106. Knowles, T.G. and Broom, D.M. 1990. The handling and transport of broilers and spent hens. *Appl. Anim. Behav. Sci.*, 28, 75-91.

The handling and transport of broilers and spent hens

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ABSTRACT

Knowles, T.G. and Broom, D.M., 1990. The handling and transport of broilers and spent hens. *Appl. Anim. Behav. Sci.*, 28: 75–91.

The effects of handling and transportation on spent hens and broilers are presented and discussed with particular reference to measures of the welfare of the birds. Points in the handling and transport process where improvements are required are outlined.

The procedures used to handle and transport spent hens and broilers result in welfare problems for the birds which are often very severe. There is evidence for substantial emergency responses, such as adrenal cortex activity. There can also be birds dead on arrival at the slaughterhouse, bruising, and high incidences of bone breakage. Housing hens in battery cages for long periods results in bone fragility.

The greatest welfare problem is the normal rough handling which leads to poorer welfare than does a short vehicle journey. Better handling procedures are essential. Poor conditions on the journey also result in poor welfare. Much research is needed using a wide range of indicators to assess welfare and to design housing systems, handling methods, and transport procedures which do not result in poor welfare.

INTRODUCTION

The transport of poultry involves enormous numbers of individuals world-wide. For example in the U.K. each year approximately 40 million spent hens, and over twelve times as many broilers, are transported to slaughter. Although this transportation forms only a brief period in the total lifespan of the birds, there are indications that it is a time when both mental and physical suffering can be high. Some of the effects that transportation to slaughter has on the welfare of spent hens and broilers are reviewed. The concept of welfare is discussed first. The general method by which poultry are loaded, transported and unloaded is then described with greatest emphasis placed on spent hens, as few descriptions are to be found in the literature. The methods of measuring the welfare of transported poultry are then described in turn and discussed. Finally, the effects of different aspects of the procedures are considered.

THE CONCEPT OF WELFARE

In the report prepared by the Brambell Committee (Brambell, 1965) it was stated that "Welfare is a wide term that embraces both the physical and the mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behaviour". Recent work on the assessment of welfare involves the use of a range of measures of the physical and mental state of animals. Broom (1986) defines welfare as the state of an individual as regards its attempts to cope with its environment. When conditions are difficult, individuals use various methods to try to counteract any adverse effects of those conditions on themselves. These methods include normal regulatory systems and emergency measures such as the use of the adrenal gland and the use of behaviour to modify motivational state and ameliorate the most extreme psychological and physiological disturbances (Broom, 1981). Whatever the method used, the individual may try and succeed or try and fail. The extent of what is done to try to cope can be measured, as can the effects of lack of success such as death, injury, or high disease incidence (Broom, 1988). Welfare in two situations can then be compared as many of these measures provide relative information. When enough data have been gathered, using a variety of measures, the extent of poor welfare within any one environment can be stated.

The quantification of welfare can be carried out in an objective, scientific way. However, the question of the level at which welfare becomes acceptable or unacceptable to individual people and to society is a moral one. One important moral approach is to consider the five freedoms proposed by Brambell (1965) as being the minimum that man is morally obliged to give to farm animals.

PROCEDURES FOR THE HANDLING AND TRANSPORT OF POULTRY

The spent hen at the end of her economic production lifetime is subjected to a number of procedures during transportation, starting with catching and removal from the farm, and finishing at the point at which she is hung on the shackling line at the slaughterhouse and then killed. In the U.K. 94% of the laying hens are caged (Webster and Nicol, 1988). All spent hens are manually caught on the farm, the actual method used depending on the husbandry system within which the hens are kept. Caged hens are removed from the cage by one or two legs and then carried out of the house, held by one leg, in bunches of 2–4 per hand, often being passed from operator to operator. The hens are usually placed in loose crates which are then stacked on a lorry bed. A typical articulated lorry will carry 4800 birds contained in 320 crates and takes a team of ten people 2–3 h to load. In the U.K. the top of the load is usually covered, as the Welfare of Poultry (Transport) Order 1988 requires the birds to be protected from the weather. There are often perforated curtains to afford protection for the side of the load. There are far fewer specialist spent-hen slaughterers than broiler slaughterers so spent hens tend to travel greater distances to slaughter. At the slaughterhouse the birds may have to wait until the crates can be unstacked. Then the birds are manually removed from the crates and hung on the shackling line.

Many aspects of the transport and slaughterhouse handling of broilers are different from those described above for spent hens. A major difference for the birds is the catching procedure as broilers are normally reared on the floor of a building. Broilers are also much younger than hens. As there are recent reviews of broiler transport by Gerrits and de Koning (1981), Gerrits et al. (1985) and Kettlewell and Turner (1985), no further details will be provided here except where relevant to experimental results.

MEASURABLE CONSEQUENCES OF HANDLING AND TRANSPORTATION

The effects of transportation on a bird may be physical, such as bruising and bone breakage after mishandling. Other effects are psychological, such as those produced by human approach or social mixing. Physical effects can be measured directly. The psychological effects of transport can be deduced indirectly by measurements of parameters such as abnormal behaviour, heart rate or respiration rate. An attempt is then made to evaluate to what extent an environment is perceived by the animal as being dangerous or aversive.

Birds dead on arrival (D.O.A.) at the slaughterhouse

The most immediate indicator of the effects on birds of a transport system is the number of birds which cannot survive the system. There are few figures in the literature to indicate the average number of spent hens dead on arrival (D.O.A.) at the slaughterhouse. One large U.K. slaughterer reports figures in the range 0.1–0.2%. Swarbrick (1986) estimates an average of 0.5% but indicates that the range of D.O.A.s within loads of spent hens is greater than that for broilers, and cites two cases of 7.4 and 26% of spent hens D.O.A. at the slaughterhouse. Losses during transport of spent hens in West Germany in January–March, April–May and June–July were 0.161, 0.17 and 0.525%, respectively, whilst for broilers, losses for the same periods were 0.215, 0.181 and 0.233%, respectively (Hails, 1978).

Löliger and Torges (1977) found death rates in broilers to be in the range 0.02–0.4% and 0–2.5% in spent hens, losses being higher in summer in both cases. However, losses directly attributable to injury during transport were rare, most losses being attributable to chronic pericarditis, epicarditis, liver cirrhosis and intestinal disease.

The incidence of D.O.A.s in loads of broilers in the U.K. has been reported as 0.40% in a survey of 8 million birds (Bingham, 1986, cited by Bayliss, 1986) and 0.42% in a 2-year survey of three processors with a combined throughput of 54 million birds (Bayliss, 1986). Bayliss (1986) noted a higher level of D.O.A.s during winter than summer with lower levels in spring and autumn.

Broken bones in transported spent hens

The pain likely to be associated with damage such as bone breakage is such that welfare could be considered to be very poor if it were to occur. At points in the sequence of handling and transport the occurrence of bone breakage can be assessed by careful dissection of birds after being killed in a way which does not itself result in bone breakage.

Laying hens from husbandry systems that restrict movement tend to have an unusually fragile skeletal system (Rowland and Harmes, 1970; Ferguson et al., 1974; Moore et al., 1977). Randall and Duff (1988) report a recent increase in the incidence of metabolic bone disease found in laying fowl, with those affected flocks showing a variable response to dietary treatments. Previous authors such as Riddell (1981) have considered osteoporosis (bone is normally mineralised but with reduced bone mass often characterised by slender trabeculae and large spaces within the bone) to be the sole cause of the problem of bone fragility in spent hens but Randall and Duff (1988) propose that the osteopenic (bone loss) condition could be due to a combination of osteoporosis and osteomalacia (bone is present but incompletely mineralized). Birds suffering from osteopenia caused by osteomalacia would respond to dietary treatment as would those with osteoporosis exacerbated by osteomalacia. Birds suffering from osteoporosis alone would not respond to dietary treatment. Birds with a fragile skeletal system are unduly prone to bone breakage when handled. Knowles and Broom (1990) showed that the wing bones of hens from battery cages were only 54% of the strength of those from a perchery, in which wing exercise is possible. Simonsen (1983) reports a Danish investigation in which a mean of 6.5% caged spent hens had broken bones before slaughter, especially humeri, compared with 0.5% broken bones from similar hens kept on a wire floor system.

Gregory and Wilkins (1989) in a survey involving 3115 spent hens from battery cages in the U.K., found that a mean of 29% had broken bones before they reached the water bath stunner at slaughter. This figure translated to 0.5 broken bones per bird, the most frequently broken bones being the ischium (17.2% of birds), the keel (12.8%) and the humerus (10.8%). Removal of the birds from their cages and hanging on the shackling line were identified as points where damage was most likely to occur. Where birds in one trial were removed individually from the cages rather than in the usual commercial manner, only 14% of birds were found to have broken bones compared with 24% in commercially removed birds.

Gerrits et al. (1985) estimate that between 10 and 30% of the 11 million broilers transported each day within the E.E.C. are injured by the process. Jespersen (1981), in a Danish study of 53 000 broilers, found 1.1% to have fractured wings after transportation. Fewer figures for the number of broken bones found in broilers arriving at the slaughterhouse seem to be available than for spent hens. Perhaps this is because there is less of a problem with broilers or perhaps the problem has not been noticed as a consequence of the different way they are processed after slaughter. Many spent hens are deboned after slaughter, whereas this is not the case with broilers.

Bruising

Bruising provides an indication of the number and severity of physical insults sustained during transportation. Many studies have been carried out on broilers (May and Hamdy, 1966; Taylor and Helbacka, 1968a; Mayes, 1980; Jespersen, 1981; Griffiths and Nairn, 1984) but there is little evidence concerning spent hens. The studies on broilers were concerned mainly with the economic consequences of bruising. Mayes (1980) found bruising in an average of 2.63% of birds processed. Griffiths and Nairn (1984) found 3.5–8.0% and Taylor and Helbacka (1968a) found an average of 20%. This large range of findings probably reflects the subjectivity of carcass grading and differences in inspection procedures. It is important to differentiate damage to the live bird from carcass damage in the data presented and this should be possible. G.L. Griffiths (personal communication, 1988) found that bruises could not be induced after birds had been stunned. Griffiths (1985), working in Australia, established histological criteria for ageing bruises found on chicken legs, thus enabling points in transportation where damage had occurred to be identified. Based on the examination of 108 bruised "drumsticks", 25% of bruises were identified as occurring prior to catching, 40% during catching and crating, and 30% after arrival at the slaughterhouse.

The incidence of bruising has been correlated with average flock weight (Mayes, 1980; Griffiths and Nairns, 1984), daily temperature (Mayes, 1980) and sex (Taylor and Helbacka, 1968b; Mayes, 1980). These factors, together with the subjective nature of scoring bruising, could make it difficult to interpret studies of bruising in comparisons of the benefits of different transport systems.

Scholtyssek and Ehinger (1976) examined broilers for bruising after journey lengths of 2, 4 and 6 h and found a greater incidence of bruising after longer journey times and in transport systems with greater space per bird.

Meat quality

Changes in meat quality have been shown to occur with the transportation of poultry. These and meat pH and colour give information about the occurrence of glycolytic processes which are associated with the occurrence of emergency physiological responses (Ehinger and Gschwindt, 1979, 1981). Hence the study of carcasses after slaughter can provide valuable information about the welfare of the bird during handling and transport.

Cashman et al. (1988) measured reflectance and found paler meat in broilers transported for 120 min and kept in lairage for 180 min than in untransported birds. However, the reduction in meat quality was not considered to be of sufficient economic importance to make changes in transportation systems necessary based on economic grounds alone.

Ehinger and Gschwindt (1979) found water binding capacity and loosely bound water in broilers to be lowest after 4 and 3 h transportation, respectively. They found that a waiting period prior to slaughter decreased the water binding capacity and the tenderness of thigh and breast meat. Post-slaughter pH of meat was found to be increased in birds transported for 1 or 6 h compared with untransported birds. However, Ehinger and Gschwindt (1981), in a trial using transport times of 2, 4 and 6 h and four strains of broiler, found a lowering of meat pH with transport time but no other substantial effect of transportation on meat quality.

Weight loss

Weight loss in broilers has been shown to increase with the duration of transportation time. Scholtyssek et al. (1977) found losses of 1.3, 2.3 and 3.1% after journey times of 1.5, 3 and 4.5 h, respectively. Weight losses in spent hens do not appear to be reported in the literature. Weight loss in broilers is of greater economic importance as the price paid for broiler meat is higher than that for spent-hen meat.

Corticosterone

In an alarm response, adrenaline and noradrenaline are released from the adrenal medulla. Levels in the circulation rise so rapidly, after starting to take a blood sample, and breakdown occurs so quickly that direct measurement of these substances cannot be used as indicators of the magnitude of the response. This response is followed by release of glucocorticoids, principally corticosterone in the fowl, from the adrenal cortex. In many other species cortisol is also released but in the domestic fowl cortisol production appears to cease within 17 days of hatching (Freeman, 1983). The rise in plasma corticosterone takes several minutes from the start of the alarm reaction and breakdown is slower than that of adrenaline. Fuller accounts of the alarm response in fowl and its general application in assessing welfare are given by Freeman (1971, 1976) and Hill (1983).

Measures of plasma corticosterone can be considered as indicators of welfare in the fowl. However, there may be individual variation in how much this method of trying to cope with conditions is used. Some adverse conditions do not lead to an adrenocortical response. Beuving and Vonder (1978) found that immobilisation by hand or by crating led to increased concentrations of plasma corticosterone whilst thirst, hunger or heat (37 °C) for 5 days did not lead to increased levels. Hence Freeman (1987) urges caution in interpreting corticosterone data.

The significant effects of handling and transport on plasma corticosterone and plasma glucose levels in spent hens are shown in Table 1. These data are from two studies by Broom et al. (1986, unpublished data, 1990) and show an increase in plasma corticosterone and plasma glucose after transportation. The birds used in the first study were laboratory birds, those in the second were taken from a commercial farm. The controls were removed from their cages and blood sampled within 60 s. Transport was for 1.75 h in Study 1 and 1 h in Study 2. In Study 1 those hens which moved to the back of the cage most or showed most head flicking when watched from close quarters had a greater corticosterone response to handling and transport. These effects on plasma corticosterone and glucose were also associated with a 13% depletion of the neuro-transmitter noradrenaline in the hypothalamus and some increase in catecholamine metabolites.

In an experiment with broilers transported for 2 and 4 h, Freeman et al. (1984) found an increase in plasma corticosterone with journey time. Birds were transported in winter (at 1 °C) and in summer (at 20 °C). Those trans-

TABLE 1

Effects of handling and transport on plasma corticosterone and glucose levels in spent hens

	Treatment	Corticosterone ($ng\ ml^{-1}$)	Glucose ($mmol\ l^{-1}$)
Study 1	Control	0.52 ± 0.15	
	Transport (1.75 h)	1.88 ± 0.45	
	($n=18$)	($P=0.02$)	
Study 2	Control	0.40 ± 0.11	11.99 ± 0.31
	Transport (1 h)	1.57 ± 0.21	13.11 ± 0.34
	($n=15$)	($P<0.0001$)	($P=0.022$)

ported in winter showed a greater increase in plasma corticosterone levels. Body temperatures of the birds remained constant across all treatments.

Heart rate and respiration rate

During an alarm response, both heart and respiration rates increase. Duncan and Filshie (1980) have successfully studied heart rate in laying hens using radio telemetric methods but heart rate response to handling and transport in spent hens has not been studied. Broom et al. (unpublished data, 1990) have shown that the average respiration rate in spent hens increases from 33.9 breaths min^{-1}, 50 s after removal from the cage, to 38.1 breaths min^{-1}, 100 s after removal from the cage ($P=0.034$). They also found that breathing rate after normal commercial handling was higher in hens which showed a larger prior response to an observer 40 cm from the front of the cage. Birds which retreated to the back of the cage in response to the observer had a breathing rate of 43.2 breaths min^{-1} after handling whilst those which showed no retreat response had a rate of 34.0 breaths min^{-1} after handling ($P=0.046$).

Duncan et al. (1986) and Duncan and Kite (1987) have used heart rate in conjunction with other measures to compare different methods of catching and handling broilers. These experiments are reviewed in a later section.

Heterophil/lymphocyte ratio

The release of glucocorticoids has a direct effect on lymphoid tissues, reducing the ability to mount an immune response. One manifestation of the altered immune system is a fall in the number of circulating lymphocytes and increases in the number of heterophilic granulocytes. Heterophil/lymphocyte (H/L) ratios in circulating blood have been shown to increase within 24–48 h in the fowl in response to blood sampling, social stress, fasting, 25 ppm corticosterone in feed, killed Newcastle vaccine, killed *Escherichia coli* cells and 125 mg kg^{-1} of orally administered malathion (Gross and Siegel, 1983). Gross and Siegel (1983) describe the H/L ratio as "a good measure of the chicken's perception of stress in its environment". To the authors' knowledge H/L ratios have not been studied in transported spent hens but the measurement of H/L ratio has been employed in a series of transport experiments with broilers by Duncan and Kite (1987) which are described below.

Tonic immobility

The tonic immobility (TI) reaction of domestic fowl is reviewed by Gallup (1979) and by Jones (1986) who describes TI as being a catatonic-like state with reduced responsiveness to external stimulation, elicited, but not maintained, by a relatively brief period of physical restraint. The duration of TI is considered as indicative of pre-induction "fear" levels and it correlates well with other tests of "fearfulness" (Jones, 1987). The longer the duration of TI, the higher the level of pre-induction fear is thought to be. For experiments involving TI, a large sample of birds is required as variation within a sample can be great. The psychophysiological correlates of TI have been investigated by Nash et al. (1976) who found that following the onset of TI, heart rate decreased, reaching its lowest level prior to termination of TI. Respiration rate increased initially and then gradually decreased whilst temperature remained lowered throughout TI. Gentle et al. (1989) found electroencephalograph (EEG) fast wave patterns for the first 30 s after TI induction, indicative of high arousal. As TI progressed, a slow wave, deactivated pattern emerged with occasional bursts of fast wave activity which became continuous just before the TI response terminated. Jones et al. (1987) found an increased H/L ratio and increased duration of TI within 4 days of fitting hens with minipumps delivering 15 $\mu g\ h^{-1}$ corticosterone compared with hens fitted with pumps delivering only polyethylene glycol vehicle. They suggested that the chronic elevation of circulating corticosterone provided by the minipumps increased fearfulness and that the findings supported the proposal that chronic adrenal activity and fear can be positively related.

The duration of TI as a function of journey time has been investigated in broilers by Cashman (1987) who found a highly significant linear relationship between journey times from 10 to 120 min and the duration of TI. A similar investigation has been carried out by Mills and Nicol (1990) with spent hens. These results show that the duration of TI is greatly elevated by transport on the lorry, but there is no relationship between the duration of the journey and the duration of TI. The duration of TI becomes high and remains so even after journey lengths of up to 5 h.

EFFECTS OF DIFFERENT HANDLING PROCEDURES

The effects on welfare of the rough handling which birds receive before and after transport can be assessed by monitoring their adrenal and other emergency responses. By measuring the same responses and using different handling procedures, a comparison can be made between the procedures.

Gentle and commercial carrying

Broom et al. (1986, unpublished data, 1990) compared normal handling of spent hens with gentle handling (Fig. 1). The hens were carried for 90 s either in the normal inverted manner or gently in an upright position. They were then blood sampled or placed in a crate 2 min after removal from the cage. Those crated were removed and blood sampled at 5 or 30 min after removal from the cage. No bird was blood sampled twice. The plasma corti-

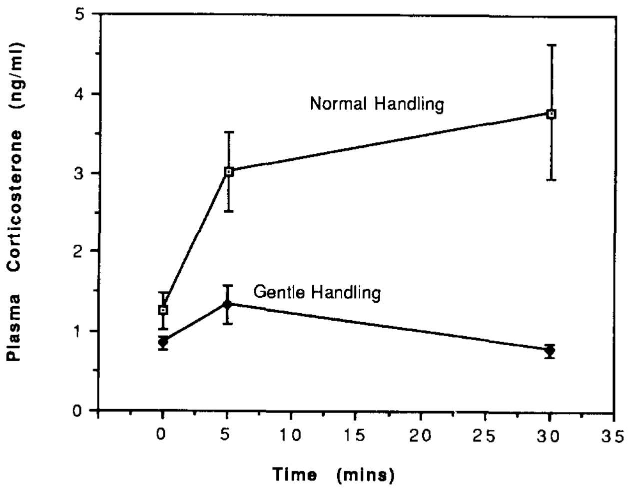

Fig. 1. Comparison of corticosterone response in spent hens to normal (rough) (□) and gentle (●) handling.

costerone levels of birds handled gently were consistently lower than those handled commercially and had returned to pre-catch levels within 30 min.

Duncan and Kite (1987) carried out a similar experiment with broilers as one of a series of experiments that used plasma corticosterone concentration, heart rate, H/L ratio, duration of TI and latencies to resume feeding, drinking and social contact as welfare indices. In this experiment they compared methods of catching and crating. They could find no difference between the effects of gentle and commercial carrying although both treatments had significant effects when compared with control birds.

Mechanical and manual catching

Duncan et al. (1986) compared manual and mechanical collection of broilers using measures of heart rate and TI. TI was significantly longer after manual catching with no difference in the duration of TI between controls and birds caught mechanically. The heart rate of both manually and mechanically caught birds rose to similar high values but the rates of mechanically caught birds returned to near normal values more rapidly. These results suggest that broilers are affected less by mechanical than by manual capture.

Degree of human contact

Following the finding that hens reacted to human approach by heart rate increases and behavioural responses (Duncan and Filshie, 1980), work more closely related to the pre-transport handling situation was carried out by Duncan and Kite (1987). They tested broilers in cages and in pens for their reaction to human approach, approach plus restraint, restraint by an unseen human and approach then being held off the ground. The latency of the broilers to feed showed human approach to have the least effect and concealed restraint the greatest, with the other two treatments being intermediate. All treatments resulted in an increase in heart rate, but the increase was less in birds from cages than in birds from pens.

Handling in the light or dark

During catching and handling, birds display escape responses which increase the likelihood of damage to themselves. A practical method of subduing the birds is thought to be a reduced light level. This method is employed by many broiler transporters. In an experiment using caged spent hens handled in a commercial manner in two light levels (Table 2) there was a trend for birds handled in the lighter conditions to show a longer duration of TI (T.G. Knowles, unpublished data, 1990).

Duncan and Kite (1987) found a more marked difference between the effects of a bright and a dim light on broiler response to handling. Manual carrying was compared with mechanical herding and conveying, both in dark (0.35 lx) and in light (88 lx) conditions. They also tried to establish whether the effects of different treatments were additive. Manual carrying had a greater effect on the broilers than the mechanical herding and conveying and both treatments had less effect when carried out in the dark. The light/dark treatments had more effect than the manual/mechanical treatments.

Social factors

Duncan and Kite (1987) placed broilers 4 to a crate (828 cm per bird) or 8 to a crate (414 cm per bird), with familiar or unfamiliar companions. TI, plasma corticosterone and heart rate all increased with crating but there was no difference between the treatments

TABLE 2

Duration of TI in spent hens handled in different light levels ($n=40$, $P=0.0546$)

Light treatment (lx)	Duration of TI (s)
15.0	487.8 ± 73.1
0.1	387.4 ± 89.9

Height of drop

If birds are mechanically caught they then have to be crated. One method is to drop them into the crates. Duncan and Kite (1987) dropped broilers from heights of up to 40 cm, after they had been transported by mechanical belt for 2 m. They found plasma corticosterone levels increased with the height of the drop. They also noted that if the drop was greater than a few centimetres the birds flapped their wings. Extended wings make the broilers more vulnerable to damage during crating.

EFFECTS OF HANDLING COMPARED WITH TRANSPORT

Broom et al. (1986, unpublished data, 1990) in an experiment to compare the effects of handling, handling and crating, and handling, crating and transport found no difference in plasma corticosterone levels between groups of hens that were removed from their cages and left stationary in crates for 2 h and hens removed from their cages, crated and transported in an enclosed van for 2 h (Table 3). The response after handling was much greater than that at the end of transport. This suggests that the handling component of transportation has the greatest effect on spent hens and that being crated and driven on a vehicle has the same effect as crating alone.

The latter finding is in agreement with the findings of Duncan and Kite (1987) in broilers. Broilers subjected to crating and then to a 40-min bumpy vehicle ride at 20 km h^{-1} or crating and 40 min left stationary showed no differences between the two treatments in the indices measured. Both treatments resulted in differences in indices from control birds.

TABLE 3

Effects of handling, crating and transport on hen plasma corticosterone levels ($n = 15$)

Treatment	Time of sample	Corticosterone (ng ml^{-1})
Control	<60 s	0.40 ± 0.11
Normal handling	3–4 min	3.00 ± 0.41
Handling + crate	2 h	1.81 ± 0.41
Handling + transport	2 h	1.45 ± 0.45

Control vs. normal handling, $P < 0.0001$.
Normal handling vs. handling + transport, $P < 0.05$.

DISCUSSION

Spent hens

It is clear from the relatively small number of studies of the welfare of spent hens during handling and transport that there are some serious problems. The emergency adrenal response is elicited so that plasma corticosterone levels rise, with consequent effects on glucose. Associated brain activity results in depletion of some transmitters and an increase in the metabolites of others. Tonic immobility, an anti-predator or fear response, increases. Some birds die during transport and many have broken bones on arrival at the slaughterhouse.

Handling appears to be the most traumatic part of the procedure and, as well as eliciting a considerable emergency reaction, it is the cause of high levels of bone breakage. The problems have been shown to be reduced by slower, gentler handling. They are exacerbated by poor cage design but the methods used by the catching gangs, who are encouraged to deplete hen houses very quickly, are the major causes of the very poor welfare. Recent research, especially that into the number of broken bones, indicates that there is much unnecessary suffering, and that it is avoidable. Bone breakage is made more likely because hens from battery cages have especially brittle bones. The factor which has most effect on this is probably lack of exercise in the battery cage but other factors such as diet and disease must also be considered.

The work Löliger and Torges (1977) indicated that disease is the primary cause of D.O.A. at the slaughterhouse in spent hens and injury as a result of transportation is only a secondary factor. If diseased birds could be identified at depletion and killed immediately, suffering on their part could be avoided and figures for D.O.A.s improved.

The conditions of housing, handling, transport and slaughter to which most hens are subjected result in so much poor welfare that most people would find the current situation unacceptable. Improvements in each of these areas are urgently needed. More research should be carried out and fundamental changes in all four areas should be considered.

Broilers

More work has been carried out on the transportation of broilers than on spent hens. As with hens, the most traumatic stages of the process and the stages most likely to give rise to physical damage, are the times when the birds are manually handled. Kettlewell and Turner (1985) reported that all the broiler transport systems in use in the U.K. can produce low levels of downgrading, but they are all dependent on operator attitudes. Gerrits and de Koning (1985) saw the percentage of broilers damaged during transportation as unacceptable on both economic and welfare grounds. A number of mechanical catching devices have been developed for broilers which seem to improve the welfare of the birds in some respects. The most significant of these are the broiler harvesters such as the Tamdev and that developed by the National Institute of Agricultural Engineering, Silsoe, U.K. However, figures for the amount of physical damage caused by these machines compared with manual harvesting are not readily available. Their uptake by the industry has also been slow because of the difficulty of operating them in broiler sheds which have vertical roof supports within the floor area. Work rates can often be lower than with manual catching. Their use can reduce labour requirements but involve reliance on a complicated piece of machinery working in demanding conditions.

Catching in the dark has been shown to have a beneficial effect on broilers and to a large extent this is already common commercial practice.

There has been a gradual move towards modular systems of transporting broilers in the U.K. These reduce the labour requirement at harvest and are generally believed to reduce injury as the modules are not prone to being thrown about as loose crates may be, and the openings through which the birds are passed are large compared with loose or fixed crates. However, few real comparative figures are available in the literature.

Problems common to spent hens and broilers and differences between them

Consistent differences in the results of transport experiments between spent hens and broilers have been found. Those figures that are available indicate that D.O.A. figures are higher with spent hens. Spent hens seem more affected by inversion than broilers, but handling in the dark seems to have a more marked effect on broilers than spent hens. The TI reactions to journey time by the two types of bird are different. These differences between broilers and spent hens emphasise the need for separate research and a different approach to transporting the two types of bird.

Short journeys in a vehicle need not have much adverse effect on the welfare of spent hens or broilers. There is little evidence concerning the effects of long journeys but there must be a journey length above which the incidence of poor welfare increases substantially. Poor conditions can have an effect on birds during any journey but the effect will be worse if the journey is long. Exposure to very hot, very cold or other adverse conditions can lead to poor welfare and death. Spent hens are often characterised by much feather loss. The loss of insulation decreases the thermal resistance of the integument and consequently increases the rate of heat loss. This means that spent hens are more susceptible to cold and less susceptible to heat than broilers (Freeman, 1984). Transporters of birds are sometimes prosecuted because they allow birds to be exposed to such conditions but only when the number of D.O.A.s has become exceptionally high. Some improvement in vehicle design is desirable and the enforcement of cruelty laws is necessary. Those who handle or transport hens should also be subject to financial penalties if the animals in their charge are caused to suffer. Such suffering is often, but not always, associated with some economic losses owing to death, bone breakages or reduced meat quality. However, because of the low value of spent hens in particular, economic reasons alone are unlikely to bring about an improvement in transportation methods.

There is still much work to be done if a good assessment of all aspects of welfare during transport is to be achieved. There has been little or no work on broilers or hens during the lorry journey and during lairage. There are few published analyses into the incidence of hen D.O.A.s at slaughterhouses or of the effects on D.O.A.s of transport firms, transport systems, catching teams, weather, husbandry systems or duration of journey. Most of the data for such an analysis are, in theory, readily available in the U.K. as slaughterhouses are required by most local authorities to keep records of D.O.A.s and all lorry journeys have to be recorded on tachograph by law. An analysis of such data could prove valuable in formulating guidelines for improving welfare during the lorry journey. More work on the occurrence and causes of bruising is necessary. Although some studies have been carried out on broilers it has usually been for economic reasons. The incidence of bruising in spent hens is not known.

One particular problem of assessing welfare during the journey and during lairage is that physical measurements such as those of ambient temperature, humidity and air speed have to be related to measures of non-specific reactions, such as the levels of plasma corticosterone, which are usually only taken after the event. A new phenomenon has become recognised in recent years which may overcome this problem. It has been found that many organisms produce specific proteins in response to specific environmental challenges such as high temperature, lack of oxygen and wounding. A heat shock protein has been shown to be synthesized in the fowl (Adams and Rinne, 1982). As the severity of the environmental challenge increases so does the production of protein. Perhaps, in the future, heat shock protein could be assayed on a regular basis after transport and lairage to ensure that a system is working satisfactorily. However, at the moment, more research is needed on the techniques for assessing bird welfare during transportation. It is clear that an array of techniques should be used in an endeavour to find methods of transporting both broilers and spent hens which are acceptable in welfare and economic terms.

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