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The Bad Side of Bacon: Industrial Hog Farming and Antibiotic Resistance

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Introduction

Antibiotic use in the rearing of livestock is a practice that is decades old, starting after World War Two. It vastly improved the lifespan and health of the animals, which in turn greatly benefitted farmers who raised and sold them. It also allowed farmers opportunities to raise more animals than before with greater efficiency. However, in the 1990s, this practice started to be exploited as natural additives and yearly antibiotics were replaced with growth hormones and antibiotic use at the subtherapeutic level to promote unprecedented – and unnatural – growth (Jackson 2016). This use of antibiotics also comes with a much more serious consequence – the rise of antibiotic resistance in bacteria, which can leave animals, and eventually humans, susceptible to infections and diseases that could otherwise have been prevented with proper antibiotic usage (Sancheza et al. 2016).

The pig industry is the second largest farming industry in the country, processing over 112 million hogs each year, or 23.2 billion pounds of pork meat (North American Meat Institute). The enormity of the industry is coupled with the sharp rise of the switch from small to industrial farms; in Illinois alone, there are only 484 industrial hog confinements, which house twelve million of the just over thirteen million pigs in the state (Jackson 2016). As a multibillion-dollar industry, large farm owners often tend to focus on profit –- processing as many pigs as possible for as little cost as possible. This desire for higher yield translates to a boom in the use of antibiotics, whose negative effects are prevalent not just for the pigs being given antimicrobial drugs, but also for the people who are handling them and those in the community surrounding the industrial farms. Antibiotic use at subtherapeutic levels in industrial hog operations has lasting consequences on the local and national scale. Workers in contact with pigs face high risk of contracting diseases and antibiotic resistant bacteria, the surrounding community can be affected through various vectors carrying the pigs' antibiotic resistance, and the environment suffers heavily from the massive amount of pollutants and wastes that accumulate daily on pig farms. Research points to the best hope for remediation through cessation of subtherapeutic antibiotics and a focus on organic practices.

Community

The antibiotics used for pigs do not remain isolated within their systems; they exit the body by means of excrement, so the farmers and workers who are in the presence of the pigs and their waste are exposed to these antibiotics as well. The conditions of CAFOs (concentrated animal feeding operation) that make them hazardous for the animals are also a reason conditions are bad for the humans working there: "feed [and therefore the antimicrobial drugs within it] is usually in powder or pellet form, which can release distinct amounts of dust during handling" (Hamscher et al. 2003). Within the close quarters of the pig confines, often with poor ventilation systems, workers are exposed to dust through inhalation. Not only are many common antibiotic drugs used, like sulfamethazine, known allergens, but their heavy concentration in the dust poses a risk for the development of antibiotic resistance in humans (Chapin et al. 2005). It is estimated that farmers working full days with exposure to the airborne dust inhale 6.3 milligrams of dust, 0.2 micrograms of which contain antibiotics (Hamscher et al. 2003); though this number seems miniscule, it is a rough estimate based on average findings. The real amount inhaled may be higher, but even if not, factoring in the years many workers put in around the animals, their exposure increases exponentially. Not only are respiratory problems in general expected from these results, but the amount of resistant bacteria each worker is exposed to grows over time, leading to the possibility that they will develop resistance to the antimicrobial drugs.

But these airborne antibiotic particles do not affect only the workers and farmers in close proximity to the animals – the wind can carry the emissions vented out of the confines across fields, affecting neighbors and local residents. Not only do these emissions smell bad, but "decomposing swine waste releases chemicals like hydrogen sulfide and ammonia that mix with the animal dander and fecal dust . . . [these] gases and airborne particles can cause respiratory illness" (Jackson 2016). Reports from retired Illinois farmer Dave Work, whose new neighbor is an industrial hog farm, says of the stench: "Nobody hangs their clothes out or keeps their windows open. It just about knocks you out. We eliminate being outside. If you have to go somewhere, you don't lollygag in your yard" (Jackson 2016). Those who are most often affected by the odors from hog farms are smaller scale farmers, people whose livelihood has depended on farm work for generations, now finding themselves unable to bear being outside on their own property. The consequences of these odors not only lead to illness – reports of headaches and congestion – and a lower quality of life – families unable to spend time outside or work on their farms – but increase the possibility of exposure to antibiotic resistant bacteria by these means (Jackson 2016). It is impossible to guarantee the containment of fumes and airborne particles from CAFOs to their own land, and thus they pose a serious health risk for nearby families.

One type of antibiotic resistant bacteria, *Staphylococcus aureus*, or MRSA, affects pigs receiving large quantities of antimicrobial drugs; however, this pathogen can also be transmitted to humans, and increases risk of infections that can range from nuisance to fatal. The chances of coming into contact with MRSA increase for those working around pigs in industrial hog operations. In one study conducted, over twenty percent of farmers tested positive for MRSA, with eighty-seven percent of these farmers coming from farms where MRSA was also detected in the pigs (Smith et al. 2013). None of the pigs sampled on antibiotic-free farms tested positive for MRSA, so the MRSA incidences in workers on those farms were not transmitted by pigs (Smith et al. 2013). MRSA can be spread by pigs to humans, and that the same antibiotic resistance their bacteria gains due to treatment can be passed to people. Though those who work on non-CAFO farms can carry MRSA, those on industrial farms where antibiotic treatments are used have clear phenotypic markers of spread via pigs in their MRSA strains, and these markers are most commonly resistance-related. One study found a prevalence of tetracycline-resistant MRSA found only in industrial hog farm workers' nasal cavities that directly linked their cases to pigs. These workers are at risk not just to bacteria, but to bacteria that is resistant to multiple types of antibiotics (Rinksy et al. 2013). While MRSA was once a condition only common in hospitalized patients with weakened immune systems, it is now appearing in otherwise healthy adults.

Another study found that eight percent of farmers' family members were also testing positive for MRSA, despite not having the same direct contact with the livestock (Graveland et al. 2010). Again, the main factor that predicted if a worker tested positive for MRSA cultures was whether they were handling antibiotic-treated animals, and workers were not contracting MRSA if they worked on antibiotic-free farms (Graveland et al. 2010). Though it seems negligible, that eight percent may not have otherwise known they had the disease, thus becoming an unknown carrier, and possibly transmitting MRSA to others within their community. When looking at the individual phenotypic makeup of the resistance found in these MRSA strands, nearly all (ninety-eight percent) strands contracted at a CAFO were resistant to at least two common antibiotics used to treat infections that are also approved for subtherapeutic use in agriculture for growth promotion. None were resistant to antibiotics like vancomycin, which is not approved for agricultural use, demonstrating that the increase in resistance can be blamed on the use in industrial swine facilities (Chapin et al. 2005). This further facilitates the possibility of MRSA spreading throughout a community that is highly resistant to antibiotic drugs, leaving few available options for treatment.

Besides the possible risk of coming into contact with antibiotic resistant bacteria like MRSA from farming neighbors, other people in the community can be at risk from factors like the meat itself purchased at stores. Given the national network and distribution of the hog industry, this risk can be amplified to a countrywide scale; meat produced locally can have national impacts. One study examined eighty different meat brands from twenty-six stores in different regions of the United States, and found pork to have the second highest likelihood for contamination by MRSA – eleven out of twenty-six samples tested positive (Waters et al. 2011). Along with this statistic, of the isolated strands of MRSA found, "ninety-six percent were resistant to at least one antimicrobial" (Waters et al. 2011). A single sample showed resistance to an antibiotic used to treat severe MRSA infections (Waters et al. 2011); though it is unlikely to have been a direct result of antibiotic use in pork, it presents the possibility of serious resistance being transmitted in the meat industry. Antibiotic use and the resistant strains of bacteria that can flourish on the farm do not disappear in the processing and packaging of the meat, but rather can be taken right along with it and sold to consumers, only increasing the possibility of an emergence of greater antibiotic resistance in humans.

Environment

In the context of the environment, the problem with pig farms stems not just from the possibility of resistant bacteria spreading with the application of manure, but the sheer volume of pig waste being produced and the seemingly impossible task of storing it all, or the lack of effort to properly do so. The result of negligence and millions of tons of waste is serious environmental hazards, like runoff into water sources, which affects both humans and animals relying on these sources.

Resistance can enter the community through improper control of manure by industrial-sized farms, where it winds up in fields as fertilizers, despite the prevalence of antibiotic-resistant bacteria in the waste, and can then contaminate soil and crops in the fields. While the manure from the CAFOs is usually first collected in manure pits and chemically treated before being put on the fields, this process does not guarantee that antibiotic-resistant bacteria is eliminated; in fact, one study found that several strains of resistant *Salmonella* were present in the soil of more than half of the sampled farms (Pornsukarom and Thakur 2016). This result can imply that the crops planted in these fields are at risk of also becoming contaminated by the soil. Hoping to connect the implication of soil impurities to the spread of bacteria in the community, another study found that eleven percent of local cases of MRSA reported in a Pennsylvania county could be linked to application of hog manure in crop fields (Casey et al. 2013). Though this number may not seem large, it is still statistically significant considering the difficulties that arise in identifying a single crop field as a source of resistant bacteria in the community (Casey et al. 2013). While only eleven percent of MRSA cases could be confidently linked to the agricultural fields, there may be an even higher correlation that went unnoticed due to the variability.

Minimal application of fertilizers made from fecal matter of industrial pigs may not initially have severe effects, but the problem is the great volume of waste and its excessive application to fields; this excess drives the persistence of antibiotic resistant bacteria in the soil underneath (Ghosh and LaPara 2007). In an experiment where antibiotic-fed pig manure was applied to a field, “resistance among soil bacteria returned to preapplication levels within 6 months of manure application" (Ghosh and LaPara 2007). However, this return to normalcy was after just a single application – likely, the continued and frequent application of contaminated fertilizers would lead to sustained and serious changes in soil microfauna and resistance. Along with the long-term changes, even in just this brief six-month period, the crops growing in the field would likely be exposed to the resistant bacteria and could pick it up and spread it farther.

Another serious risk of this application of contaminated soil is runoff into local waterways. Bodies of water "proximal to spray fields where [industrial hog operations'] liquid lagoon waste is sprayed . . . [tested positive for] MRSA" (Hatcher et al. 2016). Not only does this contamination of waterways spread the prevalence of MRSA, capable of travelling to other tributaries and communities, but the other bacteria in swine feces are spread as well, which can create other health problems for those living in proximity to CAFOs, or even within its watershed. In one study, high concentrations of fecal bacteria were found downstream of the hog farms (Heaney et al.). Technology to detect fecal bacteria, however, is still in its early years and therefore the accuracy of sample testing greatly varies in instances of increased rainfall or summer months, where bacteria decompose quickly in the heat (Heaney et al.).

These "lagoons," as they are called, of pig feces are epicenters of bacteria and disease, antibiotic resistant or otherwise, and exceptionally vulnerable to mistreatment and poor handling that can result in their contents entering the environment through waterways. Even undisrupted, the sheer volume of waste in lagoons– from hundreds of thousands of pigs on industrial farms – can lead to seepage into underground water sources (Editorial 2016). This is especially disturbing considering the reliance on groundwater by many rural communities. Flooding of the waste lagoons is also a problem "that may become more frequent as climate change leads to more severe storms" (Editorial 2016). Lagoons are also susceptible to other incidences of leaks, crumbling structures, overflowing, or simply wanton neglect. Their harm extends throughout the community, though, not just to people who drink the water. One spillage of a lagoon in Illinois in 2012 resulted in the damage of 20 miles of freshwater ecosystem as it polluted nearby Beaver Creek (Jackson and Marx 2016). After this pollution killed off almost 150 thousand fish, the river's aquatic life is only just beginning to see recovery; one witness to the incident, a small farm owner Donald Savoie, said, "there was carp, there was bass, there was bullheads, there was catfish – it was amazing how many – and the creek was black. You could smell it. It was rank" (Jackson and Marx 2016). With so many miles of the creek affected, there is no doubt that the effects were felt throughout the community. This example is just a single incidence reflective of the problems with the system as a whole; often, the massive amount of waste cannot be properly stored, and so lagoons become disasters waiting to happen for the environment and community alike. The application of contaminated swine manure can lead to further contamination and health problems in crops and waterways, which has far-reaching effects in the immediate and possibly even extended community.

The most concerning method of resistant bacterial spread in the environment resulting from pig farms, however, is through the air; airborne bacteria is more difficult to control, as well as to test and account for, and can spread throughout the community within the vicinity of industrial pig farms. As discussed earlier, foul odors and respiratory issues are not the only problems that face residents surrounding industrial hog farms, but the spread of antibiotic resistant bacteria also poses a threat to the degradation of local air quality. Problems with airborne bacteria around CAFOs begin with the shape of the housing structures: "the tunnel-ventilated design of swine CAFOs, which moves air outside of the facilities at a high flow rate, could create a situation where neighbors living downwind of the ventilation fans also could be directly exposed to airborne multidrug-resistant bacteria" (Chapin et al. 2005). The expulsion of the infected air at high velocities can propel air particles and bacteria away from the farm and across land to neighbors, and, if wind is high enough, it is realistic to assume that those even farther downwind could be at risk. The types of bacteria that have been found to go airborne are also a cause for concern; one study found the presence of several different types of bacteria resistant to drugs that are often used to treat severe cases of bacterial infections like MRSA, one such drug being clindamycin, a drug more potent than penicillin (Chapin et al. 2005). The buildup of bacteria resistant to drugs like these in the air can lead to serious problems later if an individual contracts one of these more severe types of infections, because they may become ineffective or not as potent. The use of antibiotics in pigs that are the same or analogous to antibiotics used to treat human patients is a public health threat that is only compounded by the ability of resistant bacteria to go airborne from these farms (Chapin et al. 2005). It's important to note that, as in previously mentioned studies comparing conventional and organic farming practices (non-antibiotic-using), resistant bacteria was more commonly found in the air surrounding conventional farms, and were also more resistant than bacteria in the air around organic farms (Sancheza et al. 2016). Methods of industrial hog farming pose a risk for public health through many vectors in the environment.

Response

When it comes to the fight against industrial hog farms, evidence for causation of infections and contaminations via resistant bacteria is often hard to prove, and little legislative change has been seen; however, much has been done to control industrial farms and their effects on the environment, and thus public health as well. When it comes to the problem of runoff and contamination of water due to high levels of hog waste, states like North Carolina have taken action to pass laws preventing the creation of new lagoons, as well as researched technology to create safer waste-disposal methods (Editorial 2016). Others attempt action like bringing lawsuits that claim disruption of daily life and lower quality of life due to respiratory problems from the odors and dirt wafted up at pig farms (Jackson 2016). However, in many cases, big agricultural companies are well-prepared for such legal actions with lawyers that can easily dismiss the voices of farmers and small town residents who attempt to fight them (Jackson 2016). Oftentimes, companies that own the pig farms have to just pay several thousand dollars in fines after spills and leaks from lagoons, a sum that is not too hefty to prevent them from polluting again. Or, they can use state law loopholes and other means of dismissal to ensure that they can continue running their operations under conditions that best satiate their desire for increased growth and profit without concern for the ramifications (Jackson and Marx 2016). Many who attempt to fight against the environmental harm presented by industrial farms confront a wall of lawyers blocking their path.

Conclusion

In many rural communities, pig farms represent the possibility of a future where antibiotics no longer work. The efficacy of industrial farming practices, specifically the use of subtherapeutic antibiotics, is being called into question by community activists in an attempt to shine light on what can often be a secretive process. Controversy surrounds the debate concerning industrial and organic farms, especially as more research suggests CAFOs are likely massive epicenters of antibiotic resistant bacteria that pose a threat to public health. Industrial agriculture represents a stronghold of power in the country due to its hefty economic foothold. The best hope for more control of antibiotic use at subtherapeutic levels in industrial hog farming is continued research to better inform the public about the associated risks.

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