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February 25, 2015

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Disclaimer: The opinions expressed herein are our own and do not necessarily reflect the views of The Johns Hopkins University.

To Whom It May Concern:

We are researchers at The Johns Hopkins Center for a Livable Future, based at the Bloomberg School of Public Health in the Department of Environmental Health Sciences. The Center engages in research, policy analysis, education, and other activities guided by an ecologic perspective that diet, food production, the environment, and public health are interwoven elements of a complex system. We recognize the prominent role that food animal production plays regarding a wide range of public health issues surrounding that system.

Below, we summarize the peer-reviewed scientific literature on the human health concerns associated with industrial broiler production, a model characterized in part by specialized operations designed for a high rate of production and large numbers of broilers confined at high density. This information is highly relevant to Somerset County, because in 2012 the county had an inventory of 14.9 million broilers – the largest of any county in Maryland, and the 6th largest in the United States (1). In 2012, there were 98 broiler operations in the county, 47 of which sold between 200,000-499,999 birds per operation, and 48 of which sold over 500,000 broilers per operation (1). Somerset is adjacent to counties with the second largest (Worcester) and fourth largest (Wicomico) broiler inventories in the state (1).

We are writing to present the known human health concerns associated with industrial broiler production, focusing on those that may affect citizens living near broiler operations in Somerset County.

Human health concerns associated with industrial broiler production include:

- Infections resulting from the potential transmission of harmful microorganisms from broiler operations to nearby residents, for example, via flies or contaminated air and water;

- Health effects, including asthma, bronchitis, allergic reactions, associated with exposures to air pollution from broiler operations;
- Health effects (e.g. thyroid problems, methemoglobinemia, neurological impairments, liver damage) associated with exposures to nitrates, drug residues, and other hazards that may be present in ground and/or surface waters contaminated by manure from broiler operations.

Disease transmission

Crowded conditions in industrial broiler operations present opportunities for the transmission of bacterial pathogens among animals, and between animals and humans (2). Human exposure to infectious agents can occur through multiple routes, including breathing contaminated air and drinking contaminated water (3-7).

Of additional concern is exposure to pathogens that are resistant to antibiotics used in human medicine. The non-medicinal use of antibiotic drugs as a means for growth promotion¹ in animals has become commonplace—an estimated 80 percent of antibiotics sold for human and animal uses in the U.S. are sold for use in food-producing animals (8). Administering antibiotics to animals at levels too low to treat disease fosters the proliferation of antibiotic-resistant pathogens. Resistant infections in humans are more difficult and expensive to treat (9) and more often fatal (10) than infections with non-resistant strains.

A growing body of evidence provides support that pathogens can be found in and around broiler operations. In broiler operations that administer antibiotics for non-therapeutic purposes, broilers have been shown to be carriers of antibiotic-resistant pathogens (11-14) and these resistant pathogens have also been found in the environment in and around broiler production facilities, specifically in the litter (15), flies (16), and manure (17). Additionally, *Salmonella* and *Campylobacter* are highly prevalent among U.S. broilers, and *Campylobacter* is found in about 50% of manure samples (18). *Campylobacter* infections in people have led to gastrointestinal illness, neuromuscular paralysis, and arthritis (18).

Several studies have shown that workers in broiler operations are disproportionately exposed to pathogens: in a Dutch study, 5.6% of broiler workers were carriers of methicillin-resistant *Staphylococcus aureus* (MRSA) (19) vs. 0.01% of the general population, and broiler workers on the Delmarva Peninsula were found to have 32 times the odds of carrying gentamicin-resistant E.

¹ U.S. Food and Drug Administration (FDA) voluntary industry guidelines continue to endorse the use of antibiotics in livestock production for “disease prevention”, which allows for dosing that is largely indistinguishable from growth promotion, thus tolerating business as usual (40).

coli compared with other residents in the community (3). Colonized or infected workers may transport pathogens into their communities (3).

Manure runoff from broiler operations may introduce harmful microorganisms, such as *Campylobacter* (17), into nearby water sources. Land application of broiler manure may present an opportunity for pathogens contained in the manure to leach into the ground or run off into recreational water and drinking water sources, potentially causing a waterborne disease outbreak (17).

People living near broiler operations may be exposed to harmful microorganisms, which have been found to be spread in the air up to 3,000 meters from broiler operations (4). The shape and spread of this airflow varies with changes in wind patterns, making it difficult to predict which residents might be most affected (4). Still, infectious agents have been found on deposits of particulate matter several miles from operations (4). Harmful bacteria such as *Campylobacter* have been reported to enter and leave poultry operations via insects and massive ventilation systems (6). One study on Maryland's Eastern Shore found that current methods of transporting chickens in open-air trucks releases microorganisms into the surrounding environment, likely exposing nearby residents to these pathogens (7).

The elevated presence of flies near broiler operations can be more than just a nuisance; it also may facilitate residents' exposure to pathogens, including antibiotics-resistant strains of *Enterococci* and *Staphylococci* (6, 16). One study found that residences within 0.5 mile of broiler operations were found to have 83 times the average number of flies of control households (19).

Air pollution from broiler operations

The air inside broiler operations contains elevated concentrations of gases, particulate matter, pathogens, endotoxins, and other hazards (5, 6, 16, 20-22). Airborne contaminants from broiler operations are transported from broiler houses through large exhaust fans and may pose a health risk to nearby residents (4, 6, 17, 23-28). Ammonia (29), particulate matter (17), endotoxins (27), and microorganisms (4, 6, 17) have been detected in air samples surrounding poultry operations. While there are currently few data available on odor, nitrous oxide, hydrogen sulfide, and non-methane volatile organic compound levels surrounding poultry operations, odors associated with air pollutants from intensive livestock hog operations have been shown to interfere with daily activities, quality of life, social gatherings, and community cohesion (25, 30, 31).

Exposure to airborne contaminants from broiler operations has been associated with a range of adverse health effects. Ammonia emissions have been implicated in respiratory health, with up to 50% of poultry workers suffering from upper respiratory illnesses that are believed to be due to ammonia exposure (23). Studies have shown that endotoxin exposure can exacerbate pre-existing asthma or induce new cases of asthma, and exposure was found to be a significant predictor of

chronic phlegm for poultry workers (25, 32). Particulate matter—consisting mainly of down feathers, mineral crystals from urine, and poultry litter in broiler operations—may also have detrimental effects on human health, causing chronic cough and phlegm, chronic bronchitis, allergic reactions, and asthma-like symptoms in farmers, and respiratory problems in people living in the vicinities of operations (27). Additionally, poultry workers demonstrated a high prevalence of obstructive pulmonary disorders, with increasing prevalence associated with longer exposure, regardless of smoking status (26).

A 2010 USDA study measured volatile organic compounds (VOCs) inside industrial broiler operations and found that close to 70% of VOCs included acetic acid, 2,3-butanedione, methanol, acetone, and ethanol (33); similar studies have not been conducted outside of broiler operations, and would help to characterize nearby residents' exposure to VOCs. It is important to note that even industrial broiler operations that employ best management practices and mitigation techniques have been shown to generate airborne contaminants (24).

Contaminated ground and surface water

Manure from broiler operations may contain nutrients, heavy metals, drug residues, and pathogens that can leach into groundwater or runoff into surface water (5, 28, 19, 34, 35). Studies have demonstrated that humans can be exposed to waterborne contaminants from livestock and poultry operations through the recreational use of contaminated surface water and the ingestion of contaminated drinking water (22, 35). Furthermore, the disposal and decomposition of diseased poultry carcasses may contaminate water sources and pose a threat to human health (19).

The nutrients nitrogen and phosphorus—naturally occurring in chicken manure—have been found in both ground and surface water near Maryland broiler chicken operations (36) and can have deleterious effects on water quality and human health (17, 19, 22, 26, 35, 37-39). A University of Maryland Eastern Shore pilot study found that 67% of private wells—which residents are responsible for testing and maintaining—failed to meet drinking water standards for total coliform, 36% tested positive for *E. coli*, and 31% failed the standards for total dissolved solids and pH (40). In one study, broiler chicken and corn production were associated with higher nitrate concentrations (naturally occurring in manure) in drinking water in Maryland wells (37). Ingesting high levels of nitrate has been associated with increased risks for thyroid conditions (22, 41, 42), birth defects and other reproductive problems (22, 42, 43), diabetes (22, 42), various cancers (42, 44), and methemoglobinemia (blue baby syndrome), a potentially fatal condition among infants (22, 45). Approximately 15,000 Somerset County residents rely on private wells for drinking water (46), so there is cause for concern regarding the spread of nitrate into groundwater drinking sources.

Nutrient runoff has also been implicated in the growth of harmful algal blooms (17, 19, 38, 47), which may pose health risks for people who swim or fish in recreational waters, or who consume contaminated seafood. Exposure to algal toxins (such as the toxic dinoflagellate, *Pfiesteria piscicida*) has been linked to neurological impairments, liver damage, stomach illness, skin lesions, and other adverse health effects (38, 39, 48).

Finally, there may be health risks associated with exposure to drug residues and excreted hormones found in chicken manure-contaminated ground and surface water. Of particular concern is estradiol, which is naturally found at high levels in chicken manure and is an endocrine-disruptor in humans (49). Environmental estrogens such as estradiol may be linked to increased incidence of male reproductive tract disorders, reduced sperm counts, and increases in the frequency of female breast cancer (49). Estradiol has been found in Chesapeake Bay tributaries in levels high enough to induce estrogenic effects on aquatic organisms (19, 49). Increasing the number of chickens produced in the bay's tributaries would likely increase the amount of estradiol entering the bay through manure runoff, thereby increasing the potential for endocrine-disruption in humans through water-borne estradiol exposure.

Conclusion

A growing body of evidence has implicated industrial broiler production in the spread of infectious diseases (including antibiotic-resistant strains), the generation and spread of airborne contaminants, and the contamination of ground and surface waters. We hope our letter is helpful in describing some of the public health concerns associated with the potential expansion of broiler operations in Somerset County. Through our research, we know that health departments face many barriers addressing issues surrounding industrial farm animal production (50, 51), and we are prepared to serve as a resource to your office. Please do not hesitate to contact us if you have any questions.

Sincerely,

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