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ABSTRACT. Livestock handling in dairy production is associated with a number of health and safety issues. A large number of fatal and nonfatal injuries still occur when handling livestock. The many animal handling tasks on a dairy farm include moving cattle between different locations, vaccination, administration of medication, hoof care, artificial insemination, ear tagging, milking, and loading onto trucks. There are particular problems with bulls, which continue to cause considerable numbers of injuries and fatalities in dairy production. In order to reduce the number of injuries during animal handling on dairy farms, it is important to understand the key factors in human-animal interactions. These include handler attitudes and behavior, animal behavior, and fear in cows. Care when in close proximity to the animal is the key for safe handling, including knowledge of the flight zone, and use of the right types of tools and suitable restraint equipment. Thus, in order to create safe working conditions during livestock handling, it is important to provide handlers with adequate training and to establish sound safety management procedures on the farm.

KEYWORDS. Agriculture, animal handling, cattle, cows, occupational injury

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INTRODUCTION

Livestock handling is a critical component of worker health and safety on dairy farms. A large number of fatal and nonfatal injuries occur on dairy operations,[1] and livestock handling is a major contributor of these injury incidents. In order to implement effective safety measures, it is important to understand why livestock-handling injuries occur, since in modern dairy production many safety measures are available to prevent these injuries from occurring.

Worker injury and fatality surveillance data often do not provide sufficient information to answer the question why livestock-handling injuries occur, and research addressing livestock-handling injuries and fatalities on dairy farms is limited. This paper aims to give an overview of research on dairy livestock-handling injuries, with special focus on human behavior and facility design as risk factors. Safety management and livestock-handling training programs will also be elucidated.

BACKGROUND

Livestock handling is a hazardous activity involving many potential contributing factors that may lead to worker injury or even death. However, farm workers often do not view livestock as a source of danger.[2] A variety of activities and work tasks on dairy farms involve livestock handling. These include feeding, moving cattle between locations, artificial insemination, animal care such as hoof care, dehorning, vaccinations, applying topical or administering oral medication, ear tagging, milking, loading cattle onto trucks, calving, and euthanasia.[2]

Research suggests that livestock-handling incidents account for a large percentage of the injuries on dairy farms.[3–8] For example, Layde et al.[9] reported that those living on dairy farms in midwestern US dairy-producing states had an increased risk of animal-related injuries, and cattle were involved in the vast majority of animal-related injuries. Similarly, Watts and Meisel[10] conducted a 1-year prospective evaluation of injuries resulting from direct contact with cattle in a New Zealand rural hospital and found that 90% of injuries (n = 70) took place on dairy farms. These injuries were the result of being kicked by a cow (58%), crushed between cattle and other objects (22%), stood on (9%), and head butted (5%). The anatomical location for injury was mostly the hand and wrist, which accounted for 58% of all injuries.[10] Douphrate et al.[5] reported similar findings by analyzing worker compensation claims data involving dairies in a western US state. The majority of livestock-handling injuries on US dairy farms involved large operations employing 10 or more than 10 workers. Additionally, injured workers were mostly male, young, and inexperienced working on a dairy. The highest percentage (27%) of injuries were to the wrist, hand, and fingers, and nearly 50% of livestock-handling injuries took place in the parlor while milking cows.[5]

About 5000 injury incidents that resulted in bodily injury and impeded ability to work occurred on Swedish farms during 2004.[8] About 30% of these occurred on dairy farms. Fifteen percent of all Swedish farms with milk production had one or more injury incidents during that year. Most injury incidents occurred during milking, handling, and movement of animals. These livestock-handling injury events involved the worker being kicked, stepped on, hit, or crushed by cattle. Fall-related injury incidents (e.g., slipping/tripping) were relatively common during milking as well as during manure handling, stall cleaning, and handling concentrate feed.[8,11] In a study of 127 retired male farmers in Sweden, about 20% cited work-related health problems as the primary reason for retirement, with injuries arising from livestock-handling incidents being one of the causes.[12]

Geng et al.[13] reported that differences concerning the overall risk of injury incident were small between a conventional loose housing barn with a tandem stall milking parlor (MPT) and a loose housing barn with a single automatic milking system (AMS) unit. The risk of injuries during milking (e.g., bringing cows to milking, milking, cleaning milking equipment, and washing-up) was twice as high on farms with MPT than on farms with AMS, but the risk

of injuries when performing other tasks (e.g., bedding and feeding) was higher on farms with AMS. Thus, when these risks were weighted with working time, the differences between the systems balanced out.

A case-control study of dairy farm activities identified milking and hoof trimming as having an increased risk for worker injury.[6] Other studies have reported feeding activities as a source of injury.[14–16] Research has yet to suggest other activities such as cow/calf treatment, calving, or dehorning as having an increased risk of injury,[6] but other livestock-handling activities can result in injury to those working in close proximity to dairy cows.

Dairy bulls present a high risk for worker injury, and injuries inflicted by bulls are more severe than those inflicted by cows.[17,18] In a study of farm worker injuries associated with bulls, head-butting was the most common cause of injury and bulls often inflicted multiple injuries. The most frequently injured body parts involved the legs and chest, with fractures and contusions being the most common injury types.[17] Despite reduced dependence on bulls resulting from increased use of artificial insemination (AI) on modern farms, bulls continue to cause an unacceptable number of injuries and fatalities. Until the late 1940s, nearly every dairy farm maintained one or more bulls for breeding, as high-quality breeding bulls were seen as the most important element on a successful dairy farm. Artificial insemination was introduced around 1938, with dairy farmers being the first to adopt the practice. Since then, the dairy industry has seen a rapid reduction in the number of bulls maintained on dairy farms,[19] as modern farms rely almost exclusively on AI breeding to improve herd genetics and fertility. However, bulls are still used for "cleanup" purposes in modern dairy herds or raised for beef production.[20]

Dairy bulls have a reputation for being the most dangerous and aggressive type of bulls, and contribute to most attack-related injuries.[21] As long as bulls have a presence on dairy farms, they will continue to pose a risk for the safety of farm workers as well as family members. An analysis of 287 bull-related cases from 14 countries revealed the following: (1) workers were at higher risk for injury when exposure hours to bulls were higher than exposure hours to cows; (2) the risk of a bull-related fatality, based on hours of exposure, was higher than other hazards such as tractor operation; (3) injured workers generally had considerable experience with handling bulls; (4) bulls raised from calves on-site appeared more aggressive; and (5) most injury incidents involved the worker being inside a bull holding area.[19] Casey et al.[17] reported that working alone and not having an escape option were important risk factors in bull-related injuries, and the authors emphasized the importance of proper facilities and worker training.

RISK FACTORS FOR INJURIES IN LIVESTOCK HANDLING

The questions of why and how livestock-handling injuries occur on dairy farms need to be investigated. Various studies have reported factors associated with an increased risk of an animal-related injury. Among these risk factors are younger age,[5,22] older age,[23] male sex,[5,23] number of hours worked,[7,9] hearing difficulties,[22] and arthritis/rheumatism.[22]

Farmers seem to be aware of the dangers of handling large animals.[24–26] However, simply being aware of injury risks and recommended safety practices is not enough to prevent livestock-handling injuries.[25,27] Stress is one factor believed to have an impact on decision-making and risk-taking behaviors.[27,28] Studies have shown that stress and time constraints/pressure are factors that farmers themselves commonly mention as contributing factors to injuries.[25,26,29] Worker stress may be a contributing factor in animal-related injuries, since worker stress can be conveyed to cattle, which may influence their behavior and response to handling. The relationship between worker stress and animal-related injuries is an issue for future research.

The outcome of an interaction between humans and animals is dependent on animal behavior, handler behavior, and the environment

in which the interaction takes place. Because little can be done to change behavioral instincts of cattle, there are only two factors that can be modified to decrease the risk of a livestock handling-related injury: human behavior and the working environment.[30] Human behavior including handling techniques as well as the working environment regarding facility design will be further discussed in the following section.

HUMAN BEHAVIOR

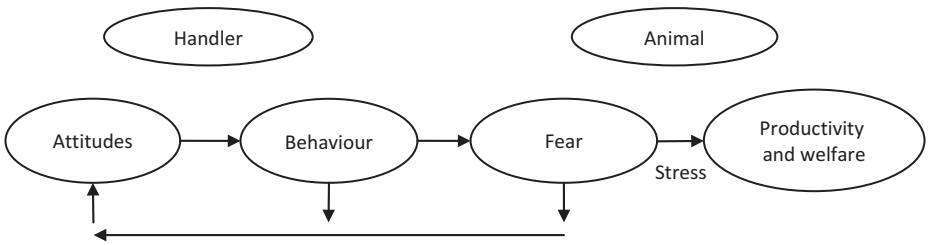
There has been limited research on human-animal interactions in dairy farming. The aim of previous research has been to study human-animal interactions in relation to animal welfare and productivity. However, the knowledge gained from such studies can also be useful when considering handler safety.

One animal motivation that will determine its response to human activity is fear.[31] Rough, aggressive, and unpredictable handling may induce fear in the animal.[32] Studies have demonstrated that a cow's fear response to humans affects their productivity, behavior, and welfare. Fearful animals are more difficult and hazardous to handle and manage,[32] and fearful and agitated animals have been reported to be a major cause of livestock-handling injuries.[33] In situations where farm animals are regularly improperly and are fearful of humans, the animals may experience acute or chronic stress responses. These stress responses affect animal behavior and compromises animal welfare and productivity.[31] A qualitative study of safety and animal-handling practices among female dairy farmers in Finland concluded that one important aspect of safe cattle handling is a trusting and positive relationship between the animal and handler.[24] Similar findings were reported in a qualitative study of Swedish dairy farmers, where handler behavior was concluded to be a main factor influencing the risk of injury during cattle handling.[26] The element most frequently mentioned by farmers in the latter study was the importance of consistently being calm and gentle when handling the animals, but they admitted that in stressful situations it is easy to lose patience and handle them improperly.[26] Bertenshaw and Rowlinson[34] reported that UK farmers believed that humans have an impact on cattle temperament, and negative experiences with humans can result in poor milking temperament. In summary, proper handling has the potential to reduce stress in cattle and reduce the risk of worker injury.[33]

Hemsworth et al.[35] reported a relationship between handler attitudes and behavior and fear in dairy cows. A positive attitude towards cows was found to be negatively correlated with the use of negative tactile interactions such as slaps, pushes, and blows.[35,36] Several studies have reported that restless behavior (flinch/step/kick responses) by cows during milking are correlated with negative tactile or loud, harsh vocal interactions by milkers.[35–37]

Hemsworth proposed a schematic (Figure 1) describing the sequential relationship between the attitudes of handlers and animal response.[38] The relationships illustrated in the schematic indicate that it is possible to invoke fear among dairy cows by handler attitudes and behavior.[35] Hemsworth et al.[39] reported lower levels of fear in cows, measured by flight distance to humans,

FIGURE 1. Model of human-animal interactions. Since fear also affects risk and safety, it could be added to the last circle together with productivity and welfare. Source: Hemsworth (2003).[38]



following a cognitive-behavioral intervention procedure designed to improve the attitude and behavior of handlers toward cows. Therefore, safety interventions addressing handler attitude and behavior may result in reduced fear responses to humans among dairy cattle.

HANDLING TECHNIQUES

Methods of animal handling may also have an influence on livestock handling-related injuries.[9] Worker understanding of the behavioral characteristics of cattle may facilitate gentle yet efficient handling, and reduced risk for worker injury.[40] Grandin[33] reported essential principles of proper cattle handling, which include the cow's flight zone and point of balance.

The area surrounding an animal that irt considers its "personal space" is referred to as the animal's "flight zone" (see Figure 3). The flight zone is the space around the animal that, when entered, causes the animal to move away from the approaching handler. As the name indicates, the flight zone is predicated on the notion that an animal will first try to move away (flee) from an intrusion into its personal space, before it will fight to defend that space. Animals in daily contact with humans have a smaller flight zone (dairy cattle), whereas animals that spend most of their time roaming with a herd have a larger flight zone (grazing beef cattle). By exploiting this concept in a gentle, nonaggressive way, a worker can encourage cows to move in a desired direction or towards a specific location, as shown in Figures 2 and 3. However, a worker not understanding this concept or applying it incorrectly increases the likelihood of the cow responding in a defensive mode or fleeing in panic, potentially increasing the risk of worker injury or even death.[33] Another important concept is the "point of balance," which is the area within the animal (usually in the central region) that if approached from the front will cause the animal to respond

FIGURE 2. Graphical depiction of the "sweet spot" concept that a handler can use as a tool to avoid the cow being surprised when approached (color figure available online).

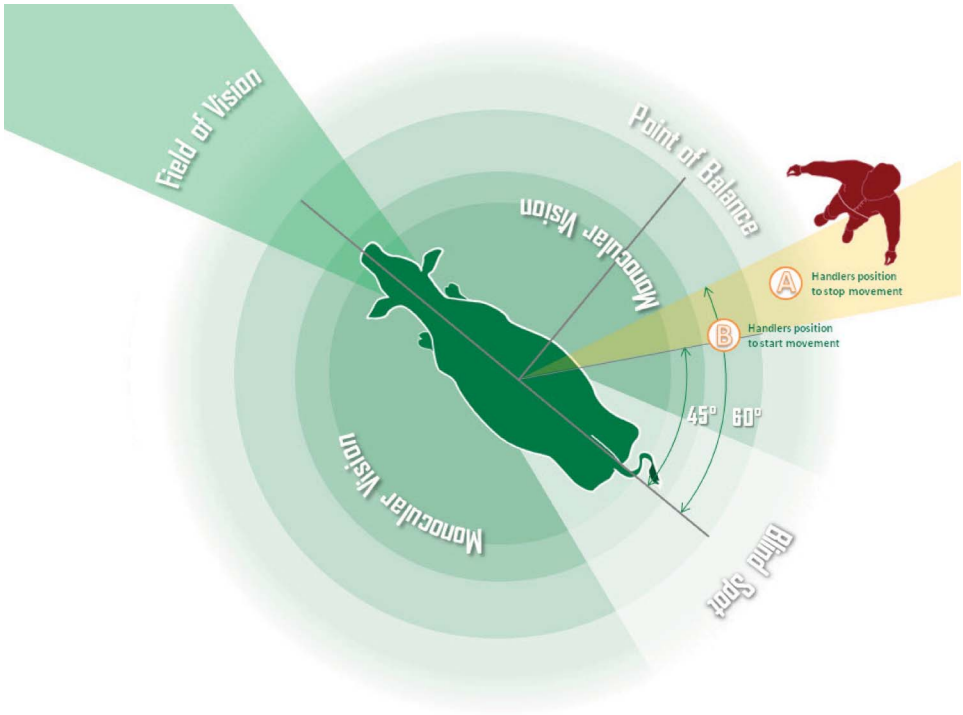
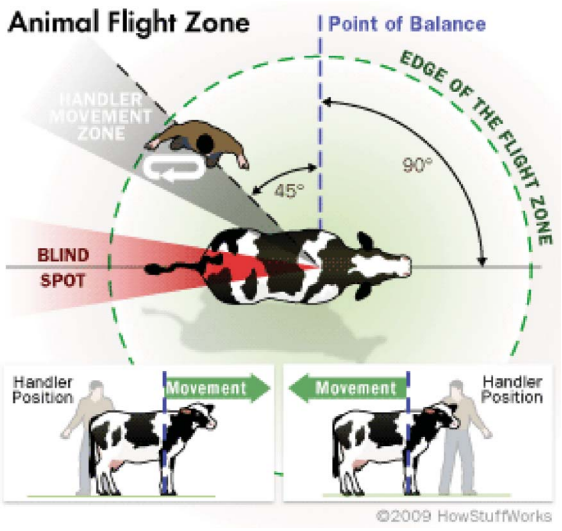


FIGURE 3. Graphical depiction of the "flight zone" concept that a handler can use as a tool to move animals in a desired direction (color figure available online).



by backing up (Figure 4). If the animal is approached from behind the point of balance, it will respond by moving forward. Therefore, the handler must understand and appreciate a cow's point of balance. By utilizing and applying the flight zone and point of balance correctly and in concert, a handler can move a large number of animals safely and almost effortlessly in a desired direction.[33]

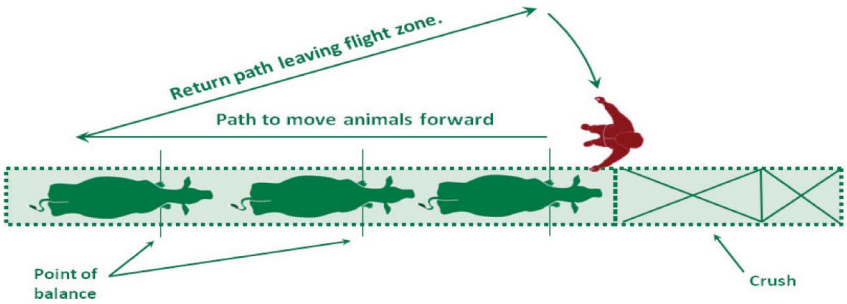
The concept of "low-stress livestock handling" has drawn much attention lately and is described in various textbooks.[41] Workshops teaching these principles have been available for several years in the United States and Australia and reported experiences by livestock handlers confirm its effectiveness and benefits. However, no scientific evaluation of low-stress livestock handling has been reported. Low-stress livestock handling deserves more attention because it explicitly utilizes the animal's behavior as the tool rather than human behavior or other methods that might be foreign to animal and potentially more prone to unforeseen and unexpected animal responses leading to injuries.

DESIGN OF FACILITIES

Proper facility design can play a major role in preventing injury incidents. Grandin has reported on livestock-handling facility design to improve cattle-handling efficiency.[42] A properly designed livestock-handling facility will facilitate the efficient moving of cattle where the animals move on their own accord with limited interaction with the handler. According to Grandin,[42] facility design based on sound ethological principles will reduce the incidence of alarmed, excited cattle as well as the risk for worker injury. Most research by Grandin involved beef cattle-handling facilities, i.e., abattoirs, markets, and yards on ranches. Therefore, recommendations may not be applicable in the traditional dairy barn. However, the basic principles on cattle behavior are universal, which form the basis for proper facility design. Some features of a good facility design are

- Facilities should have nonslip flooring.
- Alleys should be free from visual and auditory distractions causing cattle to balk (i.e.,

FIGURE 4. Graphical depiction of the "point of balance" concept that a handler can use as a tool to move animals in a desired direction (color figure available online).



shadows, reflections, changes in flooring type, and excessive noise).
- Alleys should be designed with a minimum of corners and sharp turns.
- Facilities should have escape routes so that it is possible for the handler to rapidly exit from the cattle area if the animal turns or attacks.
- Facilities should be sturdy and in good repair.[33]

Poor facility design can cause difficulties when moving cattle, which may lead to improper handling of the animals. Maller et al.[43] reported that poor facility design features in the milking parlor may affect cow behavior and ease of handling, which may also affect worker job satisfaction. Milking parlor characteristics and their effects on cow behavior and working conditions is an opportunity for future research.

Risk factors for livestock-handling worker injury include activities that increase exposure and proximity to the animal.[44] In order for an interaction between a human and animal to result in an undesired outcome (i.e., worker or animal injury), there must be a certain proximity between the animal and handler. The handler has to be within a reaching or striking distance (e.g., strike zone) of an animal to be affected by its actions. If humans could perform all animal-related handling tasks outside this strike zone, the risk of being injured by an animal approaches zero. In essence, the closer proximity between a worker and animal, the greater the risk of being injured in the event of an unexpected response or reaction from the animal. However, many tasks cannot be performed from a distance, and close interaction with the animal is often unavoidable in a husbandry scenario. From a safety perspective, it is of critical importance to assign tasks involving close interactions with cows to individuals who are highly trained to perform these tasks.

Many devices are now available to protect handlers from being exposed directly to the full force of the animal. For example, hoof trimming no longer needs to be performed from the side of the cow using a rope and clamp, as sophisticated mobile trimming rigs are available to protect both animal and handler. Treatment chutes allow handlers to restrain an animal for a multitude of procedures, which insures the safety of both the cow and worker. Cow milking is usually performed in specialized parlors that reduce the exposure of the worker to the hind quarters of the cow. Furthermore, automatic milking systems (i.e., robotic milking) remove the worker from the animal-human interface completely, thereby reducing the risk for injury. Personal protective equipment (PPE) can also be worn during tasks involving cow restraint and can diminish the impact of a kick or head butt. Continued development of safety engineering and PPE strategies will facilitate the reduction of worker injuries.[44]

SAFETY MANAGEMENT

Effective safety management may reduce injuries when working with animals.[45,46] Training on appropriate procedures and protocols should be a high priority, as well as proper supervision to ensure safety procedures and protocols are being followed by all employees at all times. This includes night shifts, relief shifts, and holidays. Promoting safe work practices with information sharing interventions that emphasize the greater profitability of safer work practices may be a viable interim supplement to comprehensive occupational safety regulations and enforcement in the dairy industry.[47] Consistency in handling animals is important from both an animal and a human welfare perspective.

ANIMAL-HANDLING TRAINING PROGRAMS

Education is believed to be a key component to prevent injuries in the livestock industry.[48] Several studies focusing on animal-related injuries in agriculture suggest livestock-handling training as one prevention strategy.[18,33,48] Langley and Morrow[48] reported that employees in livestock farms need to be trained on such issues as proper livestock handling, including animal welfare, animal loading and transportation, and proper use of personal

protective equipment. Another important issue not mentioned is proper restraint during such tasks as medical treatment and hoof trimming. According to Langley and Morrow,[48] further research is needed to develop training programs that reduce the risk for worker injury. These trainings should be accepted by workers as being and easy to utilize while maintaining animal welfare. Langly and Morrow suggested that future studies should determine if there is a decrease in handler injuries as a result of livestock-handling training.

Interventions aimed at the injury prevention rely on educational strategies.[49] However, studies on safety education have failed to show an association with reduced worker injuries.[50] An evaluation of an education-based intervention (Agricultural Health and Safety Network [AHSN] programs) did not show any observable differences in farm safety practices, physical hazards, or farm-related injury outcomes.[49] A recent review aimed to determine the effectiveness of interventions to prevent occupational injuries in agriculture concluded that educational interventions provided no evidence of having an injury reducing effect.[50] Another review of 25 farm safety interventions found little evidence that farm safety training programs had been effective.[51] However, neither of these two focused on livestock-handling education. Focused educational efforts may be more effective than general safety education and may also be easier to evaluate for their effectiveness in reducing injury.

Because of a lack of evidence of education effectiveness in injury prevention, the extensive use of educational interventions alone has been questioned.[50] Several studies recommend a coordination of different approaches to the problem, combining engineering controls, regulatory approaches, and education to reduce injuries.[44,49,52] Changing behaviors can be difficult, thus in environmental and equipment modifications focus is on providing automatic or passive protections or removing hazards completely, which makes behavior change unnecessary. An example of a very effective regulatory approach is the significantly reduced rate of tractor overturn fatalities in Sweden due to a combination of economic incentives and rollover protection system (ROPS) legislation.[53] Since research indicates that well-designed facilities combined with gentle handling can reduce stress on cattle, improving these factors may improve safety and reduce injuries.

There are a number of difficult issues to overcome related to worker training. One challenge involves the training of migrant workers. European farms employ a mix of migrant workers with different cultural, ethnic, and religious backgrounds, often with different levels of language understanding. Another challenge involves farmers' difficulties in prioritizing enough time for participation in organized injury prevention. According to Jansson and Eriksson,[52] recruitment to safety courses is best stimulated by adapting the course to farmers' work conditions and takes place near the farm and through the agricultural organizations in collaboration with representatives of different safety organizations.

CONCLUSIONS

Handling cows on dairy farms continues to be an activity associated with risk of handler injury or even fatalities. There are many variables that may minimize the risk for livestock handling-related injuries. These include an understanding of animal behavior, as well as protocols and procedures to minimize the risk associated with working in close proximity to cows. Such measures are of paramount importance on modern dairy farms, where large numbers of employees may have little or no agricultural experience and minimal to no livestock-handling skills. Managers and owners should communicate and demonstrate that carelessness and complacency are unacceptable when working with animals.

Despite a lack of evidence demonstrating that education and training leads to a reduction of injuries, further research addressing the effectiveness in livestock handling-specific training in reducing worker injuries is needed. Development of effective training in livestock handling should be developed in collaboration with those active in these type of training. Earlier studies on "farm safety intervention programs" have been criticized for weak design and

methods—which needs to be taken care of when new evaluation studies are designed. Safe animal handling in the dairy production is a global issue, which needs to be developed in worldwide collaboration.

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