Behavioural responses of poultry during kosher slaughter and their implications for the birds' welfare

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Measurements were made during *Shechita* (kosher) slaughter of 692 meat chickens, including the behaviour of the birds during the procedure and the times from their removal from the crate, to neck cutting, bleed-out and shackling. Four of 100 birds showed a mild physical response to neck cutting but the others showed no response. Approximately 60 per cent of the birds showed a physical response to touching the eye or eyelid at up to 5 seconds after neck cutting, but by 15 seconds none showed this response. The birds became unable to retain their posture and suffered involuntary muscular contractions at 12 to 15 seconds after neck cutting and had lost approximately 40 per cent of their total blood volume by 30 seconds after neck cutting.

IN Australia poultry are generally slaughtered by being stunned before having their neck blood vessels severed (Standing Committee on Agriculture and Resource Management 2001). The usual procedure is to stun them in an electrified water bath and then cut the jugular vein and carotid artery on one side of the neck with an automatic rotating blade; the stunning procedure aims to render the birds unconscious until they die. However, there are questions about the effectiveness of both the stunning and cutting procedures (Heath and others 1981, Griffiths and Purcell 1984, Duncan 1997). Furthermore, before they are stunned, the birds are shackled, usually in a dimly lit area, for a minimum of 30 seconds and a maximum of three minutes, to ensure that they are not 'flapping' and are relaxed with their head 'hanging down' (Primary Industries Standing Committee 2001); this procedure may be associated with fear (Scott and Moran 1993) and pain (Gregory 1998, Gentle and Tilston 2000).

Shechita (kosher) slaughter precludes the use of stunning before the blood vessels in the neck are cut; each bird is restrained manually and its neck is presented to the specialist slaughterman, the shochet, an appropriately trained and qualified person, who severs both carotid arteries and jugular veins with a sharp knife; the bird is then placed neck down into a bleed-out cone. There are two similarly sized plants in Australia that slaughter poultry by the kosher method, and the plant used in this study processes about 8000 birds per week; a rabbi oversees the procedure, but the day-to-day responsibility and expertise remain with the shochet. In comparison, more than seven million broilers are killed in Australia by the conventional method each week.

From the point of view of the birds' welfare it is important to establish how long birds killed using the *Shechita* procedure remain conscious. There is evidence that 95 per cent of the electrical evoked activity in a bird's brain is lost by a mean (se) of 136 (one) seconds after it has been decapitated (Gregory and Wotton 1986); this is slightly longer than the time for electrical activity to cease after cardiac arrest, 90 (eight) seconds, and shorter than the time after the cutting of both carotid arteries, 163 (11) seconds. In contrast, it takes 349 (22) seconds for brain activity to cease after the cutting of both jugular veins. The times for the loss of 50 per cent of spontaneous brain electrical activity are 14 (one) seconds for decapitation, and 19 (44) seconds for the cutting of both carotid arteries (Gregory and Wotton 1986). Irrespective of these data, it is very unlikely that birds are conscious throughout the period when there is measurable electrical activity in their brains.

This study was designed to provide some basic measurements for *Shechita* (kosher) slaughter of poultry in Australia.

MATERIALS AND METHODS

The process

The plant was a small stand-alone plant adjacent to a conventional poultry processing facility, but independently owned. Three visits were made to the plant and on each occasion, there was a truckload of birds parked in the road, ready to be processed that morning. The birds were transferred from the truck about 20 to 30 m to a covered holding area with a fork-lift truck that carried a wire-mesh-topped frame holding up to 20 crates of birds; a frame of crates was either transferred directly from the truck or from the holding area to the conveyor and the crates were unloaded manually from the frame on the fork-lift on to the conveyor by one person. The crates were conventional plastic poultry transport crates, about 49 × 70 × 26 cm, without a lid, but the frame holding them separated them and either its wire-mesh top or the stacked crates provided an effective lid. Similarly, the birds were unable to escape from the crates when on the conveyor because they were placed on the lower level of the conveyor and empty crates returned on the upper level, the two levels being sufficiently close to prevent the birds escaping.

Processing involved a number of slaughtermen. In addition to the fork-lift driver, who also transferred crates on to the conveyor, one person removed a bird from the crate, held it by both legs and supported the body, and passed it to another person who restrained the bird for the neck cut by holding both its legs in one (upper) hand and supporting its back, with its wings folded, on their forearm and other hand. The shochet extended the bird's head in his left hand with his thumb against the ventral surface of the bird's upper neck close to the beak and positioned its neck so that he could cut all the blood vessels with the knife in his right hand; after the neck cut he briefly examined the cut to ensure that all four blood vessels were severed and that the bird was not to be rejected (the rejection criteria are described below). He then released the bird's head and the restrainer passed the bird to another person who placed it into the bleed-out cone, another person removed the bird from the cone and placed it on the shackle. At all times, while the bird's legs were firmly held, its body appeared to be supported on the restrainer's forearm, rather than held, so that the bird could have reacted physically with gross body movements.

There were two shochets who took turns at intervals during the morning to cut the necks of the birds. In addition, there was a manager responsible for both the slaughter and subsequent processing. There were other people not involved in killing the birds who were responsible for processing the dead birds.

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After the first visit to the processing plant to view the procedure the following observations were made on two further visits, made on two mornings 14 days apart, starting at about 05.00 and finishing at about 09.00.

Responses to neck-cutting One hundred birds were observed, 50 on each day, by two observers who independently relayed the following categories of response to a third person who made a written record: None No movement; Mild Minor local movement of neck or head; Medium Voluntary beak, head or neck movements; Gross Includes body and/or leg movements.

Time to loss of eye response This test involved tapping one eye or eyelid of the bird with a finger at two, five, seven, 10 or 15 seconds after its blood vessels had been cut; each bird was tested at only one time and the time of each test was predetermined by using random number tables. On each of two days 20 birds were tested at each time point, a total of 200 birds. As most of the birds had the focal eye closed, only a gross behavioural response could be observed, that is, a movement of the eyelid or obvious eye movement under the eyelid; if the bird's eye was open, an additional response was movement of the nictitating membrane.

Time to loss of 'free flowing' blood The time from blood vessel cutting to the time blood stopped 'flowing' was measured in 25 birds on each day. Because of the difficulty of measuring this on the continuously moving chain the following procedure was used. A bird to be measured was selected when it was removed from the crate. After neck-cutting it was transferred into a cone utilised for bleeding out 'reject' birds. A bird was considered a reject if it was not killed according to strict religious guidelines, that is, if the knife touched the spine, the cut was in the wrong place, or all four blood vessels were not cut appropriately. Reject birds were decapitated immediately. The cone was the same as those on the chain, but it was static. The bird's head was held extended, without pressure on the cut vessels, by an observer who recorded the time when the blood stopped flowing freely, that is, started 'dripping' rather than 'flowing'. To ensure the bird's neck was not stretched while being held by the observer, a slaughterman held the bird in position by placing his hand so as to limit its vertical movement within the cone; this vertical movement occurred some time after neck cutting and was due to strong muscular contractions (see below).

Volume of blood lost and bodyweight The volume of blood that had been lost when the blood stopped freely flowing was estimated by measuring the bird's bodyweight. On the first day, 12 birds were weighed with a spring scale when they were removed from the crate; however, the spring balance had an error of ± 20 g and was considered too insensitive to calculate blood loss by reweighing them after they had been slaughtered. On the second day the blood loss from 23 birds was calculated by using a top-loading balance with an accuracy of 0·1 g. After initially weighing and killing the bird it was transferred to the 'reject' cone and when the blood stopped flowing freely it was removed from the cone, placed in a plastic bag, and reweighed. On the basis of a calculated total blood volume in hens of six per cent of bodyweight (Yahav and others 1997), the loss in bodyweight was used to estimate the percentage of the total blood volume lost by the experimental birds. The total blood volume is estimated to be about six per cent of bodyweight, but about one-third of the total blood volume is retained in the blood vessels and capillaries and cannot be lost; the volume of blood lost was therefore also calculated as a percentage of 'loseable' blood, on the basis of loseable blood constituting about 4 per cent of bodyweight.

Time to onset of muscular contractions The time from neck-cutting to the start of strong muscular contractions was measured by two observers on 50 birds on each day; the birds are unconscious during such muscular contractions (Grandin 1994).

Bird rejection rate The numbers killed and rejected on the observation days were obtained from the company's records. Birds were rejected for procedural reasons, and for conformation reasons during processing; procedural reasons included the knife touching the spine and if all four blood vessels were not completely severed; the rejected birds were placed in the static bleed-out cones and decapitated. Conformation reasons included bruising, lack of symmetry and appearance.

Time to shackle The 'time to shackle' was measured by determining how long it took the chain to move a bird from when it was inserted into the bleed-out cone to first, the location on the chain where the birds could first be removed from the cone and placed on the shackle and secondly, a complete revolution of the cone. The times were measured by one observer and repeated four times on the first day and twice on the second day. To ensure that the intended bird was seen clearly an assistant slaughterman was asked to leave four empty cones in front of the test bird for each measurement.

Time to empty a crate of birds The time taken for a slaughterman to unload each of 15 crates of birds, from the start of the removal of the first bird until the last bird was caught, and the numbers of birds per crate were determined by one observer on the second day of observations.

Time to loss of posture After neck cutting the bird was passed to an observer who held its wings close to its body and placed it upright on the floor of a crate. The time from neck cutting to when the bird could no longer remain upright, that is, when one leg was raised and the bird fell or rolled on to its side or back, was measured on 41 birds on the second day of observations.

Statistical analyses The data were initially examined for consistency between days and observers by using Students *t* test and Mann-Whitney U tests. Although there were some significant differences between days ($P<0·05$ within variables) the data for each variable were combined for the two days to calculate a mean (se) value.

RESULTS

Data were obtained from 692 birds, sampled from 2980 birds killed on the first day and 3568 birds killed on the second day, approximately 10 per cent of the total number of birds processed. The rejection rates of the birds for procedural reasons were 0·44 and 0·42 per cent on the first and second days respectively, and these birds were not included in the statistical analyses; a further 5·9 and 10·8 per cent of the birds were rejected after slaughter for reasons of conformation.

The data for the time to neck cut, time to placement in the bleed-out cone and time to loss of free-flowing blood were not normally distributed and comparisons between days were made by using Mann-Whitney U tests. The time to neck cut and time to placement in the bleed-out cone were not significantly different between days, but the mean (se) times to the onset of muscular contractions were 9·5 (0·40) and 14·5 (0·65) seconds, respectively ($P<0·001$); the longer time on the second day may have been due to the birds being heavier, the mean (se) bodyweights being 2·2 (0·09) kg and 2·6 (0·08) kg, respectively.

TABLE 1: Mean (se) and ranges of bodyweight (kg) and times (seconds) after neck cutting to various measurements in chickens killed by Kosher methods

Measurement	Mean	Number	Range
Bodyweight (kg)	2·5	(0·07) 35	1·73-3·34
Time to neck cutting	5·0	(0·15) 50	3·6-7·7*
Time to placement in bleed-out cone	8·1	(0·26) 50	5·5-10·9*
Time to muscular contractions	12·0	(0·46) 100	5·1-23·4
Time to loss of posture	13·9	(0·67) 41	8·0-25·6
Time to blood loss	29·1	(0·84) 50	21·0-45·0*
Total blood loss (%)	40·7	(2·02) 23	30·2*-64·0
Loseable blood loss (%)	62·7	(3·19) 23	46·2*-99·8

* Values of 9·7 seconds for time to neck cut, 19·1 seconds for time to placement in the bleed-out cone, 54 seconds for time to blood loss, 21·6 per cent for total blood loss and 32·9 per cent for loseable blood loss were considered to be outliers

The time taken to empty a crate of birds varied with the number of birds it contained. The mean (se) time to depopulate 10 crates containing eight birds was 21·6 (0·62) seconds, but for four crates that contained 10, 11, and 12 birds, the mean time was 27 (0·94) seconds; on the basis of the data from these 14 crates, the average time to remove a bird and pass it to the slaughterman who restrained it for neck cutting was 2·6 (0·06) seconds. The emptying of crates was occasionally stopped when the shochet was checking the smoothness of the knife edge; it happened once while the time to empty a crate was being measured, and on this occasion it took 58 seconds to empty a crate of eight birds.

The times of other events are shown in Table 1. The time from starting to remove a bird from its crate and cutting the blood vessels in its neck was, on average, five seconds and it took another three seconds to transfer the bird to the bleed-out cone. The birds' loss of posture and the onset of strong muscular contractions occurred close together; muscular contractions occurred after 12 seconds, the mean values on the first and second days being 9·5 and 14·5 seconds respectively, which was about four seconds after the birds were placed in the bleed-out cone, and they lost posture after 13·9 seconds. About 29 seconds after neck cutting the birds had lost about 41 per cent of their total blood volume, or 63 per cent of the blood that would drain from the body. The birds remained in the cones for between 76 seconds and 104 seconds, depending from where on the line they were removed from the cones on to the shackles.

Only four of 100 birds responded physically to neck cutting, showing a mild response, and the others showed no physical reaction in response to the cut.

Twenty-seven and 23 of the groups of 40 birds showed a physical response to the eye test at two and five seconds after neck cutting, but only five and four responded after seven and 10 seconds, and none responded after 15 seconds.

DISCUSSION

The data from the various tests and measurements have been presented as a sequence of events during the *Shechita* slaughter of the birds, but each test and measurement was made on a different group of birds and the sequence therefore does not necessarily represent what occurred in individual birds. Only four of 100 birds showed a mild physical response to neck cutting, the rest showing no physical response. It has been reported that cattle show only a slight quiver and no withdrawal responses in response to a neck cut (Grandin 1994). Nearly 60 per cent of the birds made a response to physical stimulation of the eye at about five seconds after neck cutting; there were difficulties in obtaining data at the specified time with this test, particularly at two seconds, but from seven seconds onwards at most 12·5 per cent of the birds responded to the test and the response had disappeared by 15 seconds. This was similar to the mean time to the loss of posture, 13·9 seconds, and the mean time to the start of strong muscular contractions, 12·0 seconds. By about 29 seconds after neck cutting the birds had lost 40 per cent of their total blood volume, or about 63 per cent of the blood that can be lost from the body; there were some assumptions in these estimates of blood loss, but they are likely to be reasonable estimates. For more accurate estimates, the blood volume of a sample of birds would have to be determined by a dye technique (Yahav and others 1997).

The efferent branches of the facial nerve (CN VII) innervate all the muscles involved in facial expression, including the eyelids, and are responsible for the palpebral reflex; this nerve exits the brain at the level of the myelencephalon, and with CN VIII travels through the internal acoustic meatus to innervate the muscles of the face (Sisson and others 1975). By cutting the throat at the base of the head, it is impossible to interfere with this nerve and consequently the palpebral reflex. The data in Table 1 show that the loss of posture occurred after the initial onset of strong muscular contractions; this may have been an error due to examining the loss of posture only on the second day, whereas the onset of muscular contractions was measured on both days. The observations on the second day suggest that the onset of muscular contractions occurred shortly after the loss of posture, the mean times being 13·9 seconds for the loss of posture and 14·5 seconds for the onset of strong muscular contractions.

The purpose of some of the measurements was to determine when the birds became unconscious. The eye test has been criticised as a test for unconsciousness because it is more indicative of brainstem reflexive function, which may be present even though an animal is unconscious (Gregory 1987). Nevertheless, the loss of the eye response, in conjunction with other indicators, such as the absence of coordination and the presence of muscular contractions, is still considered to be an indicator of unconsciousness provided there is no direct interference with the bird's neuromuscular capacity to make the response (Gregory and Shaw 2000); when this reflex is absent, it is likely that the animal is unconscious (Gregory 1998). Other indicators of unconsciousness are a lack of muscular response to a physical stimulus, and a lack of rhythmic breathing and vocalisation (Grandin 1994). The period during which involuntary convulsive muscular contractions occur has been used in other species as an indicator of unconsciousness, and in these birds they began at about 12 seconds after neck cutting. Similarly, a loss of posture is considered to indicate loss of consciousness and it occurred on average about 14 seconds (range eight to 26 seconds) after neck cutting. These data suggest that on average the birds would have lost consciousness after between about 12 and 15 seconds, although some birds may have remained conscious for up to 26 seconds. However, the accuracy of this interpretation is open to doubt, because the *Shechita* method involves cutting the bird's neck muscles, oesophagus and trachea, so that the bird may be physically unable to respond. However, this possibility is considered unlikely because the neuromuscular pathways enabled the movements of the bird during the strong muscular contractions that occurred about 12 seconds after neck cutting, including movements of the neck.

The efficacy of the procedure is generally considered to rely on the neck cut completely severing both carotid arteries and jugular veins. The blood supply to a bird's brain is primarily through the internal carotids, which supply the cerebral carotid, external carotid and external ophthalmic arteries; in contrast with cattle, the vertebral artery is not involved in the blood supply (Sisson and others 1975). The cutting of both carotid arteries should therefore result in a sudden large decrease in the supply of blood to the bird's brain, and the bird rapidly becoming unconscious.

A criterion for the time to brain failure, when an animal would be unconscious and insensible to pain, is the time to loss of spontaneous or evoked activity of the electrocorticogram (Gregory and Wotton 1986). In poultry, the times to the loss of 50 per cent and 95 per cent, respectively of the electrical activity of an evoked response after decapitation are on average 38 and 136 seconds, compared with 163 seconds for the loss of 95 per cent of evoked brain electrical activity after cutting both carotid arteries. It takes 14 and 32 seconds for the loss of 50 and 95 per cent of spontaneous brain electrical activity, compared with 60 seconds for the loss of 95 per cent of spontaneous brain electrical activity after cutting the carotid arteries. The loss of an evoked response indicates a state of profound brain dysfunction in which an animal cannot feel pain and is unconscious. However, the presence of an evoked response is not a reliable index of pain or awareness (Gregory 1987) and insensibility may occur before a profound loss of brain function. Nevertheless, the data on evoked responses in poultry suggest that the time to the loss of evoked responses is similar after either decapitation or cutting both carotid arteries, and about half the time for the loss of evoked response after cutting both jugular veins. Further use of this method to assess the time to loss of consciousness during *Shechita* slaughter would help to validate the descriptive observations made in this study.

Animals are likely to become unconscious well before the total loss of evoked brain responses, but it is not known when. The behavioural data suggest that the birds probably became unconscious between 12 and 15 seconds after neck-cutting, but for reasons given above this estimate may be too conservative. However, approximately 60 per cent of the blood capable of being drained from the birds' bodies was lost by 29 seconds after neck cutting, and it is probable that before reaching this stage, the brain would have been experiencing severe anoxia, because no oxygenated blood could have reached it.

The two main questions are whether the *Shechita* procedure is humane and whether it is acceptable, questions that involve value judgements. In considering whether the procedure is humane, it is necessary to consider whether the birds suffer fear, distress or pain before they become unconscious. Fear is generally considered an undesirable emotional state of suffering in both human beings and animals (Jones and Waddington 1992). In conventional slaughter procedures animals are stunned before being killed to ensure that they are unconscious during the procedure and are unable to feel pain or experience fear. In the *Shechita* procedure the birds are not stunned, and for this reason it is generally considered that *Shechita* slaughter may be less humane than conventional methods. Nevertheless, the method has some possible advantages, the principal one being that the birds are dead by the time they are shackled, thus obviating any pain or fear associated with shackling (Gregory 1998, Gentle and Tilston 2000). There are also potential advantages from the requirement to handle the birds individually, although achieving these advantages relies on the training and skills of the slaughtermen.

It is more difficult to decide whether the procedure is acceptable, that is, its relative humaneness; although the birds remain conscious for longer than during conventional slaughter, is the procedure relatively quick and painless? It is usually considered that decapitation results in a quick death, and as indicated above, in terms of loss of evoked activity in the brain cutting both carotid arteries is similar to decapitation and twice as quick as cutting both jugular veins. Neck dislocation is considered an humane method of on-farm euthanasia (Jones and Waddington 1992) and decapitation is considered a suitable method for the slaughter of poultry (Primary Industries Standing Committee 2001, 2002), although it is uncertain whether dislocation results in unconsciousness (Gregory and Wotton 1990). On this basis, cutting both carotid arteries should be considered as effective as the recommended procedure of decapitation. Thus, on balance, taking into account the entire process, including the removal of the birds from the crates, their behavioural responses to neck cutting, the time to bleed out and the avoidance of the need to shackle live birds, the authors consider that the *Shechita* procedure is acceptable.

There are two critical requirements in the *Shechita* procedure, one is to ensure that all four blood vessels are severed completely, and the second is to ensure that maximum blood loss occurs as rapidly as possible. It has been reported that in about half the birds all four blood vessels may not be cut completely (European Commission's Scientific Veterinary Committee 1999); this may have been, in part, due to the carotid arteries being close to the spine and the need not to touch the spine with the knife, which could result in killed birds being declared non-kosher and consequently rejected. It is therefore essential that the shochet is well trained and skilled.

In conventional slaughter the effectiveness of stunning can be tested daily by determining how long stunned birds take to recover; for the *Shechita* method an equivalent assessment would be for the shochet not currently killing the birds to access independently that all four blood vessels are being completely severed.

In relation to whether the bleed-out was as rapid as possible, the data obtained were based on atypical conditions; so that accurate measurements could be made the bird was held in a static bleed-out cone by a slaughterman and its head was held to ensure it did not get retracted into the cone and obstruct the view of the blood flow during the strong muscular contractions. The static cone was unlikely to have had an effect, but in the processing bleed-out cones approximately 10 per cent of the birds were observed to have retracted their heads and necks into the cone during the strong muscular contractions, possibly occluding the blood vessels, reducing the free flow of blood and increasing the time to unconsciousness.

The training of the shochet is apparently rigorous and involves both religious aspects and technical skills, but there appears to be no independent assessment. Similarly, although the other slaughtermen require less skill and knowledge, highly skilled stockpeople are essential for the welfare of the birds. It is also uncertain how an 'apprentice' shochet is trained, and there may be adverse effects on the birds' welfare if it is inadequate. It is therefore suggested that the training of shochets should be documented and an audit system should be established to ensure that only suitably trained persons are permitted to neck-cut birds. The welfare of the birds, particularly in relation to their handling, the lack of stunning and the need to bleed them out as quickly as possible, and the handling of reject birds should be documented in written protocols, which all the slaughter staff should be required to study; staff training in relation to these protocols should be recorded. Comprehensive documentation is available on the welfare of broilers at processing plants (Barnett and others 2001) for incorporation into company procedures.

Although it is difficult to establish how long it takes for a bird killed by the shochet procedure to become unconscious, the procedure is not necessarily inhumane. The *Shechita* procedure may be considered less humane than conventional slaughter, because the birds are not stunned, but it has potential benefits in that the birds are handled individually, their blood vessels are severed within eight seconds (range 3·6 to 7·7 seconds) after they have been removed from the crate, and they are not shackled until after the bleed-out has finished. Thus, with the *Shechita* method, the birds are dead within about 30 seconds of being removed from the crate, a shorter period than for conventional slaughter. On balance, taking these advantages into account, the authors believe that the *Shechita* procedure is acceptable in terms of the birds' welfare. Religious slaughter is controversial (Kitwood 2004,

Rosen 2004, Raj and Hughes 2004). Nevertheless, it is hoped that the results of this study and discussion may help others to make more informed decisions.

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