

Potential Occupational Health Hazards of Livestock
Producers Working in Animal Confinement Units

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Introduction

In the past, mixed species and a rather small number of food producing animals were kept per farm unit. With today's increase in specialized farming, a large number of a single species is often housed in concentrated livestock production units. Therefore, people directly associated with animals may be exposed to the common environment of a single species for longer periods of time.

Many present day housing facilities are confined or semi-confined units where animals are reared on slotted floors over manure pits or on an accumulation of manure. No bedding is used on slotted floors. This results in concentrated manure slurry. Because of these newer farm management systems, animal excreta often remains in confinement units for weeks to months instead of a day or two.

The concentration of animals and manure results, in potentially excessive direct human contact with pathogenic microorganisms and the release of harmful gases from the slurry within the confinement unit. Ventilation systems are utilized to reduce moisture, remove odors and to generally circulate air. However, movement of air and lower humidity keeps dust particles and microorganisms floating in the environment.

Review of the Literature and Research

In an effort to document the cause and effect relationship of livestock confinement units and human health hazards, an effort was made to determine

if human health hazards were a problem or if cases of illness have been reported or documented.

To determine if illness of livestock producers had occurred, I consulted the Minnesota State Department of Health. Dr. Fleming indicated that he has not received reports of illness of occupationally involved persons in livestock confinement units: no direct association had been reported.¹

In 1974 a review published entitled "Livestock and the Environment", contained 1264 abstracts of which 55 pertained to health. Of the 55, none appeared to directly document the occupational health effects associated with the livestock confinement unit.²

Preuschen³, of West Germany, reports observations made on healthy workers exposed over a long period to livestock confinement units without bedding, where excreta remains for several days or weeks, where anaerobic decomposition takes place, and where ventilators have reduced moisture of air so more dust is generated. The results were that:

1. Bad smell from animal houses is not only unpleasant, but health damaging. Irritation of the bronchias (coughing) and dizziness (similar to being sea sick) are the result.
2. Subjects with a sensitive respiratory system tend to have shortness of breath and will become easily tired.
3. Existing bronchial allergies may be intensified so that persons smelling emissions from animal houses become unable to work because of asthma.

In initial experiments, Preuschen of the Max-Planck Institute, studied the influence of respiration of human subjects on normal air and odor intensive air. Subjects with normal respiration and handicapped respiration were used. Their findings were that normal working capacity, even of healthy persons, will be reduced by inhaling air from animal houses without bedding. Persons with a previous respiratory system handicap have

to face serious health damages after they worked in such houses for one to three years.

As a practicing Iowa veterinarian working in livestock confinement units, especially swine, I have personally experienced some of the above mentioned health effects. Other practicing veterinarians have indicated similar experiences.

Research has been conducted on the constituents of the atmosphere of livestock units. Day⁴ et. al. have identified NH_3 , CO_2 , and H_2S in the atmosphere of confined swine units. Additional constituents have been identified. Investigators have implicated H_2S in swine deaths. H_2S as high as 800 ppm has been measured during anaerobic pit agitation.⁵ Lawson and McAllister⁶ found that H_2S exceeded 1000 ppm above agitated manure slurry. Both levels are high enough to be considered dangerous.

Elliott⁷ et. al. have compiled the following threshold limit values: Threshold limit values (TLV) for CO_2 , NH_3 , and H_2S considered dangerous for man and animals.

Gas	Level	
	TLV	Dangerous
	ppm	
CO_2	5,000	250,000
NH_3	50	5,000
H_2S	10	500-800

In trials Curtis⁸ et. al. have studied the affects of aerial NH_3 , H_2S , and swine house dust, alone or combined, on swine health and performance.

Ammonia alone at 50 or 75 ppm had little effect on growth performance, at levels more commonly encountered in practice (10 mg/m^3), it had no effect. Hydrogen sulfide alone at 8.5 ppm, or 2 ppm in combination with NH_3 at 50 ppm had little effect on rate of gain or feed efficiency.

Another potentially hazardous gas is methane (CH_4) which is produced in anaerobic decomposition of animal manure. It is of danger in the starting up of oxidation ditches in which manure has been collected prior to beginning of aeration. Methane which is produced in anaerobic systems is only slightly soluble in waste water or water and will escape. Methane should be vented to the atmosphere or collected and burned as a heat source. Care must be exercised to prevent occurrence of a methane-air mixture in the range of 5 to 15% by volume. Such mixtures are highly explosive.⁹

Researchers in Sweden and Europe have conducted studies concerning liquid manure gas poisoning in cattle. Chronic manure gas poisoning was first described there in the 1960's by Bengtsson, Ekesho and Jacobsson.¹⁰ The effects were described as a general deterioration in condition and production, tendency to hemorrhage, softening of hooves followed by lameness, dyspnea, and tachycardia. Further data regarding chronic gas poisoning in cattle have been presented by Hogsved¹¹, and Hogsved and Holtenius.¹²

Examination of the air in cowsheds with liquid manure handling showed that H_2S contamination of the air was characteristic and that high concentrations of this poisonous gas may occur when liquid is agitated in some way. The presence of H_2S can rarely be identified in cowsheds where solid manure is handled.¹²

Hogsvedt¹³ further indicates that a large number of acute poisonings have occurred in both cattle and pigs in Sweden. These have occurred in connection with heavy agitation of liquid manure which has been stored for a long time. Acute cases of poisoning have occurred even when agitation has taken place out of doors, if there has been an open connection between cowshed and manure tank. The development of the acute or peracute poisoning

is very rapid. Convulsions and dyspnea can occur, some animals surviving can suffer from nervous disease and laminitis afterwards.

The chronic poisoning as described by Hogsvedt can sometimes take a long time for visible signs to develop. Dairy cows lose flesh and yield and tend to develop lameness because of extreme changes in hooves in such as softening of the horn and deep infections. There is also a general tendency for cattle to develop subcutaneous hemorrhage, with some described larger than a man's head. It is believed that H_2S is an important etiologic factor. They feel that the combination of H_2S and NH_3 may play an important role in poisoning.

Minnesota Research - Survival of Pathogens in Animal Manure Disposal*

The occupational hazards of the more than 150 zoonotic diseases (those naturally transmitted between vertebrate animals and man) has been documented. In the United States some of the occupational health hazards have been caused by brucellosis, Q fever, leptospirosis, salmonellosis, the source of which usually is animals; and often livestock. In the U.S. approximately 100 human cases of leptospirosis and 20,000 human cases of salmonellosis are reported each year.

During the past 5 years I have been engaged in a research project supported by the Environmental Protection Agency and formerly the U.S. Public Health Service. This research was designed to determine the survival of pathogens in beef cattle manure disposal by the oxidation ditch. Leptospire shed from the urine and salmonella shed in the feces of infected cattle were used as study models. Both diseases cause major health and economic problems. Bacterial counts of 100 million leptospire per ml of urine, and 10 million salmonella per gram of feces have been reported being shed by infected cattle. Shedding may occur from weeks to months duration. Studies

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were conducted in simulated laboratory models and a field oxidation ditch unit over which beef cattle were housed.

During this research project four feeder cattle (1100 pounds weight) were found dead on slotted floors over the field oxidation ditch, which contained manure slurry. On autopsy a diagnosis of idiopathic toxicosis was made. Cause of death was the likely emission of toxic gases.

During the past two years research objectives were to measure the viability and infectivity of leptospire and salmonella in aerosols caused by a potential mechanical dissemination of a laboratory model oxidation ditch and the field model being used to treat beef cattle waste under a confinement housing unit.

Leptospire seeded for five days in the manure slurry of a laboratory model oxidation ditch were measured as surviving 18 days at winter temperatures (2° - 5°C) and for 138 days at summer (20°C) temperature.^{14,15,16}

In an attempt to transmit leptospire by aerosol created by the rotor of the model ditch, weanling hamsters were housed on wire mesh over the rotor of the leptospiral seeded ditch. Hamsters exposed to these aerosols did not develop evidence of infection as measured by detectable serum agglutinating antibodies of kidney infection. In other experiments, hamsters were exposed to microbioaerosols of leptospire in an isolation chamber for five minutes at concentrations of 2×10^3 to 2×10^8 . These failed to develop infection.¹⁷

Results indicated that leptospire which had been recovered from the manure slurry 17 days post seeding had lost measureable virulence when studied in hamsters.

Salmonella survived for 17 days post seeding in the model oxidation ditch at (20°C) temperatures. Survival was measured for 47 days at winter temperatures.¹⁸

Aerosol transmission of salmonella was attempted by placing week old turkey poults in cages over the seeded slurry and rotor of the model oxidation ditch. Salmonella was transmitted to poults housed above the aerated manure slurry. In further experiments turkey poults exposed in an separate isolator unit became infected when exposed to S. typhimurium at 10^4 to 10^5 bacteria per liter of air.¹⁷

To evaluate human and animal health hazards in a field beef housing unit, a aerosol sampling program was developed above the operating oxidation ditch. The air of the housing unit was found to harbor a rich bioaerosol. Counts approximating 100 to 200 total colony forming units per liter of air sampled were measured during the one year sampling period. Findings indicate that high levels of bacteria were associated with the housed animal population and not the oxidation ditch treatment system. Indicator fecal bacterial aerosols also were higher when animals were present.¹⁹

Discussion

The expansion of the concentrated livestock units which has developed in recent years has resulted in new concern for the occupational health of those who came in contact with the environment of these facilities. From a review of the literature, it is apparent that very little effort has been made in the United States to document human cases of infections or toxic diseases of those occupationally challenged in livestock confinement units.

In a closed or semi-closed environment livestock confinement unit the potential for transmission of zoonotic diseases exists directly from infected shedding livestock or indirectly by aerosols from the manures below the animals. Both disease agents leptospores and salmonella may be transmitted by airborne methods. Infected animals may shed the pathogens for weeks to months. Our research has shown that leptospores may survive for 138 days at summer temperatures in aerated beef cattle manure slurry and salmonella for 47 days at winter temperatures.

Both acute and chronic health hazards exist due to possible release of high levels of gases such as H_2S and NH_3 . Although these high levels may be the exception rather than the rule, they can occur when manure is mixed in an anaerobic pit or when a aerobic system which has failed for a period of time becomes anaerobic and then mixed again.

In reviewing the literature, I was unable to document human fatalities associated with the above conditions, but the danger and health hazard have been documented by both the acute deaths and chronic conditions resulting in cattle and swine. The hazards to both animal and human health have been documented in the literature cited from Sweden and Germany.

From July - November, 1973, I studied Environmental Health Effects of Animal Wastes Systems in several European countries and Great Britain. In Sweden, there was great concern for and documented results of the development of toxic levels of gas of livestock housed above liquid manure pits. They indicated that control or eradication of salmonellosis is nearly impossible from farms with liquid manure systems. One Swedish researcher indicated that this fact will likely result in discontinuance of the use of liquid systems on salmonella contaminated farms.

In Europe there appeared to be an increase in the flushing of animal wastes with water from a holding space beneath confined animals to a holding tank outdoors. In a number of locations the slurry was being aerated outdoors.

Work on the chronic health effect of humans of confined livestock units has been conducted in Germany. The health effects of people with previous respiratory problems has been shown.

Although the concentration of a single species on one farm, may result in greater exposure potential to people, the subsequent automation and improvement in structural facilities and design in areas such as ventilation

in some situations results in a relatively "safe" environment. But the "break-down situation, the improperly designed livestock unit or overcrowding of livestock within a unit can result in a definite health hazard being created. In the United States, we need closer cooperation between those responsible for development of systems and those concerned with the health of animals and man.

Since July 1, 1973 Swedish farmers who build new facilities for 10 cows, 50 pigs or 500 hens must have all new buildings approved and controlled by the county veterinarian. This law developed after the 1960's during which time many buildings were constructed which were unsatisfactory to animal health.

The illness and death of animals from pathogenic microorganisms and toxic gases can be utilized as an excellent example of comparative medicine. Here animals become monitors of the environment and can alert those concerned with health that a potential health problem exists for those occupationally involved. This information should be better utilized by those responsible for maintaining health.

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