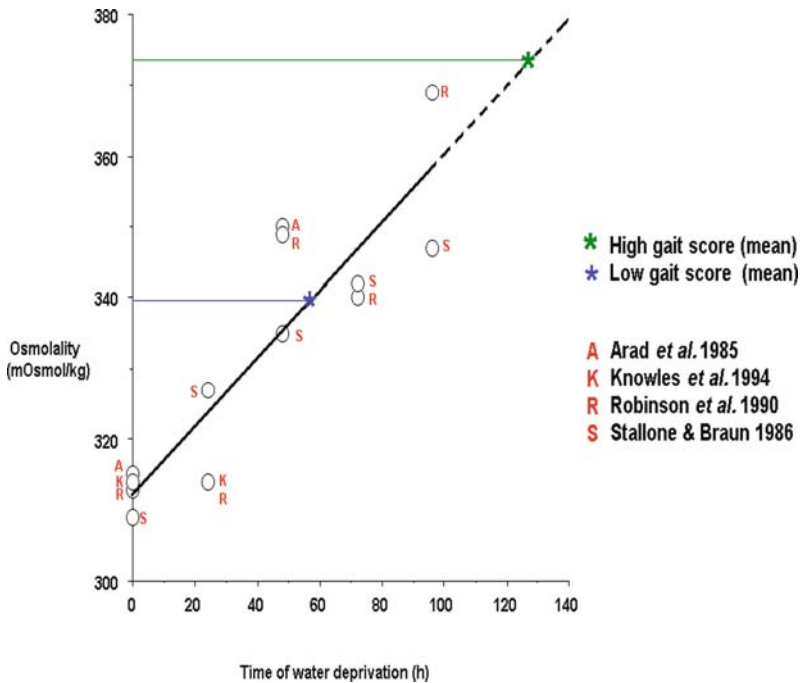


Fig. 8.4 The effect of time of dehydration on plasma osmolality in domestic fowl. A best fit line $x-y$ has been drawn for the data available from previous work (Arad et al., 1985; Knowles et al., 1994; Robinson et al., 1990; Stallone and Braun 1986). The mean plasma osmolality values for the high gait score (H) and low gait score (L) birds in this case study are also indicated, as are error bars for the standard error of the mean

Butterworth et al. (2002) who associated chronic dehydration with severe lameness (see Fig. 8.4).

There is increasing evidence that broilers in high gait score categories, many of which will be in the acute stages of bacterial chondonecrosis (BCN), are in pain (Duncan et al., 1991; Gentle and Thorp, 1994; Thorp, 1996; Danbury et al., 1997; Pickup et al., 1997; McGeown et al., 1999; Danbury et al., 2000). Osteomyelitis in human beings is recognised to be a painful and debilitating condition (Whalen et al., 1988), and chickens have been used as an experimental model of haematogenous osteomyelitis in human beings (Emslie et al., 1983). Thus we propose that BCN and osteomyelitis should be considered to have a substantial adverse welfare impact on affected birds.

8.5 Injuries and Disease Associated with Poor Husbandry

8.5.1 General

All forms of disease may be associated with poor stockmanship, but more widespread is the inadequate provision of quantity rather than quality of care. It is important to identify sick birds swiftly. Removal of diseased animals promptly is likely to reduce the spread of any infectious disease throughout a flock. Diseased birds are exhibiting poor welfare through distress and pain, and should be treated or culled without delay. However, in the majority of modern, intensive, production systems this is virtually impossible to achieve owing to the thousands of birds under each person's care.

On a typical site there could be a total of 160 thousand broilers in several houses, but only 2 stock-people. If each bird were to be visually examined daily, then even if both people spent 8 h, this would allow only 0.28 s per bird. In reality there are many other tasks to fill the working day and so sick birds get overlooked, especially in systems such as multi-tier cages for layers where it is physically very difficult to actually see into every cage. The potential for poor welfare is built into such systems where the number of human carers is dictated by economic rather than animal welfare considerations. In the EC, future legislation may force an improvement: the current proposals for a new broiler welfare directive indicate that all birds should be inspected twice daily from a distance of less than 3 m.

8.5.2 Bone Breaks

These are a major cause of poor welfare in laying hens and a concern during their handling. The number of freshly broken bones found in live birds prior to slaughter and the number of old healed breaks found at slaughter are unacceptably high (Knowles and Wilkins, 1998). The bones of most layers, especially those housed in cages, are weakened by osteoporosis which increases their susceptibility to breaks.

Birds from more extensive laying systems often have stronger bones (Gregory et al., 1991; Fleming et al., 1994) and suffer fewer breaks during depopulation, but they can have a greater prevalence of old healed breaks. For example, Gregory and Wilkins (1996) reported a rate of healed bone fractures of 23% at 72 weeks in one study. The old breaks may occur as a result of collisions due to poor design within these housing systems. The number of breaks occurring just prior to slaughter can be reduced by increasing bone strength, and by handling birds with more care. For example, Gregory et al. (1993) found the incidence of broken bones in end-of-lay hens removed by two legs from cages was less than half that in birds removed by one leg. The numbers of breaks occurring during lay can be reduced by better design of housing systems and the physical environment within them.

8.5.3 Bumble Foot

This condition is essentially an acute infection of the soft tissues (pad) underneath the foot and arises from minor skin abrasions that enable the entry of bacteria such as *Staphylococci* spp. The body's immune response produces considerable amounts of pus and often inflammation, which may be accompanied by pain. Because of the relatively poor circulation of the foot, the condition tends to persist for weeks. If treated individually by lancing and cleaning the foot or antibiotic therapy, bumble foot can be cured. This is seldom done on modern large production units to the detriment of bird welfare. Affected birds find it difficult to walk and they may approach feed and water less and thus have reduced production. Prevention lies in separating the bird from its faeces (as in conventional wire battery cages) or, preferably, in housing on a clean soft substrate. The condition is increasing in prevalence as cages modified by perches and alternative laying systems become more common (Tauson and Abrahamsson, 1994).

8.5.4 Foot Pad Dermatitis and Hockburn

The type of litter substrate and its moisture levels and ammonia content affect the incidence of these skin lesions which are a form of contact dermatitis. Su et al. (2000) found lower incidences of foot burn and of lameness on wood shavings compared with chopped straw. Tucker and Walker (1992) also reported reduced hockburn on drier, friable litter.

8.5.5 Respiratory and Eye Conditions Associated with Aerial Pollutants

In general, intensive poultry housing has the largest concentration of aerial pollutants of all farm animal housing, with inhalable dust concentrations of up to 10 mg per m³ and respirable dust (particles small enough to enter the lungs) of 1.2 mg

per m³ (Hartung, 1998). This survey also found concentrations of endotoxins in laying hen housing up to 860 ng per m³ of inspirable dust. Overall mean inhalable and respirable dust concentrations in a different survey were 3.60 and 0.45 mg per m³ in poultry buildings, with the high concentrations in broiler houses and in percheries for laying hens giving particular concern for both stockmen and animal health and performance (Takai et al., 1998). Dust concentrations are higher where litter is present.

Ammonia concentrations may vary over time and location within a house as well as between houses. Typical European mean values are 21 ppm in broiler houses and 3 ppm in cage layer houses (Seedorf and Hartung, 1999). Exposure to ammonia may reduce poultry welfare by causing irritation to mucous membranes in the eyes and respiratory system, increasing susceptibility to respiratory disease and reducing productivity (Kristensen and Wathes, 2000). At concentrations above 60–70 ppm, ammonia causes irritation of mucous membranes and of the respiratory tissues resulting in keratoconjunctivitis, tracheitis and oedema in the upper airway, and damage to the cilia in the trachea. High levels of ammonia also seem to depress the birds' appetite (Jones and Roper, 1997). At low concentrations it is likely that ammonia contributes to the severity of respiratory disease caused, for example, by Infectious Bronchitis (IB), or *Mycoplasma* infection.

Many viral, bacterial, fungal and parasitic disease organisms rely on aerial transmission to other birds and human beings. Steps should be taken to reduce shedding, spreading and concentrations in the air. For example, the risk of contamination by *Salmonella* may be reduced where air flow rates over litter or manure deposits exceed 15.6 m per minute (Mallinson et al., 2000).

The use of formalin vapour to control aerosol pathogens within the hatching chambers in broiler and pullet hatcheries has welfare benefit in terms of reduced incidence of yolk sac infection, usually caused by *E. coli* infection during the first days of life, but the highly irritant formalin vapour environment into which the chicks hatch is likely to have an impact on the birds in terms of upper respiratory and ocular irritation during the hatching period.

8.6 Infectious Diseases

Whilst it is tempting to give high priority to the “big gun” diseases in poultry, it is the low level, chronic conditions that have the most insidious impact on global poultry welfare because these conditions are often sporadic, they are hard to resolve, and there may not be strong economic pressure to resolve them. But, for the individual bird, of which there are estimated to be approximately 40 billion meat birds each year, and 5 billion layers at any given time, the combined impact of these conditions is very great. For this reason, the following summary of selected infectious diseases includes some which would not normally be considered as “big guns”, but by their common, low level nature, are likely to have substantial impact on global poultry welfare.

8.6.1 Parasitic Diseases

Through evolution, the majority of birds reached a state of equilibrium with parasites that caused tolerable debility, but rarely severe disease. The extremely rapid intensification of the industry during the last half century has disrupted this balance in favour of the parasites and at the potential disadvantage of their bird hosts. Anthelmintics provided a short term solution, but concerns for human health, and resistance of parasites to the drugs is forcing new strategies for controlling disease. Parasitism tends to be worse in free-range and large group floor housing systems that otherwise have many potential welfare benefits. Since morbidity and mortality can reach unacceptably high levels, solutions need to be found. This is likely to be a key area of concern for the welfare of poultry in many alternative systems of husbandry.

8.6.1.1 Coccidiosis

Coccidiosis is a significant poultry disease found universally in chicken, turkeys, ducks and game birds worldwide. Species of the protozoan parasites *Eimeria* and *Tyzzeri*, which cause coccidiosis are often very host specific, and site specific within each host. The disease is variable in its severity, but may result in frank enteric disease, due to damage to duodenum, caecum or rectum, with diarrhoea, which may result in increased mortality, depression and anaemia. Alternatively, the disease may not present any clinical signs, but show as poor growth. Because coccidia produce resistant oocysts, which can persist in the environment for long periods, coccidiosis is very difficult to eliminate from intensively farmed poultry, and control relies on vaccination, or use of scrolling generations of antiparasitic drugs which become ineffective as the parasite develops resistance. The welfare impact of coccidiosis on poultry is substantial because the potential for enteric disease or poor thrift is universal. The need for vaccination and use of coccidiostats in intensive systems ties animal health to the ability of the pharmaceutical industry to keep one step ahead (or at least keep pace) with the malleable resistance of the parasite.

8.6.1.2 Arthropod Ectoparasites

The developments in housing, and the increasing size of flocks have led to changes in the relative importance of different ectoparasites, and some previously uncommon parasites have become common, whereas some previously problematic conditions have almost disappeared. For example, the Red Mite (chicken mite) does not as readily infest layers in metal cage systems because of the absence of wood, roosts and static litter. Many arthropod parasite lifecycles are stopped by the short production cycles seen in broiler chicken, or by repeated house disinfection and cleaning. However, in systems which take the birds to greater ages, or which cannot easily be cleaned (free range, wooden houses), then arthropod parasites can become a very significant cause of disability in the birds. Intensively farmed poultry are affected by Lice (especially caged layers), Red Mite (broiler breeders and free range units),

Northern Fowl Mite (turkeys and broiler breeders) and Scaly Leg Mites (older birds) along with fleas, ticks and flies. Lice and mites cause irritation, feather loss, and skin damage. In systems where there are parasite challenges and dustbathing is not possible, it might be assumed that prevention of this normal behaviour which can decrease the burden of parasites, reduces welfare.

8.6.2 Chronic Diseases

8.6.2.1 Cellulitis

Localised skin infection in poultry is common. In broilers, breast blisters and cellulitis result from breaks in the skin and subsequent colonisation by opportunistic bacteria such as *E. coli* or *Staphylococci* spp.. *E. coli* cellulitis may secondarily cause subcutaneous and cutaneous skin infection with inflammation and oedema, particularly in the thigh and lower abdomen (Randall et al., 1984; Peighambari et al., 1995a; Onderka et al., 1997). In welfare terms, the likely impact of these skin conditions can be assessed by evidence provided by, for example, reports from slaughterhouse meat inspection (Yogarathnam, 1995).

8.6.2.2 Egg Peritonitis

This can be an important cause of sporadic death and poor welfare through disease in layers and breeding birds. Impacted egg material, or material from the oviduct may enter the peritoneal cavity, eventually causing localised abscesses, salpingitis and peritonitis. The cause appears to be a combination of hormonal effects and bacterial infection within the peritoneal cavity.

8.6.2.3 Mycoplasmosis

Mycoplasmas, most notably *M. gallisepticum* and to a lesser extent *M. synoviae*, cause significant respiratory disease in broilers and “egg drop” in broiler breeders or hens when the bird is subject to simultaneous infection or immunosuppression with infectious bronchitis (IB) or infectious bursal disease (IBD) (Jordan, 1996). Uncomplicated infections may cause no clinical signs or mortality, but it would appear that at the present time, Mycoplasmae are becoming a more significant cause of welfare insult through respiratory disease and lameness in intensively farmed birds of over 45 days of age.

8.6.2.4 Pendulous Crop

In chickens, the formation of an over-large, fluid-filled crop leads to poor growth and chronic ill thrift. Small birds will be culled on farm, or may suffer problems at slaughter as a result of the setting up of the stunning equipment for bigger birds. This common but sporadic problem appears to have a genetic component. Feed type,

whole grain feeding, litter type and previous exposure to disease also have a role to play in development of pendulous crop.

8.6.3 Contagious Diseases

8.6.3.1 Avian Influenza Viruses (Fowl Plague)

These viruses are a cause of intermittent serious disease, with the potential for high morbidity and mortality in intensively reared poultry. Influenza A (H5N1) virus is a highly pathogenic and contagious influenza virus affecting birds. The first outbreaks of H5N1 occurred in Cambodia, China, Indonesia, Thailand and Vietnam in 2003, and 100 million birds were destroyed in order to control the outbreak. Highly pathogenic H5N1 is now found in a number of European countries, and low pathogenicity varieties are found in wild bird populations in North America. The general trend has been for improved control through vaccination and biosecurity in farmed birds – with a reduction in the number of outbreaks, but a gradual increase in the pathogenicity in wild birds. The number of human cases of Avian Influenza is 433 cases (262 deaths) to June 2009 (WHO 2009).

For an individual bird which becomes infected, the disease has severe and profound consequences with depression, coughing, respiratory distress, nasal and ocular discharge, a swollen face, diarrhoea and finally, paralysis and death in up to 80% of cases where compulsory slaughter has not intervened. From a welfare perspective, along with the direct effects of disease, a significant welfare “threat” to farmed birds is the potential for poorly controlled destruction of birds. In a disease outbreak situation it is possible for the normal standards of handling and humane slaughter to be overwhelmed by the sense of “urgency” to protect people and other farmed birds. Recent video and news footage shows very poor regard to care and humane treatment for the birds in the culling area. Whilst it is clear that robust disease control measures are important in preventing the uncontrolled spread on AI, it should not be forgotten that a measure of “humanity” is how we treat animals in time of “crisis” – and the evidence provided by the response in some countries has not been encouraging in this respect.

8.6.3.2 Chicken Anaemia Virus

Chicken anaemia virus (CAV) is a common worldwide infectious disease of chickens caused by a Circovirus. If breeder birds are exposed to CAV before they come into lay, the disease is sub-clinical, but, if they are exposed when they first come into lay, the virus, transmitted via the egg, leads to destruction of the bone marrow and the thymus, spleen and bursa of Fabricius in their offspring. Young birds show signs of this immune depletion from about 10 days of age, and mortality is usually around 10%, but can be up to 60%. Infected birds show haemorrhages under the skin and in the muscles, and gangrenous dermatitis may occur.

Because of the anaemia and immunosuppression which results from lymphoid tissue damage, birds which recover are more susceptible to concurrent or secondary disease.

8.6.3.3 Gumboro Disease

Gumboro disease (Infectious Bursal Disease, IBD) is a highly infectious global disease that affects young chickens, including layer and breeder stock, turkeys and ducks, usually before the age of six weeks. Strains of the IBD virus (IBDV, genus *Birnavirus*), which vary from continent to continent, affect B lymphocytes and macrophages in the focal lymphoid tissue, particularly in the bursa of Fabricius (BF), tonsils and spleen. Some genotypes and strains of bird appear to be less susceptible (e.g. White Leghorn), as do older birds in which lymphoid tissue has become involuted. Birds shed the virus in their faeces, and, because of the resistant nature of the IBD virus, it is readily mechanically transmitted between farms.

Damage to lymphoid tissue by the virus in early life reduces the birds resistance to concurrent or secondary disease challenges, and may also affect the birds ability to mount effective responses to vaccines for diseases such as Marek's disease, Newcastle disease, IB and coccidiosis. In acute disease, birds become rapidly depressed, inactive, sitting with ruffled feathers, trembling, anorexic, dehydrated and soiled by watery diarrhoea. Vent pecking may become common for a period. Initial (acute) morbidity can be up to 100%, but in many cases infection may be subclinical, and "worse case" mortality is usually less than 20%. Even if the initial challenge does not produce clinical disease, the bird is subsequently permanently immunosuppressed, and this is the major animal welfare and economic impact of the disease.

Vaccination, including that of parent stock to provide maternally derived antibody, has reduced the impact of Gumboro disease worldwide, but strain variation makes complete protection complex. The immunosuppression resulting from Gumboro infection contributes to many cases of respiratory and enteric disease in chickens. The effect of Gumboro disease on the global population of (particularly) broiler chickens, cannot be overstated, as IBD has a significant impact on bird susceptibility to other disease organisms, including gut parasites.

8.6.3.4 Infectious Bronchitis

Infectious bronchitis (IB) is a highly infectious viral disease caused by the infectious bronchitis coronavirus (IBV). IB affects layers and broilers to cause initial respiratory distress, sneezing, gasping, facial swelling, and malaise and retarded growth with low mortality, but high morbidity. If the birds are infected at between 3 and 6 weeks of age, the infection may additionally damage renal tissues causing depression and mortality of up to 30%. However, in some outbreaks the initial disease can be asymptomatic, but in laying birds, damage to the oviduct results in reduced egg production, or can cause "blind" layers – where the egg is passed into the body

cavity due to damage to the oviduct. IB is controlled to a large extent by aerosol and water vaccination (*see section on Vaccination below*).

8.6.3.5 *Marek's Disease*

Marek's disease, caused by avian herpes viruses, commonly affects birds from 6 weeks or more. Six sub-classifications of Marek's disease have been suggested, although the disease may take a form which presents a mixture of the following forms (Herenda and Franco, 1996);

- (a) Per-acute, manifested by sudden death.
- (b) Anaemia, in 3–6 week old chickens.
- (c) A “classical” presentation with thickening of peripheral nerves and subsequent nerve damage, resulting in progressive spastic paralysis of the legs and wings, sometimes with torticollis (head and neck twisting) and sometimes with respiratory distress. Lymphomatous tumours appear in the skin, gut, eye, ovary, lungs, heart and liver. Total mortality in the “classical” form is usually less than 15%, with a low incidence at any one time, and disease appearing over many months.
- (d) Acute disease, in birds of 6–12 weeks of age and characterised by sudden death or lymphomatous tumours in the gut, spleen, kidneys, brain and spinal cord.
- (e) Skin leucosis is the most common form of Marek's disease seen in meat producing birds, in which multiple skin tumours are seen. Birds at slaughter age may show this form as thickening and enlargement of the feather follicles.
- (f) Transient paralysis in 12–18 week old pullets.

It is likely that a proportion of culls in commercial broiler flocks, especially those showing progressive leg paralysis or recumbency, and during the late part of the broiler growing cycle, are due to breakout of Marek's disease despite selection for resistance in breeder stock and vaccination.

8.6.3.6 *Newcastle Disease*

Newcastle disease is caused by an enveloped RNA virus, a *Paramyxovirus* (NDV). Over 200 species of birds are reported to be susceptible to NDV although some birds e.g. ducks and geese, show few clinical signs, even if infected with strains virulent for chickens. The history of NDV is marked by global panzootics in which disease spreads across the world, with the initial occurrence in all cases in the far or Middle East. It is suggested that NDV may spread over huge distances as an aerosol, although this has never been clearly demonstrated. Human and bird vectors are more likely to have been the disseminators of disease in all recent outbreaks. Racing pigeons are vaccinated against paramyxovirus 1, and exotic birds are quarantined to help prevent international spread. The NDV viruses are very persistent, surviving for several weeks at low ambient temperatures (Alexander et al., 1998). Vaccination is the cornerstone of protection from NDV for intensive poultry production, and in terms of animal welfare, NDV provides a good example of vaccination as a valuable

tool in protecting animal welfare. Some people might argue that it is the intensive nature of poultry production that creates the potential international movement of the NDV, and creates the conditions in which huge numbers of birds are “at risk” within the same airspace or on the same site. The welfare of birds which become infected with NDV is impacted either (a) by the disease itself or (b) by methods used to eradicate the disease on farm.

Welfare Impacts of Newcastle Disease

In the most virulent viral infection, the per-acute form, sudden death may be the presenting sign, but depression, lameness, diarrhoea with haemorrhagic lesions in the gut, particularly the proventriculus, swelling of the head and neurological signs may precede death and mortality can be up to 100%. In the moderately virulent form, severe respiratory disease with inflammation of the trachea and haemorrhages in the lung, beak gaping, coughing, sneezing, gurgling and rattling, yellowish-green diarrhoea and nervous signs occur, and mortality may be 50%. In laying hens, diarrhoea and pronounced egg drop (reduced egg production) occurs. In the low virulence presentation, mild respiratory distress occurs in chickens and turkeys, but if other diseases are present at this time, the “severity” of the NDV will be increased. The welfare impact of NDV is profound for the affected bird or flock. Serious disease of this nature prevents feeding, drinking and activity, and because of the numbers of birds affected in virulent outbreaks, stockman “care” is not feasible.

Welfare Impacts of Eradication Methods

Newcastle disease and Avian Influenza represent serious disease in commercial poultry, and in most countries, an outbreak is subject to vigorous culling to reduce the risk of transmission (e.g. 92/66/EEC). It is the practical difficulties of implementing humane on-farm compulsory destruction of birds that creates potential welfare problems. In the UK (Animal Health Act 1981, Diseases of Poultry Order 1994), and under similar legislation in many countries worldwide, diseased and “at risk” birds are compulsorily killed by gassing, neck dislocation or poisoning. The logistical problems of killing birds on-farm in a humane manner are huge. Manual killing of large numbers of birds is exhausting for the operatives, and is likely to lead to poor control of welfare at killing. Pneumatically operated mechanical stun/kill guns have recently been developed that may reduce these difficulties (www.awtraining.co.uk). It has been proposed in a number of countries that mobile stunning and slaughter lines could provide emergency capability to kill large numbers of broilers, layers or turkeys on farm in the event of NDV, but as yet, no such capability exists.

8.6.3.7 Oncogenic Viruses

Birds appear to be unusually susceptible to oncogenic disease, and, particularly in systems which raise birds to maturity, tumours may become a significant cause of

morbidity and mortality. Reticuloendotheliosis viruses, chick syncytial virus, spleen necrosis virus and duck infectious anaemia are examples of oncogenic (cancer causing) viruses which may cause tumour formation by inducing the *myc* oncogene.

8.6.3.8 Salmonella

To date, there are nearly 2,500 serovars of *Salmonella* described, but in commercial broilers, *S. enteritidis* and *S. typhimurium* dominate. Individual *Salmonella* serotypes fluctuate in significance, with fluctuations in the relative importance of phage types 4, 7, 6, 8, 13A, 29, and 34 in recent years. Salmonellosis usually affects young birds of less than 1 month of age. The morbidity rate for *Salmonella* infections is very variable, and mortality is usually low, at less than 20%. Birds affected by *Salmonella* may become depressed, inactive, with visual impairment and pasting of faeces around the vent. If broilers are affected before 4 weeks of age, there is often significant variation in the weight of birds by slaughter age. This size variation can result in welfare problems through differences in ability to reach drinkers, and some birds may be inadequately stunned as a result of difficulties in adjustment of automated electrical stunning and neck cutting machinery to suit flocks containing a wide range of bird sizes.

8.6.4 Fungal Toxins

Mycotoxins, are complex chemicals produced by fungi and moulds which can cause problems of toxicity in commercial poultry if spoiled grain is fed. Trichothecenes (*Fusarium*, *Stachybotrys*) can cause immunosuppression, anaemia, defects in feather and skin growth and reduced growth, lethargy, paralysis and seizures (Bermudez et al., 1997). Aflatoxin (*Aspergillus*) can cause suppression of growth and haemorrhage into the skin and muscles, bruising, reduced sperm count in breeder birds, and immunosuppression, resulting in increased susceptibility to secondary infections. Young birds and ducks are particularly sensitive to ochratoxin, usually produced by *Penicillium veridicatum* mould, and may show depression, dehydration and renal failure (Wu et al., 1993, 1991). Infection of vertebral bone with *Aspergillus fumigatus*, most probably via the thoracic air sacs may cause spinal cord compression and paraplegia in chickens (Thorp, 1998).

8.7 Prophylaxis

Clearly the majority of husbandry, nutrition, environment or genetic interventions that have the aim of improving poultry welfare may also benefit the expression of disease. As well as those suggested in other chapters, of which the provision of a good balanced diet that includes adequate vitamins, mineral and trace elements, clean fresh water and air and plenty of space for exercise are the most vital, some other measures are given below.

8.7.1 Vaccination

Vaccination is a very important disease control tool in almost all commercial poultry production systems. This is because the breeding, hatching, transport and growing of birds in large groups, and their exposure to environmentally derived and endogenous disease, particularly viral conditions, is a very significant threat to the health and productivity of poultry. Some people view the large scale use of multiple vaccines for poultry as evidence of an industry which needs technical “props” to maintain animal health in the face of difficulties in maintaining biosecurity, challenge by wild bird derived or environmental infection, and control of endogenous disease, whilst others see control of a number of poultry diseases as a victory for technological advances. A pragmatic view is that the benefits to the individual bird in terms of avoidance of disease balances the fact that prevalent production methods make vaccination virtually essential to control diseases. Examples of common vaccination programmes are shown in Table 8.1. Poultry diseases for which there are widely used vaccines are shown in Table 8.2.

Table 8.1 Examples of common vaccination programmes for broilers

Age	Vaccine	How administered
Day 1 When sexed/sorted at hatchery	Infectious Bronchitis IB + (sometimes) Newcastle Disease ND	Aerosol (Sometimes by injection)
Day 7–16	Infectious Bronchitis IB + Infectious Bursal Disease IBD	In drinking water
Day 14–21	Infectious Bursal Disease IBD	In drinking water

Table 8.2 Some poultry diseases for which there are vaccines available

Viral disease	Bacterial disease	Coccidia
Avian Encephalomyelitis	<i>Escherichia coli</i> (Airsac disease, septicaemia)	Paracox – <i>Eimeria</i> lines
Chicken anaemia	<i>Pasteurella</i> and <i>Erysipelothrix</i>	
Duck plague	<i>Salmonella enteritidis</i>	
Egg drop syndrome	<i>Mycoplasma gallisepticum</i>	
Infectious bursal disease		
Infectious bronchitis		
Newcastle disease		
Turkey Herpesvirus		
Reovirus		
Marek’s disease		
Paramyxovirus		
Turkey rhinotracheitis		

8.7.2 Probiotics

In his recent review of probiotics in broiler production, Ghadban (2002) defines probiotics as “biological products, which stimulate the immune system and increase its defensive activity against pathogenic bacteria”. Whereas research may be driven to solve problems of food-borne pathogens for humans, such as Salmonella, feeding probiotics may improve the health and welfare of the birds. The intended mode of action of microorganisms used as probiotics is competitive exclusion of pathogenic and toxicogenic organisms in the intestines of fowl and they must therefore be robust enough to survive the digestive processes of the crop and gizzard. Widespread use of probiotics may be limited in the future because of safety concerns about the large quantities of industrially produced cultures that can also be distributed into the environment (Reuter, 2001).

8.7.3 Antibiotics

8.7.3.1 Growth Promoters

The routine use of antibiotics in feed as growth promoting agents is now recognised as bad practice from two perspectives. It has led to bacteria developing resistance, thus limiting the choice and efficacy of therapeutic antibiotics in both veterinary and human medicine. Second, it can mask the effects of relatively poor diets, environments and husbandry. Thus many countries, particularly in Europe are banning their use, so that producers will need to promote good bird health via the fundamentally more sound and sustainable approaches of a diet that promotes good digestion and a healthy balance of intestinal flora (Bedford, 2000), and management techniques that include improved biosecurity.

8.7.3.2 Therapeutics

Undoubtedly the use of antibiotics to treat infectious diseases caused by bacteria has reduced the suffering and improved the quality of life of millions of birds. However, they tend to be used on a flock basis when the proportion of birds that are sick is high enough to justify the cost of mass medication. Before this point and if it is not reached, sick birds suffer from lack of treatment. Beyond it; some healthy birds are treated unnecessarily, which has implications for increasing the antibiotic resistance of bacteria and for environmental pollution. There are therefore sound reasons, not least for the welfare of individual birds, for therapeutic agents to be used on individuals within a husbandry system that promotes good health through other measures.

8.7.4 Anti-coccidials

The welfare impact of Coccidiosis can be very significant (see section on the disease) and, for the individual bird, effective prevention or adequate control can

be seen as a valuable contribution to the wellbeing of the animal. Infection with *Eimeria spp.* results in a strong immune response in the fowl. When numbers of parasites in the environment are low, there is seldom a health and welfare problem for the birds. However modern, intensively stocked floor-rearing systems, especially of breeders, results in such a high challenge that Coccidiosis frequently ensues. Coccidiosis is controllable by three possible artificial mechanisms, vaccination, removal from the body using coccidiocides, or reduction of the worst effects of Coccidiosis by use of pharmaceutical products called coccidiostats which inhibit the parasite. Vaccination is a comparatively recent method for coccidian control, with live attenuated precocious oocysts from a range of *Eimeria* lines being given orally. Coccidiocides are used in pigeons, and occasionally in small groups of poultry to attempt elimination of coccidia, but by far the most common method for control of Coccidiosis worldwide at present is the use of coccidiostats. A number of compounds have coccidiostatic properties including, inonophores, quinolone antibiotics, nitrobenzamides, carbanilide, and the sulphonamide antibiotics. Over time, the efficacy of many coccidiostats has reduced as coccidial resistance has developed. The cost of these agents, and the changes in sensitivity of the coccidian to the agents means that control of Coccidiosis relies on a combination of management (hygiene, site depopulation and cleaning), treatment with coccidiostats, selection for birds with reduced susceptibility to Coccidiosis and vaccination.

The use of coccidostat drugs to control the disease has two main disadvantages: the need for a withdrawal period before both meat and eggs can be used for human consumption and the increasing resistance of the parasite to drugs. Thus more use is being made of live vaccines to the oocyst (infective) stage of the parasite's life cycle in order to promote immunity before the bird is exposed to a high challenge of parasites. Such vaccines are usually accepted for organic production. While they can replace the use of coccidiostat drugs in feed, many authorities recommend an integrated approach where both are used (Chapman, 2000). It is hoped that this will combat the increasing resistance to coccidiostats of the parasites. Other approaches to improving the efficacy of coccidiostats, such as the use of betaine, which helps to preserve the integrity of the intestines and to reduce lesions, are being explored (Bedford, 2000). Traditional techniques for limiting the build-up of parasite numbers, such as pasture rotation and low stocking densities should not be overlooked.

8.7.5 Disinfection and Biosecurity

Biosecurity is particularly important in large units because so many birds can be affected. The aim is to minimise the chance of any potential disease-causing organism from gaining entry to the house. Clearly predators, rodents, snakes, pets and wild birds should be physically excluded from even small poultry units. Measures such as electric fencing, and roofs over feeders can reduce faecal contamination or direct contact from other species in outdoor units. It is usually impossible to completely exclude micro-organisms, but an all-in all-out policy for a whole site is often adopted, allowing a period for thorough cleansing and then disinfection of

housing with minimal potential for re-infection. Fumigation is generally needed to kill red mite and similar ectoparasites or fungi.

Simple biosecurity measures, such as twice-weekly replenishment of boot dips and water sanitisation, reduced the risk of *Campylobacter* infection of broilers by 50% (Gibbens et al., 2001). More stringent precautions would include sterilising feed, water and litter, filtering air, having personnel shower and change before entry and wearing of complete protective clothing. The presence of a hygiene barrier was found to be the most important biosecurity measure for the production of campylobacter-free broilers in a Danish survey of 88 broiler flocks (Hald et al., 2000). Delivery vehicles may be excluded from the farm premises and other essential vehicles can be washed and disinfected on arrival and departure. Records should be kept of all visitors, and the usual requirement is a declaration that they have not been in other poultry units within a week nor be suffering from any infectious disease. It is clearly important that live bird transport containers and vehicles be thoroughly cleaned between batches and farms.

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