THE QUALITY CONTROL OF HUMANE SLAUGHTER

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SUMMARY

Reflexes used to judge the depth of chemical general anaesthetics are inappropriate to assess the state of sensibility of an animal during slaughter. Thus it is impossible to assess whether or not a slaughter process is humane by the examination of individual animals at the abattoir. However, sufficient information is now available to be able to construct specifications of a slaughter process which can be considered, with a high degree of confidence, to be humane.

Once specifications have been repaired quality control (QC) programs for the equipment, its operation and its effects on the animal can be instigated.

It is suggested that QC programs should be the responsibility of the company operating the abattoir and that the regulatory authority is responsible for quality assurance of the QC program.

INTRODUCTION

Factors determining whether or not a slaughter process is humane include the state of the apparatus, the way in which it is used and the effects of such procedures on the sensibility of the animal. Observations of the reflex reaction of individual animals are inappropriate as, with the exception of CO_2 anaesthesia, those used to judge the depth of chemical anaesthesia are of little value in assessing insensibility in animals during the slaughter process (Blackmore and Delany 1987). However, in light of present knowledge, it should be possible to produce specifications for a process which, if adhered to, will allow the process to be considered with confidence to be humane, the two key words being specification and confidence.

The effective control of a slaughter process is dependent first, on the preparation of strict specifications covering the equipment and its operation and effects. Secondly, there must be some form of quality control (QC) to ensure such specifications are met. Thirdly, there needs to be a system of independent quality assurance (QA) to check that QC procedures are effective and constantly maintained.

EQUIPMENT

Equipment at the time of installation should be effective but may deteriorate without proper maintenance. A classic example being the captive bolt pistol which, if not regularly cleaned, will lose muzzle velocity and fail to stun animals (Daly 1987). Similarly, electricians at abattoirs in New Zealand frequently make electrical modifications to electrical stunners. It is also important to ensure that the equipment is safe. This relates to both electrical circuitry and abuse of safety devices.

Quality control systems must include checks on the maintenance required on a daily or longer periodic basis. For captive bolt pistols, daily cleaning and lubrication would be required, whereas maintenance of electrical circuitry might be on a less frequent basis.

OPERATIONAL PROCEDURES

Apparatus can be rendered ineffective if operated incorrectly and a process specification must include reference to the method of use. In relation to electrical stunning this should include currents to be used, times of application and site of electrode application on the animal. Different parameters will be required for different classes of stock (Anon 1987). For captive bolt stunning, requirements must include size of charges to be used for different classes of stock and details of the site at which the instrument is to be applied to the animal's head. Proper restraint of the animals is often an integral part of the stunning operation and specifications should also cover the installation, maintenance and use of restraining apparatus.

Several techniques can be used to bleed animals (Blackmore and Delany 1988), and the method must be specified and limits to the levels of operational defects must be stated. It is unrealistic to expect 100% of bilateral carotid severance in a transverse incision of the neck (Blackmore and Delany 1987). Tolerance values will depend in part on other components of the slaughter process. If head-to-body electrical stunning is in use, cardiac arrest should occur and incision of both common carotid arteries becomes a less critical factor. If head-only electrical stunning is employed, from which animals could recover, precise specified stun to stick intervals are essential. As a general principle, to protect the welfare of animals, stun to stick intervals should always be as short as possible (Anon 1987).

CHECKING THE ANIMAL

Although a definitive assessment of the state of sensibility of an individual animal on a routine basis is impossible, there are certain signs which are strongly associated with an effective method of slaughter.

In both percussive and electrical methods of stunning, animals exhibit a typical epileptiform fit (Blackmore and Petersen 1981). Under normal working conditions it is usually impossible to observe and time all three phases of the fit. However, it is possible to check that animals immediately after stunning exhibit a phase of tonic muscular contraction for at least 10 s. Periodic inspection of animals to check on the presence of tonic spasms can be specified.

The site of penetration of a captive bolt is critical to obtain an effective stun (Gregory and Wotton 1984; Daly 1987). It is often difficult to check precisely on correct placement at the knocking box. However, periodic checks of skulls on the head rail can be included in a QC program.

In the case of head-to-body electrical stunning, concurrent cardiac failure should occur. Thus a specification for such a process must include details of checks to be carried out on animals immediately after stunning to ensure that cardiac activity cannot be detected.

Once procedures are known to be operating according to specification, it is necessary to carry out an investigation of the total reactions of a sample of animals. The frequency of sampling will depend on past information on the efficiency of the process or an indication that the process is out of control It is suggested that individual animals are periodically removed from the process immediately after stunning and before exsanguination, and placed in lateral recumbency in an area where they can be observed for up to two minutes.

If the stunning process is only expected to produce a period of reversible insensibility of up to 40 s, such as head-only electrical stunning, a typical epileptiform reaction should be observed with no evidence of voluntary head raising for at least 50 s (Blackmore and Delany 1987). If these events do not occur, the procedure must be considered suspect. If the procedure is designed to produce permanent insensibility the tonic phase of epileptiform seizure should be noted. Later, reflex body movements may or may not be more violent, but these should subside and eventually pupillary dilatation should occur. If the animal shows signs of recovery, the process is not operating to specification.

If these recommendations are accepted, it is inevitable that some animals will partially or completely recover from a stun and be returned to the slaughter process for a second time. This raises important ethical considerations and value judgements. In the case of electrical stunning, there is evidence that the procedure is not aversive, or at least it is not remembered b y sheep as a noxious stimulus (Leach et al. 1980). Thus, in the authors' opinion, the welfare of animals is not prejudiced if animals are stunned a second time. If animals are ineffectively stunned with a captive bolt, the recurrence of sensibility, even if only temporarily, could be associated with considerable distress. If such a sample of animals were not subjected to this form of examination, many others, could be inhumanely slaughtered without the problem being recognised.

QUALITY CONTROL AND QUALITY ASSURANCE

Although it is impossible to assess accurately the state of sensibility of an individual animal on a routine basis in an abattoir, it is possible to assess, with a reasonable degree of confidence, whether or not a slaughter process is operating according to specification and is therefore likely to be humane.

In a modern abattoir or meat works, confirmation that procedures are operating according to specifications will involve the principles of QC and QA. Quality control will consist of specially trained company personnel carrying out routine checks on a specified regular basis together with the process operators themselves. Quality assurance will be carried out, often by the regulatory authority, to ensure the QC system is achieving the desired results.

Specifications and QC and QA programs must be designed to suit individual operations. For instance, in a hypothetical process involving Halal slaughter of 10,000 sheep a day by head-only electrical stunning followed by a transverse incision of the neck by a Muslim slaughterman, specifications would cover the conveyor delivering the sheep to the stunner, minimum stunning currents for different classes of stock, maximum stun-to-stick intervals, and tolerance levels for bilateral severance of carotid arteries.

Specifications must also include the checks required by QC team. These will include the type and frequency of inspection of the stunning apparatus by the works electrician and the frequency of checking the operating skill of stunner and slaughterman and how often an animal will be removed from the process before sticking to ensure it has been properly stunned.

The QA team will need to produce a similar protocol to ensure the QC program is operating effectively and to decide on action to be taken if the program fails to adequately control the process.

All modern manufacturing enterprises, including meat producers employ QC and QA programs for processing procedures after slaughter. However, it appears these principles have seldom been applied to the slaughter process which is the crucial point at which muscle becomes meat, or where fully sensible animals should be converted to insensible products in a humane manner.

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REFERENCES

Anon (1987). Proceedings of pre-slaughter stunning of food animals, Brussels p.176.

Blackmore, D.K. and Petersen, G.V. (1918). *New Zealand Veterinary Journal* **29**:99.

Blackmore, D.K. and Delany, M.W. (1987). Proceedings of pre-slaughter stunning of food animals, Brussels p.17.

Blackmore, D.K. and Delany, M.W. (1988). Slaughter of Stock. Publication 118, Foundation for Continuing Education, Massey University, New Zealand.

Daly, C.C. (1987). Proceedings of pre-slaughter stunning of food animals, Brussels p.94.

Gregory, N.G. and Wotton, S.B. (1984). *British Veterinary Journal* **140**:570.

TABLE 1: Effect of duration of access to water, water intake, and muscle water content on carcass weight of steers offered water after a 30-hr journey to an abattoir

Duration of access to water (h)*	Water intake per head (l.)	Carcass weight (kg)	Water content of muscle (% of F.F.D.M.)
0	0	369	76.0
3.5	33	383	77.7
7	33	383	77.5
28	47	381	78.2
32	N.A.	376	78.0
32 + feed	58	379	78.1

* Before a 16 hour period before slaughter without water

Table from Wythes et al. (1980).

Losses in carcass weight would also be expected to increase with increasing temperature, although apart from pigs (Danzer 1970), data are sparse.

It is debatable whether transport *per se* increases liveweight or carcass weight loss, relative to that which occurs in animals deprived of feed and water for similar times, over and above the effects of the different microclimate on transported animals. Schmalfuss and Kasebier (1978) found greater liveweight loss in cattle transported in unsuitable rail wagons than in cattle transported by road. Transport (1880 km) did not reduce carcass weight more than that which occurred when cattle were subject to similar feed and water deprivation in situ (Holmes et al. 1982) but transported calves lost more carcass weight than calves fasted for a similar period (Phillips et al. 1985).

Hydration status affects carcass weight more frequently and to a greater extent than tissue catabolism. Cattle transported for 30 h and denied access to water before slaughter had carcasses which were 3.8% lighter than those of similarly transported animals allowed access to water on arrival at the abattoir for 3.5 or 7 h prior to a 16 hr preslaughter period with no feed or water (Wythes et al. 1980), see Table 1; the difference was 6% when steers were transported for 27 h and when controls had access to water for 26 h before slaughter (Wythes et al. 1983). Differences in carcass weight were closely correlated with variations in the water content (as a percentage of fat-free dry weight) of muscles (Table 1).

Larger than expected increases in carcass weight, relative to dehydrated animals, have been recorded when animals were given access to water, close to the time of slaughter, after a long period of feed and water deprivation (Wythes et al. 1980, 1983); this is indicative of a temporary overhydration. Although resting and feeding and watering cattle en route to slaughter reduced carcass weight loss somewhat (12.1 v 13.1%, van den Heever et al. 1967; 4.2 v 5.8%, Young 1973) as did providing water and feed in transit (Young 1973) or during lairage at the abattoir (Wythes and Shorthose 1984) they did not prevent it.

Rates of liveweight loss are measured relative to initial liveweights. The potential weight of gut fill, relative to liveweight, is related to a number of factors. As actual weight of gut fill can account for up to 22% of liveweight (Taylor 1954) variations in gut fill at the initial weighing influence the extent of weight loss reported relative to this initial weight. This actual weight of gut fill is affected most by the lapse of time from the last feed or drink. As animals cannot be weighed instantaneously, the order(s) of weighing contribute(s) to variation in weight loss and large numbers of animals are necessary to achieve precision in the estimation of weight loss. Apparent seasonal variations in liveweight loss can arise in pasture-fed cattle when they are weighed at a fixed clock time whereas cattle grazing times are related to day lengths.

Carcasses are dressed differently around the world and even from abattoir to abattoir in the same country. The "standard Australian cattle carcass" now has all udder, or cod fat, the tail, all internal fat (channel fat and kidney fat) removed and some subcutaneous fat trimmed so that losses may differ from situations where other carcass dressing procedures are used. It is difficult to measure carcass weights accurately, because of the impossibility of estimating the, notional, carcass weight of live animals with sufficient accuracy, and of allocating live animals to groups with the same initial carcass weight. Consequently, for adequate precision in estimates of carcass weight loss, large numbers of animals are needed.

PROCEDURES TO REDUCE LIVEWEIGHT, CARCASS WEIGHT AND ORGAN WEIGHT LOSSES

Losses will be reduced by minimising the time animals are off feed and/or water. Siting of abattoirs, the method of marketing (via saleyards or direct to abattoir), and handling procedures can have large effects on national losses. Access to water should be available whenever possible. Optimising microclimates in trucks will also reduce weight losses.

Feeding should increase water intakes. The lack of a large effect of feeding on mean weight loss is, in part, due to total inappetance in some animals induced by the psychological stress (high blood cortisol concentrations) of transport. Sporadic feeding may disrupt the equilibrium of rumen microorganisms, either interfering with the digestive process (Baldwin 1967; Hutcheson and Cole 1986) or increasing the rumen concentrations of pathogens like salmonella (Brownlie and Grau 1976). Hutcheson et al. (1984) recommended K intakes 20% greater, than N.R.C. requirements for normal calves, to maximise gain of feeder calves after transportation. Available evidence indicates that feeding after transport is not economic on the grounds of its effect on carcass weight alone. However, liver weights are increased by feeding (Kauflin et al. 1969). Wilcox et al. (1953) found that appropriate amounts of sucrose (2.7 kg/head) fed for about 30 hours increased dressing percentages and live weights but 5.4 kg of sucrose over this period reduced dressing percentages.

BRUISING

Bruising and associated hide damage are important sources of product loss. Losses occur due to