RESPONSE TO ANTI-RAW MILK ARTICLE

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Researchers from the College of Veterinary Medicine in Columbus, Ohio, supported by the Ohio Agricultural Research and Development Center and John Sheehan, implacable raw milk foe from the FDA, kicked off the new year with an attack on raw milk published in the January issue of *Clinical Infectious Diseases*.

The journal is aimed at medical practitioners and frequently publishes clinical practice guidelines. The article, entitled "Unpasteurized Milk: A Continued Public Health Threat,"[1] differs from other recent attacks in that it is aimed at health care professionals rather than consumers, but when it comes to content it merely offers more of the same. (The article is posted at http://www.journals.uchicago.edu/doi/full/10.1086/595007?cookieSet=1.)

The authors conclude that clinicians can "promote behavioral changes among individuals who hold strong opinions" about the health value of unpasteurized milk by better understanding and targeting the values that underlie their patients' decision-making processes, clarifying and repeating the message, and utilizing the "enormous advantage" they have as credible sources of medical information. Just in case they fail to convince any of these clinicians of the veracity of that message in the article, they end with a threat: since the American Medical and American Veterinary Medical Associations clearly assert that only pasteurized milk should be sold for human consumption, "physicians, veterinarians, and dairy farmers who promote, or even condone, the human consumption of unpasteurized milk and dairy products may be at risk for subsequent legal action."

Why might these rogue clinicians (and their patients holding strong opinions) remain unconvinced? The authors repeat several poor arguments common in the anti-raw milk literature. They discuss the prevalence of intramammary infections in conventional dairy herds and the prevalence of pathogen contamination in raw milk without considering whether the milk is intended for sale as raw milk, whether the cows are confined or raised in open pasture, or whether the cows are fed grain and bakery waste or green grass and hay. They cite evidence of foodborne illnesses associated with raw milk but never critically evaluate that evidence or show that raw milk is more commonly associated with such illnesses than pasteurized milk. And they dismiss claims for the benefits of raw milk as lacking adequate scientific evidence but conclude that these claims should be suppressed rather than further researched.

A more honest approach to evaluating the safety of raw milk would have discussed how raising cows on fresh, open pasture can minimize the risk of contamination by boosting the natural immunity of the animals; they would have reviewed evidence detailing the many outbreaks of foodborne illness tied to pasteurized milk; and they would have acknowledged the substantial scientific support, cited by raw milk advocates, for the health benefits of raw milk compared to pasteurized. Obviously more research into the

health benefits is needed, not suppression of the evidence currently available in the scientific literature.

Subclinical Mastitis Is Not Inevitable

According to the authors, milk naturally contains bacteria as soon as it leaves the animal. Harmless symbiotic organisms colonize the skin of the teat and the epithelial lining of the teat canal, through which milk exits the mammary gland. These bacteria begin to colonize the milk as it flows through the teat. Pathogenic organisms, however, can also colonize the milk at the same time if there is a systemic infection or an infection specific to the mammary gland. The authors consider mastitis, inflammation of the mammary gland due to an intramammary infection, "the single disease that has the most significant impact on milk quality." While milk from cows with clinical mastitis is altered in appearance and usually withheld from the farm's bulk tank, milk from cows with subclinical mastitis looks the same as milk from healthy cows and therefore easily enters the food supply. Once in the food supply, the contaminated milk can transmit the pathogens responsible for the infection to human consumers.

The authors cite two studies conducted between 1991 and 2001 showing that fifty percent of dairy cows from New York, Pennsylvania, and Wisconsin had intramammary infections.[2, 3] They therefore argue that there is widespread opportunity for unpreventable contamination of raw milk, but fail to address the research showing that the diet of dairy cows governs their risk of mastitis. This research strongly suggests that raising cows on fresh, open pasture is a better way than pasteurization to make milk safe.

Vitamin E and selenium improve immune cell function and allow proper closing of the streak canal after milking, the canal through which pathogens generally infect the mammary gland. A number of studies have examined the relationship of vitamin E and selenium status to the incidence of clinical mastitis or the somatic cell count of the milk. (Somatic cell count is a test used to diagnose subclinical mastitis.[4])

Selenium intakes vary widely according to the selenium concentration of the soil in which the food was grown and are deficient year-round in certain geographical regions. Vitamin E intakes of cows on fresh grass are five to six times higher than the intakes of cows on silage stored for six months. Vitamin E concentrations in hay are even lower than those in silage, and those in cereal grains are the lowest. Vitamin E intakes of lactating cows on pasture can be four to five times higher than the average intake in the United States and over ten times the minimum intake recommended by the National Research Council (NRC), but even the concentrations of vitamin E in fresh grass vary 25-fold. Vitamin E and selenium supplements synergistically reduce the incidence of clinical mastitis. When the dose of vitamin E starts to approach the average obtained from fresh pasture, clinical mastitis is reduced ten-fold from 25 percent to 2.6 percent; when it is twenty percent higher than the average obtained from fresh pasture, the somatic cell count of the milk is reduced between two- and five-fold, down to well below the level that indicates freedom from subclinical mastitis.[4]

These findings clearly suggest that feeding fresh, high-quality pasture is the most important means of preventing subclinical mastitis and should compel us to invest in further research to discover which factors determine the vitamin E content of grass. Neither of the studies showing high rates of intramammary infections in dairy cows ascertained their vitamin E or selenium status of the cows or determined whether the cows were raised on fresh pasture.[2, 3] The *Clinical Infectious Diseases* review does not even mention the role of diet in preventing subclinical mastitis.[1] Instead, its authors assume that the rates of intramammary infections will be the same regardless of whether the cows are raised to produce raw or pasteurized milk and regardless of whether the cows are fed grain in confinement or raised on fresh, open pasture. The data published in peer-reviewed journals clearly show that this assumption is untrue and that a scientific approach to traditional grass-based farming can be used to minimize the contamination of milk by boosting the natural immunity of the animals.

In addition, the *Clinical Infectious Diseases* article makes no mention of Somatic Cell Count testing protocols routinely used by raw milk dairy farmers. It is very easy for these conscientious farmers to monitor the health of their cows through routine testing. In fact, dairy farmers engaged in pasture feeding routinely get somatic cell counts well below the level that would indicate subclinical mastitis in the herd.

Pasteurization Cannot Ensure the Safety of Milk

Although the authors regard mastitis as "the single disease that has the most significant impact on milk quality," they acknowledge that milk "can be contaminated at any stage in the production-to-consumption continuum." They list three major bulwarks against this contamination: enhanced animal health, improved milking hygiene and pasteurization. Their recommendations for enhanced animal health are limited to diagnosing and treating diseases and make no mention of improving nutrition or using grass-feeding to boost the natural immunity of the animals. They cite one review of hygienic standards for milking procedures,[5] but state that because of "the ineffectiveness of environmental hygiene screening to adequately control microbial risks in milk, pasteurization has become the cornerstone of milk safety." There are two problems with this argument. These hygienic standards, while valuable, do not include measures for raising dairy animals on pasture and are therefore incomplete. Furthermore, while pasteurization is certainly capable of killing many pathogens, it is not adequate to ensure the safety of the milk to which it is applied.

The authors present a list of pathogens that can be found in raw milk. As shown in Appendix 1, however, some of these organisms do not cause disease when consumed in raw milk and others are just as likely to show up in pasteurized milk. Some pathogenic bacteria and bacterial toxins are capable of surviving pasteurization. There are also many opportunities for contamination after pasteurization has already been performed, such as contact with contaminated surfaces of cooler floors or those in freezers, processing rooms, cases and case washers, floor mats and foot baths, and beds of paper carton linings.[6] Pasteurized milk can thus contain the following pathogens and associated toxins: *Staphylococcus aureus* enterotoxin A, *Salmonella* species, *Escherichia coli*, *Listeria*

monocytogenes, *Mycobacterium* paratuberculosis, *Bacillus* species, *Clostridium* species, and *Yersinia entercolitica*.[7, 8, 9, 10] According to certified information the CDC has provided to us, between 1980 and 2005 there were 41 documented outbreaks attributing 19,531 illnesses to the consumption of pasteurized milk and milk products.[11]

Thus, while the authors threaten physicians, veterinarians, and farmers with legal action if they promote or condone raw milk because hygienic standards cannot guarantee safety, they themselves promote and condone pasteurized milk, even though pasteurization cannot guarantee safety either.

Is Raw Milk a Continued Threat to Public Health?

The authors claim that mandatory pasteurization has led to a 25-fold decline in the contribution of milk to foodborne and waterborne illness from 25 percent of all cases in 1938 to less than one percent in 2000. The source for this information is the online foreword to the FDA's Pasteurized Milk Ordinance, which states these statistics but offers no citation for them and provides no information about how they were obtained.[12] As states voluntarily adopted this ordinance in the years following 1924 when it was first issued, however, they adopted not merely pasteurization standards but "guidance pertaining to all aspects of production, handling, transportation, processing, testing, and sale of milk." The unsanitary production of milk in the early years of its industrialization was doubtlessly responsible for a great number of preventable illnesses and the institution of hygienic standards for raw milk production and pasteurization standards for milk produced in suboptimal conditions should certainly be regarded as important contributions to food safety. There is no way, however, to tease out the effects of pasteurization from those of the other guidelines in the ordinance. Moreover, much of this apparent decline is likely due to much better detection of foodborne illness from sources other than milk.

In the next paragraph, the authors cite the number of outbreaks "that were suspected or confirmed to be associated with unpasteurized milk products" between 1973 and 2006 and conclude that "it is clear that disease associated with the consumption of raw milk is still an important public health concern in the United States." They never present the number of outbreaks or illnesses attributed to pasteurized milk. Although there were fewer outbreaks attributed to pasteurized milk than to raw milk between 1980 and 2005 (the years for which the CDC has data available in both categories), those outbreaks attributed to pasteurized milk were larger, and there were therefore nearly eleven times as many illnesses attributed to pasteurized milk as there were to raw milk.[11] As shown in Appendix 2, it is impossible to use this data to accurately compare the relative safety of raw and pasteurized milk. Certainly, however, disease associated with the consumption of pasteurized milk is also still an important public health concern in this country.

We have produced two other reviews of the literature purporting to attribute foodborne illness to raw milk products and have shown that this literature incorporates systematic biases against raw milk and that much of it is heavily politicized.[13] (These are posted at

www.realmilk.com/documents/SheehanPowerPointResponse.pdf and www.realmilk.com/ResponsetoMarlerListofStudies_.pdf.)
In 70 outbreaks and individual cases of illnesses attributed to raw milk that we analyzed, 80 percent had no positive milk sample and 93 percent provided no evidence that pasteurization could have prevented the outbreak. One report even blamed an outbreak of *C. jejuni* on raw milk when all of the milk samples tested negative and 360 samples of locally sold chicken tested positive! The relative contribution of raw milk to foodborne illness is thus likely to be greatly exaggerated.

The authors cite four recent reports from 2007 and 2008 of illness purportedly associated with raw milk. Two of these are news articles, neither of which state that any contaminated milk samples were identified.[14, 15] The other two reports provide a scientific basis for the attribution of the illnesses to raw milk, one of which was published in the peer-reviewed journal *Foodborne Pathogens and Disease* and the other of which was published in the CDC's *Morbidity and Mortality Weekly Report.*

The first report, published in 2008, provided what at first glance appears to be convincing statistical and molecular evidence tying a 2005 outbreak of *E. coli* O157:H7 to a cow share program in Washington State.[16] The authors reported that they had used the media attention generated by the case to close the legal loophole that had allowed cow shares to operate outside of state licensure requirements and boasted that their paper "shows how it is possible to improve upon the current and unsatisfactory conditions around the sale of raw milk in the United States by turning the findings of an epidemic investigation into legislative reform." Unsatisfied with the reform they had already achieved, the authors explicitly mentioned the Weston A. Price Foundation, citing its Campaign for Real Milk, and stated that their paper was "evidence against the legalization of the sale of raw milk." They concluded that the 24 states where raw milk is legal must "consider the path chosen by other states" and prohibit the sale of not only raw milk but all raw milk cheeses as well.

While the evidence the authors present in this paper is compelling on the surface, it is difficult to discern truth when science becomes so adulterated with politics. This is especially of concern in this case because the family who operated the cow share, who meticulously documented the investigation and videotaped most of it, claims that the same milk samples found positive for the organism by the Department of Agriculture were found *negative* by an independent laboratory. They also documented a number of suspicious activities and disingenuous tactics employed by the Department of Agriculture leading up to and in the wake of the outbreak.[17]

The second report documented an outbreak of 29 cases of *Salmonella enterica* serotype Typhimurium traced to a Pennsylvania dairy in 2007.[18] In this case, the outbreak strain of salmonella was traced back to the bulk tank milk of a dairy that supplied milk to the majority of cases. Seven out of 29 illnesses had no potential association with the dairy identified, suggesting at least one other source contributed to the outbreak. As we have argued elsewhere,[13] selection bias is likely to favor the disproportionate identification of illness in people who drink raw milk compared to those who do not, so it is possible that

there were many more undetected cases not associated with the dairy. The dairy kept 120 cows in a barnyard and produced milk for pasteurization as well as two to three hundred gallons per week of raw milk sold to 275 regular customers. The cows were fed primarily soy, corn, silage, and haylage, all produced on the farm. The Pennsylvania Department of Agriculture claimed to identify "improper cleaning of milking equipment, insufficient supervision of workers, unspecified illness among lactating cows, and bird and rodent infestation." If this milk was indeed responsible for the outbreak, its contamination could almost certainly have been prevented without resorting to pasteurization by raising the cows on fresh, open pasture and rectifying the reported hygienic deficiencies in the milking parlor.

Neither of these two outbreaks resulted in any deaths. A 2007 outbreak of *Listeria monocytogenes* traced to adequately pasteurized milk sold in Massachusetts, by contrast, sickened five people, killing three elderly men and one unborn child. This milk was contaminated after pasteurization.[19] To date, neither the FDA nor any state health departments have waged a campaign to prohibit the sale of pasteurized milk, nor to prohibit any of the wide range of foods and drinks other than dairy products to which over 99 percent of foodborne illnesses are attributable.

The Benefits of Raw Milk

The authors claim that "[s]cientific evidence to substantiate the assertions of the health benefits of unpasteurized milk is generally lacking," but relegate any discussion of this evidence to a table outside of the text. The table reveals that pasteurization of milk destroys lactase-producing bacteria that aid in the digestion of lactose in lactose-intolerant individuals, and partially degrades antimicrobial proteins such as lysozyme and lactoperoxidase. While scientific research into the benefits of raw milk is still desperately needed, there is more substantiation for these benefits than the table would lead one to believe.

Classic pasteurization of milk destroys 65 percent of its lactoferrin,[20] a protein the FDA has approved for use as a spray to prevent contamination of meats with *E. coli* O157:H7.[21] When homogenization is preceded by pasteurization, it destroys 69 percent of the xanthane oxidase,[22] an enzyme that potently inhibits the growth of *E. coli* and *Salmonella enteritidis* at concentrations naturally present in raw milk.[23] The table claims that antimicrobial proteins called bacteriocins are stable to pasteurization, but pasteurization destroys the friendly bacterium *Lactococcus lactis*, which produces a bacteriocin called nisin to protect itself against pathogens such as *L. monocytogenes*; moreover, homogenization of milk renders existing nisin ineffective.[24]

While modern chemical assays suggest that pasteurization leads to very little destruction of vitamins, research from the 1930s using feeding studies showed that pasteurization led to marked destruction of vitamin A, vitamin C, and the B complex.[25] One possibility that could explain this discrepancy is that the biological activity or bioavailability of these nutrients is diminished by pasteurization while their ability to be detected by the chemical assays is not. There are a number of heat-sensitive proteins in milk that could be

responsible for these effects: for example, heat-sensitive beta-lactoglobulin enhances the intestinal absorption of vitamin A; 90 to 100 percent of the folate in milk is bound to a heat-sensitive protein that doubles its intestinal absorption; and vitamin B_{12} in milk is bound to heat-sensitive proteins of unknown function.[26, 27]

Raw milk also contains beneficial bacteria such as *Lactobacillus* and *Bifidobacterium* species.[28, 29] A 2006 study found that people who drank more raw milk were less likely to suffer from eczema and allergic disorders. The authors suggested it may have a probiotic effect: "Unpasteurized milk can also contain lactobacilli, and our finding of a protective effect for eczema is consistent with the evidence of a protective effect of lactobacilli- and *Bifidobacterium* species-containing probiotics on eczema."[30] This is consistent with another study finding a similar benefit to raw milk and yogurt.[31] Since the field of "probiotics" is new and rapidly developing, there may be many other benefits to these friendly bacteria yet to be discovered.

Many people have been convinced by their own experience or the anecdotes of others that raw milk has the potential to reverse a wide spectrum of diseases and promote general health. Given the research described above documenting the many beneficial components of milk that are susceptible to pasteurization, these claims should be further researched rather than ignored.

The Right to Drink Raw Milk

The authors allege that many consumers continue to believe that raw milk is beneficial because "when the public is presented with a large body of conflicting information, their decision-making process does not always yield the same results as that of experts," which in turn occurs because members of the public "seek information that is supportive of their views" and "also unconsciously process information in a biased fashion." They end by enlisting medical practitioners in the campaign against raw milk and threatening that "physicians, veterinarians, and dairy farmers who promote, or even condone, the human consumption of unpasteurized milk and dairy products may be at risk for subsequent legal action."

The authors suggest that unlike consumers with strongly held opinions, "experts" with strongly held opinions do *not* selectively seek out information supportive of their views or process it in a biased fashion, yet they themselves choose to discuss the ability of pasteurization to kill pathogens without acknowledging the ability of grass-feeding to prevent contamination; they themselves choose to discuss illnesses attributed to raw milk without admitting that more illnesses have been attributed to pasteurized milk; they themselves choose to discuss modern assays finding little or no destruction of vitamins without accounting for older feeding studies showing dramatic reduction in their biological activity; and they themselves choose to conclude by threatening experts who do not select information and unconsciously process it exactly as they do with the heavy hand of the law. There is a word for this kind of double standard and it is called hypocracy.

If there is truly a "large body of conflicting information" encountered by the public, each individual should have a right to decide how to interpret that information and should be free to act on his or her own interpretation. Entangling farmers and physicians in legal battles will waste precious resources that could better be devoted to researching improved methods of soil care and grass-farming to maximize the natural immunity of dairy animals and prevent the contamination of milk in the first place. Enlisting all "experts" in the campaign against the right to drink raw milk will create an adversarial relationship between the scientific community and the raw milk community when what is needed is a partnership between these communities so that the principles of good science can be used to further perfect the traditional methods of pasture farming, enabling humanely treated and healthy cows raised in the open on high-quality pasture grown in vibrant soil to produce safe, nutrient-dense raw milk for healthy and happy consumers.

Appendix 1: Pathogens in Raw Milk

The authors present a list of pathogens that often contaminate commercial milk before it has been pasteurized but never consider raw milk actually intended for sale as raw milk or compare the potential of raw milk to cause illness to that of pasteurized milk. Of the organisms they list, some do not transmit disease through raw milk, some are not neutralized by pasteurization, and others are capable of contaminating milk after it has already been pasteurized.

Q Fever is Not Contracted by Drinking Milk

The first organism in the list is *Coxiella burnetti*, the agent that causes Q fever. It is present in 94 percent of bulk tank milk collected on United States farms. The available scientific evidence, however, strongly suggests that milk contaminated with *C. burnetti* is not capable of causing Q fever and that the illness is caused by other forms of contact with infected animals. In 1992, Fishbein and colleagues investigated a Q fever outbreak at a psychiatric institution in France. They cited published evidence showing that all attempts to transmit Q fever, even to human volunteers, by feeding naturally infected raw milk had failed. In their own study, they found that patients who worked with animals directly were more likely to have experienced an acute illness; patients who merely drank raw milk from the animals, however, were more likely to show evidence of immunity to Q fever but were no more likely to have contracted an acute illness.[32] These results suggest that raw milk contaminated with *C. burnetti* may be able to confer immunity to Q fever but cannot cause the disease.

Pasteurization Does Not Protect Against Crohn Disease or Listeriosis

The next two organisms in the list, *Mycobacterium avium* subspecies *paratuberculosis* (MAP) and *Listeria*, are both capable of surviving pasteurization; *Listeria* can also contaminate milk after it has been pasteurized. MAP is associated with Johne disease in infected cattle and some investigators have hypothesized that it contributes to Crohn disease in humans. *Listeria*, by contrast, is associated with acute illness and sometimes

death. There is no evidence that pasteurization protects against these diseases; it may even render these organisms more dangerous.

A British government study conducted over the course of 1999 and 2000 found MAP in 1.8 percent of raw milk samples intended for pasteurization and 1.6 percent of milk samples that had already been pasteurized, which it concluded "appears to confirm laboratory studies demonstrating the relative heat resistance of this organism" and suggests "that MAP will survive HTST (high-temperature short-time) pasteurization." The difference was not statistically significant, and the authors of the report suggested that the greater number of other, mostly harmless, bacteria in raw milk may keep the growth of MAP in check during laboratory testing. Presumably they would also keep the growth of MAP in check outside the laboratory, where they could offer protection to raw milk drinkers against the harmful effects of this organism. Whether the feeding of high-quality pasture can protect against MAP still needs to be investigated.

In 1999, Czechoslovakian researchers showed that if pre-pasteurization levels of *Listeria monocytogenes* are high, dangerous levels capable of causing disease will remain even after properly performed high-temperature short-time (HTST) pasteurization.[33] A scientific review concerning the microbial contamination of dairy foods published in 1990 cited even earlier evidence of this but concluded that contamination of dairy products with *L. monocytogenes* after pasteurization was even more common. It further noted that the acidity generated by the aging of cheese is one of the principal inhibitors of *Listeria* growth.[6]

Although there are a number of outbreaks of *Listeria* from soft cheeses that investigators have unconvincingly blamed on raw milk,[13] the only documented case in which the outbreak strain was actually found in a raw milk sample was a Swedish soft cheese outbreak in 2004 that was traced to milk from goats kept in unsanitary conditions traditionally considered fit only for the production of hard cheeses aged for a much longer period of time.[34] The authors did not report any deaths.[35] By contrast, the literature paints a much bleaker picture of the risk of pasteurized milk and other commonly consumed foods. The first documented *Listeria* outbreak occurred in 1981 and was traced to coleslaw.[36] The second occurred in 1983 and was traced to pasteurized milk – 49 victims became ill and 14 died.[37] Most recently, a 2007 outbreak of *Listeria* in Massachusetts was traced to skim and 2% low-fat milk that had been contaminated after adequate pasteurization; it sickened five people, killing three elderly men and one unborn child.[19]

In 2003, the FDA, USDA, and CDC jointly released a report estimating that, on a per-serving basis, non-reheated hot dogs carry nine times and deli meats carry eleven times as great a risk of listeriosis as raw milk. Since deli meats are so commonly consumed, the report estimated that, on an absolute basis, they carry 515 times as great a risk as raw milk.[38] As shown in Appendix 2, this report may have underestimated the consumption of raw milk seven-fold, meaning that these foods might actually be 70 times as dangerous as raw milk on a per-serving basis and over 3,500 times as dangerous on an absolute basis.

Campylobacter Rarely Found in Raw Milk

The authors cite two references claiming to indict raw milk as a source of *Campylobacter jejuni*.[39, 40] The first was an overtly politicized British report published by Hutchinson and colleagues in 1985 in which the authors acknowledged that pasteurization orders were "damaging to the farmer and unwelcome by the public" but nevertheless advocated the outright banning of all raw milk. They tried blaming an outbreak of acute illness in a small village, in which the entire population obtained raw milk from a single farm, on *C. jejuni* from the milk; while they were able to find the organism in rubbish heaps and watering holes, they failed to culture it in milk or milk filters taken from the farm under sterile conditions.[39] The second report was a case of mastitis that resulted in pink milk filled with blood clots; unsurprisingly, no human illnesses were associated with the obviously infected milk.[40]

We have reviewed the Hutchinson study and other literature that purports to attribute *C. jejuni* outbreaks to raw milk elsewhere.[41] Over and over again, investigators blame outbreaks of *C. jejuni* on raw milk even when all of the milk samples turn up negative. Doyle and Roman showed in 1982 that *C. jejuni* cannot grow in milk and that when they inoculated milk with massive amounts of it, it survived twice as long in sterile milk as it did in raw milk.[42] Investigators then argue that *C. jejuni* is present in raw milk at concentrations that cause disease but not in concentrations that can be detected. Yet *C. jejuni* is easily detectable in other foods. Even Schmid and others in 1987 blamed a local outbreak of *C. jejuni* on raw milk when all of the milk tested negative and 360 samples of locally sold chicken tested positive![43]

The only convincing demonstration of a *C. jejuni* outbreak traced back to raw milk is a 1984 report by Hudson and colleagues.[44] The outbreak – which resulted in eleven cases of diarrhea – appeared to be the result of low-grade mastitis in one cow. The brief report provided no information about the production practices at the farm, but as discussed previously, considerable evidence suggests that feeding cows on fresh, open pasture can prevent most if not all cases of mastitis.[4]

No Evidence of E. Coli Outbreaks Due to Raw Milk

The authors list only one reference for their assertion that raw milk can be a source of *E. coli*. This reference is an estimation of the prevalence of Shiga toxin-producing *E. coli* in Brazilian cattle with mastitis.[45] As discussed earlier, however, both clinical and subclinical mastitis are preventable and milk from cows with clinical mastitis generally does not enter the food supply. We have previously reviewed literature cited by the FDA and Bill Marler, JD, allegedly tying raw milk to *E. coli* O157:H7 outbreaks and concluded that although there have been several reports of possible outbreaks due to raw milk cheeses, none of the reports provide convincing evidence tying the outbreak to the raw milk that was used to produce the cheese.[13] The FDA estimates that between 1996 and 2005, fresh produce was responsible for over 8,000 *E. coli* O157:H7 infections, eggs were responsible for over 6,500, processed foods were responsible for over 3,000, and

sprouts were responsible for over 1,500. The FDA has not yet launched a campaign to prohibit the sale of any of these items.

Pasteurized Milk Responsible for the Largest Salmonella Outbreak in History

The authors list only one reference for their assertion that raw milk can be a source of *Salmonella enterica.* This reference is a study showing that experimental production of intramammary infections by injecting the "dublin" subtype of this species into cow teats leads to shedding of the organism into the milk of the infected animals.[46] As discussed earlier, however, vitamin E and selenium from nutrient-rich pasture can in all probability prevent most if not all intramammary infections.

The number of salmonella infections attributed to pasteurized milk vastly dwarfs the number of all illnesses attributed to raw milk combined. In 1985, for example, there was a multi-state outbreak of antibiotic-resistant *Salmonella* typhimurium traced to pasteurized 2% low-fat milk from a Chicago milk plant. Over 16,000 culture-confirmed cases were documented in seven states, and the researchers estimated that between 150,000 and 200,000 people had been affected. It was the largest outbreak of *Salmonella* in the nation's history.[47] A more recent multi-state outbreak of this organism in April, 2000, in which there were 38 culture-confirmed cases, implicated pasteurized milk from a Pennsylvania dairy plant. The investigation of the plant revealed that pasteurization was adequate, but bacteria counts in the milk were elevated up to six-fold above the legal limit. The authors of the report noted that "inadequate pasteurization is a relatively uncommon event compared to contamination after pasteurization."[48]

Since most of the pathogens that can be found in raw milk can also be found in pasteurized milk, and since at least one of them is demonstrably unable to transmit disease through raw milk fed to human volunteers, merely presenting a list of pathogens with no further discussion does not constitute good scientific reporting.

Appendix 2: Reliable Data to Compare the Risk of Pasteurized Milk to That of Raw Milk Do Not Exist

According to certified information the CDC has provided to us, between 1980 and 2005 there were 41 outbreaks reported to the CDC attributing 19,531 illnesses to the consumption of pasteurized milk and milk products. This is 10.7 times the number of illnesses attributed to raw milk during the same period.[11]

The FDA, CDC, and USDA estimate that 0.5 percent of milk consumed is raw.[38] This estimation is based on an unpublished survey sent to state regulatory officials in 1995, which researchers associated with the FDA used to argue that state laws banning the sale of raw milk can effectively prevent foodborne illness.[49] It unrealistically assumes that no raw milk is consumed in states where its sale is prohibited.[38] The CDC, by contrast, conducted a randomized telephone-based survey of the general population in 2002 and 2003 in which it ascertained the frequency of exposure to over 150 different putative risk factors for foodborne illness and estimated that 3.5 percent of households in the general

population use raw milk.[50] Using this estimate, the CDC data suggest that raw milk is about 2.4 times as risky as pasteurized milk on a per-serving basis.

We have reviewed the literature that purports to implicate raw milk in foodborne illness elsewhere, however, and have demonstrated a systematic bias against raw milk and explained in detail how this bias operates.[13] Among 70 reports of outbreaks or individual cases of foodborne illness blamed on raw milk that we analyzed, 80 percent failed to find a valid positive milk sample and 93 percent failed to show that pasteurization could have prevented the outbreak. One report even blamed an outbreak on raw milk when the milk tested negative and 360 samples of locally sold chicken tested positive!

To illustrate how the questionable quality of this data compromises any attempt to compare the risk associated with raw milk to that associated with pasteurized milk, let us consider what our estimate would be if we eliminated 80 percent of the illnesses attributable to raw milk – the same percentage of reports in the literature that have no valid positive milk sample. In this case, rather being over twice as dangerous as pasteurized milk, raw milk would be less than half as dangerous.

To put these figures in perspective, the risk assessment for *Listeria* published by the CDC, FDA, and USDA estimated that deli meats and non-reheated hot dogs are approximately ten times as risky as raw milk on a per-serving basis even assuming that only 0.5 percent of milk consumed is raw[38] – if the CDC's higher estimate of raw milk consumption is correct, these foods could actually be as much as 70 times as risky as raw milk. Because they are so commonly consumed, deli meats are thus on an absolute basis between 500 and 3,500 times as likely as raw milk to cause listeriosis. Yet there is no campaign being waged to threaten physicians with legal action if they promote or condone the use of deli meats or hot dogs, further demonstrating the pervasive bias of the FDA, CDC, and state health departments against raw milk.

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