An HSUS Report: The Welfare of Animals in the Veal Industry

Abstract

Intensive confinement of calves raised for veal has long raised pointed concerns regarding the animals' welfare. Traditional production practices include individually isolating calves in narrow wooden stalls or pens, which severely restrict movement, feeding the animals an all-liquid diet deliberately low in iron, and prematurely weaning the animals. Stressful conditions lead to a high incidence of stereotypic behavior and illness. Scientific reviews of the welfare of intensively confined calves raised for veal have concluded that the young animals suffer when reared in conventional systems.

Introduction

As defined by the U.S. Department of Agriculture (USDA) Food Safety and Inspection Service (FSIS), veal "is the meat from a calf or young beef animal. A veal calf is raised until about 16-18 weeks of age, weighing up to 450 pounds [204 kg]. Male dairy calves are used in the veal industry. Dairy cows must give birth to continue producing milk, but male dairy calves are of little or no value to the dairy farmer. A small percentage are raised to maturity and used for breeding."[1]

Two types of veal are recognized by the USDA: bob veal, produced from calves slaughtered at up to three weeks of age, and special-fed veal, from calves slaughtered around 16-18 weeks. Calves raised for both bob and special-fed veal are fed liquid milk-replacement diets.[1] Of the more than 700,000 calves raised for veal in the United States annually[2]—the vast majority of whom are male dairy calves, primarily Holsteins[3]—approximately 15% are marketed as bob veal,[1] with special-fed veal, also known as white (for its very pale hue), milk-fed, or formula-fed veal, comprising the bulk of the industry.[1]

Presently, the majority of calves raised for veal in the United States are reared indoors in individual stalls[1] typically measuring 66-76 cm (26-30 in) wide by 168 cm (66 in) long,[4] and approximately 10% are raised in group-housing systems.[5] Although commonly referred to as "crates," veal stalls are constructed with open backs and partial walls separating each individually confined calf. Calves are tied to the front of the stall with a fiber or metal 0.6-0.9 m (2-3 ft) tether,[4] restricting virtually all movement until they reach slaughter weight.

Though not identified by the USDA in its FSIS "Veal from Farm to Table" fact sheet,[1] a third type of veal is marketed in North America—grain-fed or non-special fed veal—produced from calves who receive a diet that contains grain and forage (hay, silage, or pasture), as well as liquid milk replacer,[4] and are typically housed in group pens or loose housing after weaning at 6-8 weeks old.[6] The calves' flesh has a darker color[7] and is often referred to as red or pink veal. While grain-fed veal production in the United States is rare, it makes up greater than 70% of the Canadian veal industry.[6]

Due to strong public opinion for the improved welfare of these young animals, individual housing beyond eight weeks old has been prohibited in the United Kingdom since 1990,[8] and fibrous food and bedding have been required since 2000.[9] Group housing beyond eight weeks of age and daily fibrous food rations from two weeks of age have been mandatory in the rest of the European Union (EU) since January 1, 2007.[10,11] Tethering in individual housing is not permitted and may only be used in group housing for a maximum of one hour following each milk feed.[11]

In the United States, no federal laws protect animals while on the farm. However, Arizona voters approved a citizen initiative, Proposition 204, in November 2006, which states: "A person shall not tether or confine any pig during pregnancy or any calf raised for veal, on a farm, for all or the majority of any day, in a manner that prevents such animal from lying down and fully extending his or her limbs, or turning around freely."[12] The law, effective December 31, 2012, will prohibit housing calves in the individual stalls commonly used throughout the U.S. veal industry. Colorado followed suit in 2008, banning crates for both veal calves and pregnant pigs with a ten year phase-out period.[13]

In January 2007, two of the nation's largest veal producers, Strauss Veal[14] and Marcho Farms,[15] both announced corporate policies to convert their operations to crate-free group housing within 2-3 years due to animal welfare concerns. As reported by *Meat Processing*, Strauss Veal & Lamb International "is committed to raising veal calves in a more humane manner. The company's goal is to be 100-percent converted to raising calves by the European-style, group-raised method within the next two to three years." Randy Strauss, co-president and CEO, stated to the industry journal that "this is the right thing to do...The traditional way of raising veal calves involves putting each calf in an individual stall. This practice is increasingly being frowned upon by a growing number of customers and consumers alike throughout the world."[14] Industry journal *Feedstuffs* reported eight months later that the American Veal Association's board of directors "unanimously approved new policy that the veal industry fully transition to group housing production by the end of 2017," a "policy resolution" due in part to the fact that "[v]eal customers and consumers are concerned with current individual stall systems, and how animals are raised is increasingly part of customer and consumer purchasing decisions."[5]

After a comprehensive two-year study, the independent Pew Commission on Industrial Farm Animal Production, a project of The Pew Charitable Trusts and the Johns Hopkins Bloomberg School of Public Health chaired by former Kansas Governor John Carlin and including former U.S. Agriculture Secretary Dan Glickman, concluded that veal crates should be phased out:

> After reviewing the literature, visiting production facilities, and listening to producers themselves, the Commission believes that the most intensive confinement systems, such as restrictive veal crates, hog gestation pens, restrictive farrowing crates, and battery cages for poultry, all prevent the animal from a normal range of movement and constitute inhumane treatment.[16]

Despite important movement toward the group-housing of calves raised for veal by U.S. and European industries, legislative bodies, and consumers, individual housing and restrictive tethering of calves are not the only aspects of veal production that degrade calf welfare. Many customary veal industry practices fail serious scientific examination of their impacts on calf health and well-being. Indeed, research has shown that many of the welfare problems associated with customary U.S. veal industry practices could be substantially reduced or eliminated by group housing on straw, teat-feeding, and the provision of solid feed. In a study on the effects of different types of husbandry on calf behavior, Webster *et al.* concluded that "the practice of rearing calves for veal on teats and in groups appears to be 'natural' in the sense that their behavior is, in many respects, similar to that of calves at pasture with their mothers."[17] Andrighetto *et al.* conducted a similar study and determined: "Group pen calves had the opportunity for locomotion and social behaviour and were allowed to adopt more comfortable resting postures. The improved welfare of calves kept in group pens was confirmed by the higher haemoglobin levels at the end of the growing cycle."[18] Sabbioni *et al.* found that group-housed calves had higher growth performance and better food conversion ratios than individually housed calves. They concluded that the lower incidence of stress in the group housed calves, as confirmed by lower cortisol levels, may be the reason for their lower energy consumption.[19] As well, in its *Report on the Welfare of Calves*, the European Commission's Scientific Veterinary Committee (SVC) wrote that "general comparisons indicate that the housing of calves in individual pens, and the tethering of calves, result in problems for their welfare which are significantly reduced when the calves are group-housed on straw."[20] In a study on the welfare impacts of solid feed supplements for veal calves, Morisse *et al.* concluded that supplying calves with straw-cereal pellets helped reduce non-nutritive chewing and was "positive for the physiological aspects of welfare."[21] Cozzi *et al.* found that providing solid feed to veal calves promoted forestomach development and improved calves' health status, with fewer iron treatments for anemia and medical treatments for respiratory and gastrointestinal diseases

necessary.[22] In sum, a review of the welfare of calves of veal units published in 1982 reported: "Although calves are sucklings of social-living ruminants, veal calves are not allowed to suck, to have a social life or to ruminate. This, added to anaemia in order to obtain white meat, and the high rate of morbidity caused by high density of the animals, sums up the welfare problems which arise."[23]

Impacts of Unnaturally Early Weaning

Cows, like all mammals, produce milk to feed their young and, as such, must give birth to a calf in order for lactation to begin. On typical commercial dairy farms, cows are impregnated and calve on a yearly cycle for milk production, and calves are usually separated from their dams within a few hours of birth.[24] Female calves to be used as replacement dairy cows are raised in individual pens and fed milk replacer until 4-12 weeks old when they are moved to group pens and weaned onto solid food.[25] As male calves are not the desired breed for beef production, they are commonly sold to the veal industry, primarily through livestock auctions.[4] Indeed, according to the American Veal Association, "The special fed/milk fed veal industry was born in the United States in the mid 1960's [*sic*] in part, as a result of a need to relieve the US dairy industry of its unneeded byproducts."[26]

In natural cattle herds, dam and calf forge very strong and long-lasting bonds. Reinhardt and Reinhardt studied cow-calf relationships in a herd of semi-wild Zebu cattle (*Bos indicus*) over five years and found that "all cows preferred their daughters and sons over non-related calves as licking and as grazing partners for several years." The birth of a second, third, or even fourth calf failed to disrupt the close association between the cow and her older offspring. Female calves remained attached to their dams even after having themselves calved once or twice, and relationships between cows and their male offspring were evident after four and one-half years, past the son's sexual maturity.[27] Vessier *et al.* observed similar behavior in a herd of domestic beef cattle (*Bos taurus*). The cow and her yearling calf had more contacts and stayed closer to each other than did unrelated cows and yearlings, and that close bond remained unbroken even after she gave birth to a new calf. The presence of the yearling did not alter the establishment of the maternal bond with the newborn calf.[28]

Maternal Deprivation

The routine early separation of cows and their calves in the dairy and veal industries is distressing for both.[25] Hudson and Mullord found "that 5-min contact with a calf immediately post partum is sufficient for the formation of a strong, specific maternal bond with that calf."[29] Calves separated from their dams at birth, as observed by Lidfors,[30] were less active and vocalized and licked themselves more than calves remaining with their mothers. Marchant-Forde *et al.* reported that calves separated from their dams 24 hours after birth recognized and responded to recordings of their dams' calls 24 hours after separation, with the cows' vocalizations eliciting cardiac and behavioral responses in their calves.[31]

In its 1995 *Report on the Welfare of Calves*, the SVC concluded: "The best conditions for rearing young calves involve leaving the calf with the mother in a circumstance where the calf can suckle and can subsequently graze and interact with other calves."[20]

Colostrum Deficiency and Impaired Immune Function

Newborn calves have no antibodies against infections and are entirely dependent on immunoglobulin in mother's milk for immunological protection.[25] Colostrum, the milk dams produce during the first few days after calving, is especially high in immunoglobulin. Adequate intake of colostrum is critical for the future health of the calf, as those with low concentrations of absorbed immunoglobulin are more susceptible to diarrhea.[25] The routine practice of removing newborn calves from their dams within a few hours of birth may jeopardize this important transfer of immunoglobulin.

Although colostrum is collected from recently calved cows, in top dairy-producing states such as California, it is often sold to facilities specializing in raising female calves for the dairy industry,[4] as their long-term health is

considered to be of greater value than that of male calves reared for veal. Surveys of U.S. veal farms confirm that many calves do not receive adequate colostrum. Stull and McMartin, in a study of western U.S. veal facilities, reportedly found that only one in five (20%) of calves entering veal units had received adequate colostrum.[32] Stull and McDonough reported similar results after their evaluation of the welfare of calves at ten commercial U.S. veal farms, determining that only 22% had received adequate transfer of colostral immunoglobulins, leading them to conclude that "[t]he major factor likely to adversely affect the welfare of the veal calf was an inadequate immune system on its arrival at the veal facility."[33]

The colostrum delivery method is important as well. Lidfors found that calves who receive colostrum by suckling their dams have lower mortality rates and higher serum immunoglobulin concentrations than those given colostrum from an open bucket.[30] Weary and Chua found that calves kept with their dams for four days after birth had fewer bouts of diarrhea during the first three weeks of life than calves separated at six hours or one day, despite the fact that all the calves were bottle-fed colostrum within 24 hours of birth.[34] Metz and Metz showed that dam-reared calves defecate and urinate earlier after birth than artificially raised calves, likely as a result of frequent licking of the calf by the dam, and concluded that the early removal of the meconium (first excretion of feces) by the dam promoted colostrum intake and digestive functions in the calf.[35]

Denial of Natural Sucking Behavior

On most U.S. commercial veal farms, calves are bucket-fed liquid milk replacer twice per day, in contrast to the four to ten daily suckling sessions they would naturally have with their dams.[36] According to Donald Broom, Colleen Macleod Professor of Animal Welfare at the University of Cambridge Department of Clinical Veterinary Medicine, the biological mechanisms that have evolved in order for calves to receive nutrients are searching behaviors, which should result in finding a teat, followed by licking and sucking to ingest milk. These behaviors are not eliminated if the gut is filled with milk—that is, the licking and sucking behavior itself is greatly important to the calf.[37] Hammell *et al.* found that calves who were bucket-fed milk replacer *ad libitum* sucked an artificial, dummy teat that did not supply milk for 13 minutes a day and that the sucking of the dummy teat often interrupted milk-drinking. The researchers concluded that "[t]his study underlines the strong need for sucking in the young calf. Sucking is maintained even while not rewarded by milk, and it can even interrupt milk drinking. The response is not even cancelled by satiation with milk."[38] Sucking is also important for the release of metabolic, gastrointestinal hormones that aid the digestive process and are thought important for satiety.[39]

In young mammals, the motivation to suck is assumed to be strong, as under natural conditions their survival would depend on it. Denial of this important, instinctive behavior by bucket feeding, for example, often results in non-nutritive sucking of such objects as the enclosure or tether, or of other calves,[39] known as cross-sucking. Cross-sucking is typically directed at the ears, mouth, navel, scrotum, and prepuce, and occurs primarily within 10-15 minutes after milk feeding.[40] Cross-sucking has never been reported in calves raised by their dams or nurse cows.[40] The American Veal Association had in the past cited the prevention of cross-sucking, which is believed to increase disease transmission,[39] as one of the principal defenses of tethering calves in individual stalls.[41] Numerous studies, however, have shown that providing calves with an artificial teat to satisfy their need to suck, as well as the provision of fibrous foods such as hay, largely eliminates cross-sucking in group-housed calves.

Veissier *et al.* compared the behavior of bucket-fed calves with those fed with an artificial teat.[42] During the feeding, bucket-fed calves had higher heart rates than teat-fed calves and, after the meal, engaged in non-nutritive sucking of the bars, themselves, and their conspecifics. Teat-fed calves took longer to consume the milk replacer and laid down more quickly after the meal. The researchers concluded that "teat-feeding reduces non-nutritive oral activities after the meal and induces a calmer state [in the calves] than bucket-feeding."[42] de Passillé found that feeding calves through an artificial teat with a small orifice (to slow flow rate and increase sucking time), combined with the provision of hay at the end of a milk meal, greatly reduced cross-sucking in group-housed calves.[39] These results echoed the findings of Haley *et al.* who also found that providing milk through an artificial teat as well as supplying hay significantly reduced non-nutritive sucking after a milk meal.[43]

In the European Union, where group housing of calves raised for veal is required after eight weeks of age,[10] the tethering of group-housed calves for one hour following each milk meal is permitted to help reduce cross-sucking.[11] However, in a review of the effects of feeding method on cross-sucking in group-housed calves, Jensen concluded: "[T]he best way of preventing cross-sucking is to provide an outlet for the natural motivation to suck in connection with ingestion of milk….From an animal welfare point of view, the use of milk feeding methods that provides [*sic*] an outlet for the motivation to suck is preferred to tethering after the milk meal. Firstly, because a tethered animal may feel frustrated if they are highly motivated, but not able, to suck....Moreover, sucking in itself has beneficial physiological consequences for the calf in relation to digestion."[40]

Impacts of Diet

Cattle are ruminants, animals who digest their food in two stages. They have evolved to efficiently digest grass and other fibrous plants by chewing and swallowing once, regurgitating later, and chewing again at their leisure,[44] a practice commonly known as "chewing the cud." Calves raised outdoors begin to eat grass and ruminate after a few weeks of age; by four months, the young animals may spend six hours a day grazing and several hours ruminating.[45]

In contrast, the majority of calves in the U.S. veal industry are fed only liquid milk replacer.[1] This unnatural diet, low in fiber, is also formulated to be low in iron to pale the calves' flesh.[46] Consumers are generally believed by the veal industry and the retail sector to assess veal quality on color, with whiter meat commanding higher prices.[46] As the color of the calves' flesh is greatly influenced by the amount of iron in the diet, feeding animals exclusively milk replacer achieves the desired minimal iron intake.[46]

Feeding all-liquid diets to calves limits development of the gut and prevents normal maturation from the preruminant state, predisposing the animals to enteritis (inflammation of the small intestine caused by a viral or bacterial infection that can lead to diarrhea, abdominal pain, fever, and dehydration).[47] Cozzi *et al.* compared the growth performance and forestomach development of calves fed only milk replacer with calves fed the same liquid diet plus 250 g (8.82 oz) of dried beet pulp or wheat straw. In calves provided solid feed in addition to milk replacer, a clear progression in forestomach development was observed, as well as a marked reduction in the number of hairballs.[22] The finding is particularly noteworthy, as large hairballs can clog the rumen, resulting in digestive problems and even death.[44] Morrisse *et al.* studied changes in the rumen of calves fed either an all-liquid diet or ones supplemented with 10-25 kg (22-55 lb) of pelleted straw and cereals. Compared with calves given only the all-liquid diet, both groups of calves on pellet-supplemented diets showed increased reticulo-rumen weight, the presence of small papillae that help nutrient absorption from food, and significantly fewer hairballs.[21]

The SVC recommends: "Every calf should be fed a daily source of long fibre to stimulate the development of villi in the rumen, and the long fibre should be supplemented with a fermentable material such as starch to maintain the microbial flora of the gut. They should receive a minimum of 100 g [3.53 oz] of roughage per day from 2 to 15 weeks of age, increasing to 250 g [8.82 oz] per day from 15 to 26 weeks of age but it would be better if these amounts were doubled."[20] This recommendation forms the legal minimum requirement for fibrous food for calves raised in the United Kingdom,[48] while for the remaining European Union member countries, the legal minimum requirement at 2 weeks of age is slightly lower, at 50 g (1.76 oz) per day.[11]

Iron Deficiency

The already low iron content of all-liquid milk-replacer diets commonly fed to calves raised for veal is reduced at the beginning of the fattening period.[46] A deficiency in iron can inhibit the body's ability to produce red blood cells and result in reduced hemoglobin concentrations and eventually iron-deficiency anemia. Stull and McDonough's evaluation of calf welfare at ten commercial U.S. veal units found that one in four animals was

marginally anemic (blood hemoglobin concentration under 4.9 mmol/l) and one in ten was clinically anemic (blood hemoglobin concentration under 4.34 mmol/l) when sent for slaughter.[33]

According to the SVC's *Report on the Welfare of Calves*, many studies "indicate impaired performance and an increased disease susceptibility in calves whose blood haemoglobin concentration is below 4.5 mmol/l….It is therefore recommended that calves should be fed sufficient dietary iron to maintain the haemoglobin concentration at a minimum of 4.5 mmol/l until slaughter."[20] In 2006, the European Food Safety Authority (EFSA) recommended blood hemoglobin concentrations to be maintained at a minimum of 6.0 mmol/l throughout the life of the calf,[49] although the European Union legal minimum remains at 4.5 mmol/l.[50]

Numerous scientific studies have linked milk-replacer diets with insufficient iron levels. For example, Welchman *et al.* compared blood hemoglobin concentrations in calves fed milk replacer either alone or with solid feed of varying iron content and found that calves raised exclusively on milk replacer had levels indicating iron-deficiency anemia at 16-20 weeks; only calves who received solid feed with substantial iron content showed hemoglobin concentrations similar to calves raised for beef production.[51] Reece and Hotchkiss also reported the development of iron-deficiency anemia in calves fed milk replacer only, both in individual housing and group housing, compared to an increase in hemoglobin concentration over 15 weeks in calves fed hay and grain.[52] Similarly, the study by Morrisse *et al.* found that calves on milk-replacer diets supplemented with either 10-25 kg (22-55 lb) of solid food had higher hemoglobin concentrations than those fed exclusively milk replacer; however, only those calves receiving the supplemental 25 kg (55 lb) of solid food were in conformity with the EU minimum requirement.[21] In Cozzi *et al.*'s investigation, calves receiving milk replacer plus 250 g (8.82 oz) of dried beet pulp or wheat straw per day required fewer iron treatments for anemia than those fed milk replacer only and needed fewer medical treatments for respiratory or gastrointestinal diseases, and only those calves fed beet pulp had a darker carcass at slaughter, not those given wheat straw.[22]

Inactivity may also contribute to iron deficiency, which is of particular concern for individually housed calves who are typically tethered and severely restricted of movement. Although both group- and individually housed calves on milk replacer-only diets developed anemia in Reece and Hotchkiss' study, those animals in group housing had higher hemoglobin concentrations than calves in stalls.[52] Xiccato *et al.* also found that group-housed calves had higher hemoglobin concentrations than individually housed calves even though both groups of calves received the same diet.[53] The authors of both studies concluded that the higher physical activity of group-housed calves led to a muscle oxygen deficit that stimulated red blood cell production, whereas the persistent inactivity of individually housed calves did not stimulate red blood cell production as the muscles were not oxygen-deprived.[52]

Stereotypic Behavior

On all-liquid diets, calves cannot perform the normal behaviors of rumination and chewing. The natural instinct of calves to ruminate and manipulate material with their mouths is so strong that milk-fed calves will perform sham activities, attempting to ruminate despite not having ingested roughage and engaging in vacuous oral motions.[49] As a result, calves develop oral activities such as tongue-rolling and sucking, licking, and biting inanimate objects.[21] Social deprivation,[45] the inability to groom the hindquarters,[37] and the inability to explore[50] can exacerbate purposeless oral actions in individually housed calves. Purposeless oral behavior is identified by animal welfare expert Donald Broom as "abnormal behavior that is not shown by calves that can cope well with their environment." "[J]ust as in man, zoo animals or sows," Broom has written, "stereotypies are indicators of poor welfare."[37]

The provision of solid feed, particularly hay, reduces the frequency and incidence of some non-nutritive oral activities such as chewing.[21] Mattiello *et al.* found purposeless oral behaviors were more common in calves fed only milk replacer and lowest in calves also fed straw. By the end of the fattening period, however, the addition of 250 g (8.82 oz) of straw per day, the EU legal minimum, no longer prevented abnormal oral behavior as this amount was presumably unable to satisfy the needs of growing calves. The researchers concluded that 250 g (8.82 oz) per day of fibrous food for calves aged 15-20 weeks is inadequate to reduce abnormal oral behavior at

the end of the fattening period.[54] Vessier *et al.* also found that provision of solid feed largely reduced the amount of non-nutritive nibbling performed by calves. Tongue-rolling, however, seemed to come from a cumulative effect of lack of roughage and social deprivation, since it occurred mainly in calves both housed in individual stalls and fed milk replacer.[45] Webster *et al.* identified a similar cumulative effect of social isolation and lack of roughage when studying different rearing systems on calf behavior. Calves in individual stalls without solid food spent 16% of their time in purposeless oral activity, while the mean for all other groups, including those group-housed without solid food, was 2%.[17]

Abomasal Damage

Stress in mammals is often reflected in stomach-wall damage, and calves raised for veal frequently show damage of the abomasal wall (the lining of the fourth compartment of the stomach).[55] Differences in occurrence and degree of ulceration may be related to coping capabilities among calves.[55] Stereotypic behavior such as tongue-rolling may help individually housed calves cope in an environment that lacks social and environmental stimulation by increasing sensory stimulation and muscular and skeletal activity, and giving them a sense of control over their relationship to the environment.[56]

Wiepkema *et al.* studied the relationship between behavior and abomasal damage in calves. In their study, all of the calves were housed in individual crates and bucket-fed milk replacer twice daily with no solid food supplements. At slaughter, 67% showed abomasal damage, either ulcers, scars, or both. However, those calves who had developed tongue-rolling (33% of the animals in the study) had no ulcers or scars, while all of the calves who had not developed tongue-rolling (67% of the animals) did have ulcers or scars. The occurrence of biting or licking had no relationship to abomasal damage, suggesting that these abnormal oral behaviors are more related to other factors, such as lack of solid feed, than to stress.[55]

The American Veal Association maintains that feeding calves roughage causes abomasal damage, thereby supporting all-liquid diets.[41] While coarse straw as a feed supplement has been shown to enhance abomasal damage, calves fed milk replacer only also develop this damage.[55] According to the SVC, when calves raised for veal receive a solid feed supplement that is balanced for starch, fiber, and degradable protein, the amount of abomasal damage is less than in conventional all-liquid diets.[20]

Impacts of Intensive Confinement

Presently, the most common U.S. veal production housing system is the open-backed stall in which calves are separated by wooden, slatted partitions and individually tethered around the neck by a 0.6-0.9 m (2-3 ft) chain or rope affixed to the front of the enclosure.[4]

In its 1995 report, the SVC concluded:

> The welfare of calves is very poor when they are kept in small individual pens with insufficient room for comfortable lying, no direct social contact and no bedding or other material to manipulate….Every calf should be able to groom itself properly, turn around, stand up and lie down normally and lie with its legs stretched out if it wishes to do so.[20]

Neither the open-backed stall nor the individual pen allows calves to fulfill these behaviors.

Restriction of Movement

Among the greatest deprivations individually housed calves suffer are their ability to adopt their preferred lying posture and to stand and lie down naturally.[23] As a primary purpose of lying down is to relax certain muscles, the restrictions that stalls and tethers place on most normal lying postures of calves may impede full relaxation of the body and prevent the animals from lying comfortably.[36] For all young mammals, rest is critical, and sleep

disruption may occur if certain lying positions cannot be adopted.[50] Lying posture is also very important for thermoregulation. Stretching out the legs laterally can help maximize surface area to prevent overheating.[50]

Several studies have shown that calves tethered in stalls or confined in narrow pens cannot adopt the postures they would choose for most effective body temperature regulation or comfort. In Stull and McDonough's evaluation of the welfare of calves in ten commercial U.S. veal units, nine facilities used stall and tether systems and one used group housing. The researchers found that group-housed calves extended one or more legs when lying down 13% of the total lying time, whereas calves in stalls extended their legs only 2% of the lying time.[33] These results were echoed by Andrighetto *et al*. who found that individually housed calves spent more time lying with all four legs bent, while group-housed calves more frequently adopted postures with one or more legs outstretched.[18] Smits and de Wilt found that the incidence of lying with the head turned back on the shoulder or belly decreased more rapidly over time for calves in individual pens than for those group-housed, and the occurrence of lying with the head reclined forward on the floor increased over time in the individual, but not group, pens. The researchers concluded that lying with the head turned backwards is thwarted by the sides of the pen.[57] Similarly, Webster *et al.* determined that compared with those in group pens, calves in individual pens spent less time sleeping at two-weeks-old and concluded that their inability to adopt the normal sleeping posture with the head tucked into the flank may be a factor.[17]

The American Veal Association has claimed that calves tethered in open-backed stalls enjoy greater freedom of movement than those housed individually in fully enclosed pens.[41] Wilson *et al.* compared the stress and behavioral effects of enclosed individual pens without tethers and individual partial stalls with tethers, and found no consistent differences in postures or behaviors among calves in the two individual housing systems. Tongue-rolling and purposeless chewing were exhibited in both treatments, as well as increased cortisol levels over time, which suggests an increased degree of stress in individual housing designs regardless of the use of tethers. The researchers concluded: "Few consistent differences were observed in stress indicators…in special-fed veal calves as a result of tethering in partially divided stalls vs nontethering in enclosed individual pens."[58]

Despite the American Veal Association's past claim that tether and stall systems are more welfare-friendly than individual pens, several studies have shown them to be similarly poor for calf welfare. van Putten compared the behavior of 150 calves housed in the same building but kept in three different housing systems: individual crates, individually tethered between partitions, or in groups of three. No significant differences in measured behavioral patterns were found between the crated and tethered calves. A tendency towards greater grooming frequency noted for the tethered calves was explained by the fact that the observed grooming behaviors were often only failed attempts at grooming aborted due to the shortness of the chain around their necks. The authors concluded: "Tethering is not a real solution [from a welfare perspective] because of the restriction of grooming and lying down."[23] Le Neindre *et al*. also compared the behavior of individually tethered versus group-housed calves and found that those who were tethered had difficulty stretching their legs and interacted less with other calves. The researchers concluded: "Tethering for the entire resting period is not a good system for maintaining a minimum acceptable standard of welfare for veal calves because it limits their activities."[59] The 2006 *Scientific Report on the Risks of Poor Welfare in Intensive Calf Farming Systems* by the EFSA (an update to the SVC's 1995 *Report on the Welfare of Calves*) echoed this conclusion, stating: "Tethering always causes problems for calves. Calves housed in groups should not be tethered except for periods of not more than one hour at the time of the feeding of milk or milk substitute. Individually housed calves should not be tethered."[50] This opinion was enshrined in EU law and went into effect on January 1, 2007.[11]

Unsuitable Flooring in Open-Backed Stalls and Individual Pens

Flooring type has influence over calf movements, particularly getting up and down, lying, and resting. Most calves raised for veal in the United States are kept on bare wooden slats or a plastic-coated metal grating,[4] while under U.K. law, calves must be provided "appropriate bedding" from birth until slaughter.[48] When cattle are allowed to choose between different floor types, they reportedly prefer deep litter to slatted floors, especially for resting,[50] indicating welfare would likely be improved with the provision of bedding over standard barren flooring.

Wooden slatted floors absorb liquid from manure and become slippery,[50] making it difficult for calves to get up and down,[20] which can lead to leg disorders. According to the SVC's report, studies have found that calves raised for veal who were housed on wooden slatted floors showed damage of the carpal joints at slaughter, whereas those kept on rubber flooring slipped less and had less damage to their carpal joint.[20]

Given the importance of adequate rest for growing animals, a suitable floor is particularly important for calves, particularly those raised in barren enclosures without appropriate sleeping and resting quarters. Webster *et al.* compared the behavior of calves in several husbandry systems, including at pasture with their dams, group-housed in straw yards, in individual pens on concrete floors, and in individual crates with slatted wooden floors. The researchers found that, compared to calves in any other housing regimen, those in wooden crates on slatted floors spent less time lying down and almost twice as long standing idle, often appearing to be standing insecurely, suggesting they were reluctant to change positions possibly because they found the surfaces slippery.[17] Indeed, reported the SVC, slippery slatted floors may result in decreased frequency of lying bouts.[20]

Lack of Exercise

Calves, like all young mammals, have evolved with a need for regular exercise, which helps reduce problems associated with inactivity,[37] such as abnormal bone and muscle development and joint disorders. Intensive confinement systems prohibit exercise and normal muscle growth in order to produce tender veal.[60]

If healthy calves are raised in an environment with ample space to play vigorously, they will gallop, buck, and kick.[61] If housed with other calves, they will also engage in play fighting.[62] In contrast, when closely confined for prolonged periods, these normal behaviors are frustrated, resulting in an intensification of the drive to perform these activities.[56] Dantzer *et al.* compared the behaviors of calves tethered in stalls with group-housed calves when released into an open field. Tethered calves exhibited higher activity scores and spent less time immobile, suggesting a compensatory reaction to deprivation of these activities when restrained.[63] Similarly, Dellmeier *et al.* found that calves housed in individual stalls or pens for six weeks exhibited more locomotive and social behavior when released in an open field than calves housed in groups. Only stall- and pen-confined calves stumbled and fell during the field test, suggesting that prolonged inactivity had inhibited muscle development and coordination. The researchers concluded that "[t]he greater incidence of highly active behaviors observed for the more confined calves during open field testing, despite their tendency to stumble and fall, attests to the strength of motivation induced by ethostasis of locomotion."[64]

Social Deprivation

Cattle are social animals who obtain physical, physiological, and psychological comfort from each other.[36] Under natural conditions, calves from two weeks of age start to associate in groups during the day while their mothers forage and begin to form relationships with their peers.[25] In Reinhardt and Reinhardt's study of semi-wild Zebu cattle, the majority of calves formed close relationships with one or two other non-related calves of a similar age and maintained those bonds over three or more years. The scientists concluded: "In natural cattle herds the social structure is based on matriarchal families which in their turn are interconnected by means of friendship relationships between non-kin partners."[27] For calves raised without their mothers, social contact with other calves is particularly important.[50]

Tethering calves in open-backed stalls prevents the animals from adequate social contact, a fact disputed by the American Veal Association, which had claimed that the restricted calves can see other calves and are able to make head contact through the slatted partitions.[41] Holm *et al.* investigated calves' motivation for access to full social contact as compared with head-only contact. The researchers found that while calves were willing to work to gain access to both types of contact, they were more motivated to gain access to full social contact than head-only contact and concluded that "calves' welfare may be threatened if they are not allowed to perform social behaviours, and since motivation is apparently higher for full social contact than for head contact it is likely that their welfare will be better if housed in groups…."[65]

When calves are confined, their motivation for social contact intensifies. Dellmeier *et al.* studied the effect of four methods of confinement on calf behavior: tethered in individual stalls, individually penned, in outdoor hutches open at one end and restrained on a 2.5 m (2.7 yd) chain, and group housed in an outdoor yard. After six weeks, the calves were individually tested in an open field in the presence of unfamiliar calves. According to the authors: "The number of social encounters in which calves engaged increased with increasing degree of confinement….Social encounters were typically initiated by licking the ears, face, or neck of another calf, rubbing foreheads together, or butting heads."[64]

Given the natural behaviors of calves, the EFSA concluded: "Since calves are social animals they should be kept in social groups wherever possible."[49]

Inability to Explore

All animals explore their surroundings in part to discover sources of danger as well as areas of retreat or escape.[37] Calves reared on pasture spend considerable time investigating their environment through visual, auditory, tactile, olfactory, and gustatory cues.[36] When tethered in stalls, however, their ability to explore is severely restricted, limited primarily to sniffing and licking the front part of the enclosure.[36]

The negative impacts of denial of exploratory behavior on calf welfare weres outlined in the SVC's 1995 report:

> Calves given little space, low environmental complexity and no variety in their environment have little possibility for exploration and this may result in poor welfare as indicated especially by high levels of abnormal behaviour….It is likely that the inability to explore, and to escape from perceived danger contributes to the high level of oral stereotypies, self licking and hair ingestion which occurs in calves confined in individual pens.[20]

In addition, the inability to investigate surroundings can lead to increased fearfulness in individually housed calves. de Wilt reportedly observed the behavior of calves raised for veal in various housing systems and concluded that those animals tethered in individual stalls are more easily alarmed because their ability to explore their environment is significantly restricted.[66] Similarly, Jensen *et al.* found that calves reared in individual stalls for prolonged periods are more fearful than group-housed calves. They housed calves in four different types of housing (small single pen, large single pen, small group pen, and large group pen) for three months, twice as long as Dellemeier *et al.*, and then introduced them to a novel environment. In open-field tests with an unfamiliar calf present, individually reared calves from both small and large pens were reluctant to sniff the calf and had high heart rates, and a greater percentage of individually reared calves were afraid to enter the arena than group-reared calves.[67] These findings echo the EFSA's 2006 report that stated: "Calves need to explore and it may be that higher levels of stereotypes and fearfulness in poorly lit buildings or otherwise inadequate conditions are a consequence of their inability to explore."[50]

Inability to Groom

In order to maintain personal hygiene and help prevent disease, animals groom themselves when necessary, principally by licking themselves. Stimuli to groom may emanate from anywhere on the body, and once grooming is initiated, there is an urge to groom the whole body.[37] Cattle naturally lick all the accessible parts of their bodies, including their hind limbs and tails, and will often rub against objects such as branches and fence posts to reach inaccessible parts.[36] Calves tethered to the front of stalls, however, are unable to rub the hind parts of their body as the design of the open-backed stall lacks objects or structures behind the animals. Licking of the hindquarters is also greatly restricted by the tether and sides of the stall. Excessive licking of the forelegs, a re-directed behavior, is common in stall and tether systems.[36]

Stress

Individual pens and stall and tether systems do not permit calves to respond to many types of stimuli, both internal, such as the need to scratch an itch, and external, such as the need to avoid a perceived threat, and, as discussed above, also frustrate many of the calves' drive-motivated behaviors, including grooming, exploring, and interacting socially. The chronic deprivation of these needs and behaviors can lead to stress.[36]

Dantzer *et al*. showed that calves tethered in stalls had higher cortisol responses to adrenocorticotropic hormone (ACTH) than group-housed calves, demonstrating that the adrenal glands of tethered calves were more active than those of loose calves, a physiological indicator of stress.[63] Similarly, Friend *et al*. found that calves tethered in stalls had higher adrenal responses to ACTH than group-housed calves, as well as increased levels of thyroid hormones and a higher neutrophil to lymphocyte ratio, another physiological indicator of chronic stress.[68] Raussi *et al.* found that the presence of another calf greatly reduced the stress of confinement for calves in the veal industry. In their study, individually housed calves who could see, sniff, touch, and lick calves in adjacent pens through open wooden partitions were compared to calves housed in pairs in larger pens. The individually housed calves had higher cortisol responses to ACTH than pair-housed calves. The scientists concluded that calves feel a need for social contact and that pair-housing can reduce the stress due to separation from conspecifics.[69]

Disease

According to the Veal Quality Assurance Program & Veal Issues Management Program industry fact sheet, individually housing calves and "minimizing calf-to-calf contact" are important for disease control.[3] Yet, according to Friend and Dellmeier, who examined the problems relating to artificially rearing calves:

> [V]irtually all crates are wooden and can readily harbor microorganisms, and the vast majority of them have slatted partitions separating calves, which would not inhibit transmission of airborne organisms. Typically calves can also touch each other's head and frequently do make oral contact and nasal contact…possibly because this is one of the few sources of stimulation available to them… Thus, there remain many avenues for transmission of disease in most crate-housing systems.[36]

Diarrhea and pneumonia are common diseases in commercial veal production facilities.[70] The stresses of transport to the livestock auction and then the veal unit, the mixing of calves from different sources, the possibility of immune compromise as a result of inadequate immunoglobulin transfer, nutritional inadequacies of an all-liquid diet, and over-intensive stocking can predispose calves to pathogens.[71] In a study of eight commercial veal units in the United States, McDonough *et al.* found that 92% of ill calves had not received sufficient transfer of passive immunity from their dams. Of those calves who died from diarrhea, all had had complete failure of immunoglobulin transfer.[71]

McFarlane *et al.* studied the effect of iron intake on the welfare of individually housed calves and found that those in all dietary regimes experienced elevated incidences of pneumonia and digestive illnesses. The lungs of all calves in the experiment showed signs of pneumonia at some point during the rearing period. As the calves were housed in individual stalls and denied solid food, the prevalence of pneumonia could have been linked to either of these factors.[72]

Waltner-Toews *et al.* found that rearing calves outdoors in individual hutches, as opposed to indoors in adjacent pens, appeared to significantly decrease both diarrhea and pneumonia rates. There was no significant difference in the incidence of disease between individually housed and group-housed calves reared indoors.[73]

Handling and Transport

Many calves, whether group-reared or tethered in a stall, endure the stress and discomfort of transport at least twice during their lifetimes. Most calves who will be raised for veal are trucked to livestock markets at 7-10 days old,[74] where they are auctioned and then transported to the purchasing farm, though a small number may be

sold directly to a veal facility.[4] After approximately 16-18 weeks[1] of fattening, the calves are transported to the slaughterhouse.

Studies have shown that transport can cause calves to become stressed, dehydrated, and fatigued, as well as experience muscular exertion or damage. Kent and Ewbank investigated the response of three-month-old calves to 18 hours of transport. The researchers suggest that the calves' reduced rumination and lying, excessive defecation and urination, and looseness of feces were signs that the calves were stressed by both loading and vehicular movement. The calves' decreased appetite and prolonged lying and sleeping after travel suggest they were also fatigued by the journey.[75] Similarly, Atkinson found that transported calves spent more time resting and sleeping after a journey than non-transported calves. The skin of transported calves was also significantly thicker the morning after transport than control calves, indicating dehydration.[76]

Grigor *et al.* studied the effect of nine hours of road transport on young calves and reported high plasma cortisol responses, suggesting that one or more components of the transport were stressful. Calf behavior immediately after transport indicated that some calves were dehydrated, others were hungry, and, for some, the priority was to lie down and rest. During lairage, the transported calves spent significantly more time lying down than control calves, suggesting that the transported calves were fatigued.[77] McCausland *et al.* examined 16,400 calves raised for veal and found that 50% had bruised stifle joints (corresponding to human knee) after transport.[78]

Although some of the transport-related welfare problems, such as dehydration and fatigue, may be exacerbated by long journeys, short trips are also stressful for calves due to loading and unloading. Grigor *et al*. reported higher heart rates both during and after a nine-hour journey, as well as greater plasma cortisol concentration and plasma creatine kinase activity immediately following the trip, compared with calves slaughtered on-farm who therefore were not transported.[79] Creatine kinase is a muscle-associated enzyme, and its concentration in blood can indicate the degree of physical exertion or muscle damage, such as bruising. The higher levels of this enzyme in the calves' bloodstream could indicate trauma at some point during the transport process—during loading, transport, and/or unloading, and/or as a result of interaction among conspecifics. More bruised carcasses were observed in transported calves than those slaughtered on-farm.[79] These results echoed those of Van de Water *et al.* who also found increased heart rate, plasma cortisol concentrations, and plasma creatine kinase activity in calves transported for 2-3 hours. The calves' behavior during loading—balking, reversing, and defecating—indicated the process was stressful. The researchers concluded that the entirety of the transport event, including loading, the journey, unloading, and lairage in a new environment, is stressful even if the journey portion is short, as plasma stress markers reached their maximal values within 30-60 minutes of the start of the journey.[80]

Both severe and acute stress are known to be immunosuppressants. As a consequence, increased disease incidence, particularly respiratory disease, has been observed in transported calves.[81] Staples and Haugse reportedly found that 60.3% of calves in their study transported before two weeks old fell ill during the following four weeks and 21.7% died. Pneumonia was identified as the greatest cause of death.[82] Similarly, Stephens reportedly recorded a mortality rate of 23% among calves transported for long distances during their first two weeks of life.[83] In a review of post-transport calf mortality, Knowles concluded that "young calves are not well adapted to cope with transport and marketing, often suffering relatively high rates of morbidity and mortality, both during, and in the few weeks immediately following transport" and recommended that calves not be taken to market until at least four weeks of age.[84]

The effects of handling and transport are greater on individually housed calves than those group-reared. Trunkfield and Broom found that calves raised in stalls had higher blood cortisol concentrations after transport than calves of the same age who had been group-housed. The isolated calves had more difficulty walking and a significant increase in body temperature following transport. The researchers suggested that the increased temperature response was due in part to the trauma of walking for the first time in six months, particularly when boarding the ramp to the truck, as well as to the stress of mixing in close confinement with conspecifics for the first time.[81] Lensink *et al*. attributed the significantly higher heart rate found among individually housed calves

during transport to mixing with other calves, despite the fact that the individually housed animals could see and touch each other through the slats during rearing.[85]

Slaughter

According to the Humane Methods of Slaughter Act,* U.S. federal legislation, calves should be "rendered insensible to pain by a single blow or gunshot or by electrical, chemical or other means that is rapid and effective, before being shackled, hoisted, thrown, cast or cut."[86]

In a 2004 audit of five U.S. veal slaughter plants, slaughter expert Temple Grandin reported "some very bad problems," including calves slipping on slick floors and excessive use of electric prods by truck drivers.[87] According to Grandin, the most significant welfare problem was the shackling and hoisting of live calves for kosher slaughter at one plant.[87] There, the vocalization of the calves was scored at 25%, compared to 3% or less at the plants that stunned calves—an increase Grandin attributes to the shackling and hoisting of fully sensible calves by one back leg.[87]

Stunning techniques in cattle, especially calves, can also present welfare problems.[88] Large cattle are typically stunned using a captive bolt shot into the front of the head. When performed correctly, this method is effective.[88] Electrical stunning is more commonly used in calves. According to Anil *et al.*, electrical stunning of calves may produce shorter periods of unconsciousness and insensibility than with sheep or pigs.[88] Lambooy and Spanaard found that the shortest duration of unconsciousness following conventional (head-only) electrical stunning on calves was 21 seconds,[89] while others have reported periods of 45 seconds and 59 seconds.[88] As such, it can be assumed that calves may regain consciousness at some time between 22 and 60 seconds after head-only electrical stunning. Grandin surveyed several U.S. veal slaughterhouses and concluded:

> A stunning method which produces either permanent or prolonged insensibility is essential for humane stunning of calves. I have observed calves reviving during bleeding in slaughter plants when conventional electric stunning was used. Calves may revive even if they are bled immediately after conventional electric stunning.[90]

Grandin recommends the use of cardiac arrest stunning. In this method, electrodes are placed on the calf's head and back or leg. Sufficient amperage is important to ensure cardiac arrest. Blackmore and Petersen[91] reported that a head-to-leg stunner set at 2 amps for five seconds produced 100% cardiac arrest in calves, whereas 0.8 amps for five seconds was successful in just over half the calves. Grandin recommends a minimum amperage of 1.25 for wet calves with good electrodes, but states that many variables will change amperage requirements and settings higher than 1.25 amps will be required in many slaughter plants.[90]

Conclusion

Presently, the customary veal production practices in the United States—namely housing in close, restrictive confinement, social isolation, deprivation of solid food, and provision of an iron-deficient diet—have been widely criticized on animal welfare grounds and are illegal throughout the European Union. The welfare of calves raised for veal can be dramatically improved with group housing on straw, provision of solid feed, and teat-feeding of milk, all of which have been shown to significantly reduce the suffering of calves during rearing.

* Religious ritual slaughter is handled separately within the statute.

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