

# Protecting Against the Unseen: Chazal's Approach to Chemical and Biological Hazards

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## Cultural Backdrop

In terms of the outside environments that surrounded the Talmud, the Sassanian empire surrounded the Rabbis of the Babylonian Talmud, whereas the Greco-Roman tradition surrounded those of the Yerushalmi. Regarding the approaches of the surrounding environments to health, Geller points to differences between the Greco-Roman and Akkadian/Babylonian approaches [1]. Greco-Roman medicine attributed disease to an imbalance of the four humours and as such, used diet, purges, changes of environment, and bloodletting as treatments [2]. In contrast, Akkadian/Babylonian medicine attributed disease to demons or other external factors and therefore used external drugs for treatment, rather than diet, purging, and bloodletting [3].

In terms of what public health might have looked like in the surrounding Babylonian and Greco-Roman cultures, Babylonia maintained a folk tradition, viewed the physician and magician as equal, and did not have any public health organizations per se [4]. They did however have a sense of illness being contagious, as they left records of quarantine [5]. Moreover, they did have drainage systems, as evident from archaeology, though it remains unclear if they had them for health reasons or for aesthetic reasons [6]. Roman society had many innovations, such as hospitals and C-sections for dying women; however, records indicate poor waste disposal, which contaminated food and water, and low life expectancy (25 years) [7].

The Greek doctor Galen had a significant influence on Western medicine. Would the Rabbis of the Talmud have had knowledge of Galen? Geller maintains that whereas the Yerushalmi Rabbis would have known Greek, the Babylonian Rabbis would not have known Greek (others maintain that the Babylonian Rabbis too knew Greek) and therefore the

Babylonian Rabbis would not have had a familiarity with the writings of Galen [8]. Preuss, writing earlier, likewise, maintains that the Rabbis of the Talmud would not have read Galen but instead offers the reason that in general, the writings of Galen did not commonly circulate at that time, when folk medicine instead prevailed [9]. According to Geller, the Babylonian Rabbis would have learned medicine from the surrounding Babylonian scholars, who read cuneiform [10].

## Innovative Measures

In assessing the presence of pestilence, *Chazal* took an innovative approach in that they measured the rate of the epidemic rather than measuring an epidemic by an objective number of cases. The *Mishna* (*Yerushalmi Taanit* 3:1) established that three cases of death in three consecutive days in a town of 500 footman constitutes a pestilence; Rashi adds that one case per day needs to occur [11]. Moreover, *Chazal* utilized an early instance of case reporting, as *Taanit* 21b discusses an injunction to report to Shmuel, Rav Nahman, and Rabbi Yehuda in situations when many deaths occurred [12]. Additionally, *Chazal* issued a declaration to stay indoors with the windows closed when *dever* (pestilence) was present, an early example of quarantine [13].

## Hygienic Water

The field of public health strongly concerns itself with water quality for the public. This concern in fact dates to antiquity:

Alcmaeon of Croton (floruit ca. 470 B.C.) was the first Greek doctor to state that the quality of water may influence the health of people. (Aëtius, *On the opinions of the philosophers* V.30.1) Hippocratic treatise *Airs, Waters, Places* (around 400 B.C.) deals with different

sources, qualities, and health effects of water in length. (*Airs, Waters, Places*. 1, 7, 8, 9) Various other Hippocratic treatises (mostly written around 400 B.C.) contain short comments on the influence of water on the health of people (*Internal Affections*. 6, 21, 23, 26, 34, 45, 47; *Diseases I*. 24; *Epidemics II*. 2.11; *Epidemics VI*. 4.8, 4.17; *Aphorisms*. 5.26; *Humours*. 12; *Regimen IV* or *Dreams*. 93).

According to B.C. Vitruvius from the late first century, marshy areas must be avoided when the site of a city is chosen. (*De Architectura*. I.iv.1) Pliny the Elder in the first century A.D. had in his works a long section concerning the different opinions on what kind of water is the best. (Plinius *NH*, XXXI, xxi–xxiii). Galen (2nd century A.D.), one of the most famous doctors during antiquity, summarized the preferable qualities of water (Galen. *De Sanitate Tuenda*. I.xi) [14].

*Chazal* might have had some familiarity with these teachings from antiquity and also would have had additional observations of their own about the effects of water quality on public health. Accordingly, we find various instances in the Talmud indicating that *Chazal* did recognize the need for access to high quality water. They even viewed some water sources as therapeutic or protective against disease. For *Chazal*, the Tigris and Euphrates rivers, the bathhouse of the *Deyomset* river, and the springs of Tiberias all had an impact on the health of the population.

For example, *Chazal* attributed the acuteness of the inhabitants of Mehoza to the fact that the dwellers of this city drank the water of the Tigris (Brachot 59b). Rav Ashi ascribed the

name of the Tigris (Hebrew: *Chidekel*) to an acronym of sharpness (Hebrew: *chadin*) and lightness (Hebrew: *kalin*). Rashi explained that the water of the Tigris was sharp and light, the latter of which rendered it healthy to drink because it did not weigh down on the body. One might also argue that perhaps *Chazal* thought that the sharpness of the water conferred sharpness upon those who drank it. Regardless, this example indicates that *Chazal* believed that access to healthy water brought about beneficial health benefits, such as acuteness.

A similar concept regarding water quality appears in the writings of Hippocrates, in the aforementioned “Airs, Waters, Places.” Hippocrates writes on how different types of climate, e.g. sunny, windy, etc., influence local water composition, such that different areas with their different climates have different types of water. Each type of water composition, in turn, influences the health of that area’s population. For example, he discusses cities that “lie to the rising of the sun,” namely to the east: “For the sun in rising and shining upon them [the waters] purifies them by dispelling the vapors which generally prevail in the morning. The persons of the inhabitants are, for the most part, well colored and blooming, unless some disease counteracts. The inhabitants have clear voices, and in temperament and intellect are superior to those which are exposed to the north, and all the productions of the country in like manner are better” [15]. Thus, according to Hippocrates, a sunny climate improves the purity of that area’s water source, which in turn benefits not only the health but the intellect as well of that area’s population. Strangely, in a similar vein, current science has found that the presence of perchlorate in drinking water drunk by pregnant women can cause a decrease in babies’ IQs [16]. However, the addition of fluoride to the water supply, as commonly occurs in many countries, does not impact

children's IQ, as previously suggested [17]. Nevertheless, the idea that chemicals in the water can impact brain development does not seem as unusual in light of modern scientific analysis.

In addition to believing in the health benefits of water, *Chazal* believed in the protective effect of certain water against disease. For example, *Chazal* posited that Babylonia had no lepers because its residents bathed in the water of the Euphrates (*Ketubot* 77b). Here we see a case in which *Chazal* believed that good quality water, in this case that of the Euphrates River, had the ability to prevent disease, either because the water remained uncontaminated of leprosy or because the water itself had inherent therapeutic power. A 2016 research study found that the bacteria responsible for leprosy, *Mycobacterium leprae*, appeared in 24.2 percent of the water in patient areas [18].

Additionally, *Chazal* thought that immersion in bathhouse water kept a person healthy. The list of ten things that a city needs to have in place in order for a Torah scholar to live there included a bathhouse (*Sanhedrin* 17b). Furthermore, the Talmud prohibited standing on the floor of the therapeutic bathhouse of *Deyomset* on Shabbat because even just standing on the floor of the bathhouse warmed and healed (*Shabbat* 147b), which would go against the limitations on healing on *Shabbat*. Rashi defined *Deyomset* as a particular river with salty water. The Talmud clarified that water of this particular bathhouse was therapeutic for twenty-one days starting from *Shavuot*, as during this time period the water naturally became warm. In contrast, a medicinal drink created with this water was effective during the time period from *Pesach* to *Shavuot*, when the water became cold. In both cases, *Chazal* viewed the water of the *Deyomset* bathhouse as therapeutic, whether one stood in the water or consumed it medicinally. The idea that *Chazal* thought of

the *Deyomset* water as therapeutic does not contradict modern scientific inquiry. Along similar lines, folklore about soil in an area in Northern Ireland traditionally stated that the soil held healing properties and, interestingly, researchers recently found that this soil contains a specific bacterium that produced a novel antibiotic bactericidal towards antibiotic resistant pathogenic microbes [19].

Conversely, *Chazal* discerned that the wrong kind of water could pose a public health problem. The Talmud mentioned the springs of Tiberias in the context of the water with harmful properties (*e.g.*, *Shabbat* 109a; 39a) [20]. Drinking this water upset the stomach. Rambam commented that since the water caused an upset stomach, it did not constitute an actual *halachic* liquid and, as such, it neither became impure nor imparted impurity, as per the *Mishnah* (*Machshirim* 6:7) [21]. Additionally, one could receive a wound (*halachically* considered a boil (*Nagaim* 9:1)) from contact with waters of Tiberias, presumably due to their high temperature. Accordingly, the spring waters of Tiberias could harm the population by drinking or by skin contact. Modern science has characterized the water of the hot springs of Tiberias as saline and radioactive: “the water...is of Na–Ca–Cl-type with a temperature of ca. 60°C...with a total dissolved salt content of 31 g/L [and] is characterized by high radium (226Ra) and radon (222Rn) concentrations [22]. As such, “[o]wing to its high salt concentration, this [hot spring] water was not fit for drinking. But it was used for cleaning and healing, for instance, with spas developing in the Jordan Valley in Second Temple and Roman and Byzantine times” [23]. Often, contamination of water by a pathogenic bacterium or a parasite can cause stomach distress. Researchers, in fact, have identified one class of bacteria found in the hot springs of Tiberias as of the order *Hyphomicrobiales* [24]. However, these particular bacteria are nonpathogenic [25].

### Contaminated Water

Today, water contamination has become an extremely pressing issue. Water contamination by two main sources, sewage and industrial waste, became such a severe problem in America that it necessitated both the Clean Water Act of 1972 (modified in 1977, 1987, and other times) and the Safe Drinking Water Act of 1974 (modified in 1996) [26]. Historically, many outbreaks of microbial disease occurred due to unsafe water, such as outbreaks of cholera and dysentery [27].

*Chazal* too dealt with the problem of water contamination and issued injunctions to address this problem [28]. For example, the *Mishnah* stated that one must distance flax-steeped water from vegetables, because the flax water ruins them (*Bava Batra* 2:10). In this case, *Chazal* took preventative measures not to allow contaminated water to damage food. In modern times, agricultural runoff still poses a problem: “Agricultural runoff into surface water is a problem...in arguably all agriculturally active countries” [29]. Moreover, many contaminants have the potential not only to damage food sources via water but to render those foods a health hazard. Threats to food safety include the heavy metals: mercury, lead, and cadmium, as well as pesticides and industrial waste [30]. A new pollutant of concern involves brine (concentrated saltwater) from desalination plants that produce the brine as a byproduct, which if deposited into the environment could cause deleterious ecological effects. As some countries increasingly rely on desalination to compensate for freshwater shortages, improvements in the desalination process are needed to avoid the harmful effects to terrestrial and aquatic ecosystems [31].

Sewage also has the potential to contaminate water. Jewish law provided injunctions against improper disposal of sewage [32]. The Talmud

cited a *Beraita* that discussed guidelines for dumping sewage into the public domain: “those who open the gutters and drain the sewage or shovel [sewage from] their caves [into the public domain], during the summer they do not have permission [but] during the rainy season they do have permission; even when they do have permission, if it causes damage then they are liable to pay [for the damage]” (*Bava Kama* 6a) [33]. Today too, sewage has the potential to contaminate water and many regulations are in place to prevent this from happening.

### Pathogens

*Chazal* adhered to various theories as to how disease emerged and spread. Although they did not have modern epidemiological tools, some of their ideas and observations resemble current public health concepts and fit in with what we know today. For example, *Chazal* discussed insects, animals, and dirty clothing as entities that have the potential to spread disease. Moreover, while they might have learned some public health concepts from contemporaneous medical knowledge, *Chazal* also made some observations on their own.

Modern research has identified three means of the spread of contagious diseases: vectors, airborne transmission, and reservoirs. A vector involves an organism, for example a fly or tick, that can transmit vector-borne diseases, such as malaria, dengue, and West Nile virus [34]. Although they did not know about microscopic pathogens, *Chazal* intuitively recognized the concept of vectors. Regarding *raatan*, a disease characterized by watery eyes, upset stomach, and other symptoms, Rabbi Yochanan issued a warning to avoid the flies of a person with this disease (*Ketubot* 77b). Incidentally, Ostrer defines *raatan* as a pulmonary disease, rather than as a skin disease, as previously suggested [35]. Rashi clarified that flies that reside on someone with this disease can transmit the disease to another person. Likewise, healers at the time also

thought that the causative agent of *raatan* was a type of insect. As such, part of the treatment protocol required the healers to eradicate the insect by burning it. Furthermore, *Chazal* had a concern for airborne transmission of diseases, even though they did not necessarily know of the modern concept of airborne pathogens, as Rabbi Zeira worried about staying in the same area, *i.e.* breathing the same air, as the person with *raatan*. The concept of a reservoir in modern public health involves a non-human source where pathogens live and multiply and can include rats, food, or water [36]. Scientists often work to trace the source of a disease to its appropriate reservoir, such as *Coxiella burnetii* in rats, which transmit this bacterium to humans to cause Q fever [37]. Without a formal definition, Rav Ami and Rav Asi developed the concept of a reservoir, in their case food: Rav Ami and Rav Assi would not eat eggs from the alley of a person who had *raatan*, an expression of concern that food can spread disease. Additionally, pigs can serve as a reservoir for influenza, as human influenza viruses can in fact incubate in a pig's digestive system [38]. *Chazal* believed that disease could spread from pigs to humans, based on the belief that pigs and humans have similar intestines, to the point that when a pestilence spread amongst the pigs, Rav Yehuda declared a fast so that the people could repent and not become susceptible to the pestilence (*Taanit* 21b).

In advance of modern public health measures, *Chazal* believed in the importance of hygiene as a preventative against disease, especially so in the case of laundry. *Chazal* in fact believed that not laundering one's clothing led to insanity (*Nedarim* 81a). Rashi clarified that this referred to clothing unwashed to the point of being blackened.

#### Air Pollution

Even prior to and certainly since industrialization, air pollution has become a global problem that poses a threat to public

health. Studies have shown that air pollution can contribute most obviously to respiratory diseases, such as asthma [39-40] and possibly less obviously even to diseases such as autism, though researchers of this latter finding noted that the results need to be interpreted with caution [41]. Energy consumption, a basic part of modern life, significantly contributes to air pollution in modern times [42].

As is the case for water pollution, Jewish law offers injunctions against air pollution [43]. For example, *Chazal* issued ordinances about threshing floors (chaff), tanneries (odors), and kilns (smoke). The Mishnah prohibited building a threshing floor or a tannery within 50 cubits of a town (*Bava Batra* 2:8-9). The threshing floor also must remain distant enough from plantings and plowed fields that its chaff would not cause damage to them (*Bava Batra* 2:8) and similarly from gourds and cucumbers, as the chaff infiltrates their flowers and dries them (*Bava Batra* 24b). According to Rabbi Akiva, one may not build a tannery at all in the western direction of the city, as the winds would carry the odor (*Bava Batra* 25a). In the tosefta, Rabbi Natan ruled that kilns too must remain at least 50 cubits away from a city (*Tosefta Bava Batra* 1:7). Furthermore, *Chazal* viewed smoke damage as severe enough to exclude it from the stipulation of *chazaka* (acquired by privilege) (*Bava Batra* 23a). Moreover, the Talmud also discussed how when a specific family separated chaff from flax, the chaff would fly into the air and harm people (*Bava Batra* 26a). When those affected by the chaff complained to the Rabbis, Mar Bar Rav Ashi ruled that the family was liable for any resulting damage, on the grounds that the chaff harmed people. As a comparison, the Talmud cited a similar ruling about damage caused by one who beat a hammer to the point that sparks flew into the air and caused damage [44]. Additionally, during the time of the Talmud, a toxic odor from black cumin had occasion to permeate the air and one who slept downwind of the storage

area of black cumin had their own blood on their head (*Brachot* 40a).

From these examples, we see that *Chazal* took preventative measures against harmful substances in the air. In the case of the chaff and the hammer, although they did not prohibit the causative activity, they did warn that any resulting damage would incur a liability. This penalty, perhaps, incentivized people to not pollute the air to the point that it harmed people. Like the odor-producing tanneries mentioned in the Mishnah, a case recently occurred in California regarding farms of flowering Cannabis plants: “As a result of the stench, residents in Sonoma County, north of San Francisco, sued to ban Cannabis operations from their neighborhoods...‘I can’t be outside more than 30 minutes,’ Mr. Guthrie said of peak odor times, when the Cannabis buds are flowering and the wind sweeps the smell onto his property. ‘The windows are constantly closed. We are trapped inside. There’s no escape,’” [45] which indicates that similar cases still occur.

#### Foodborne Toxins

*Chazal* were proactive against food contamination. For example, *Chazal* took measures against snake poison finding its way into the water supply and into food: they forbade the drinking of water, wine, or milk left uncovered for the duration that it would take for a snake to drink from and to inject its venom into it (*Terumot* 8:4). They clarified that this edict applied to all liquids in vessels, but allowed for liquid in the ground if it measured forty *seah* (a type of liquid measurement) or more, because that amount of liquid would dilute the poison (*Terumot* 8:5). Moreover, one cannot eat fruit if it has bite marks, even a large fruit, because a snake might have bitten the fruit (*Terumot* 8:6).

*Chazal* were concerned not only about the presence of toxins but also about how toxins spread. Bartenura explained that for a large

fruit with a bite mark, if the fruit has moisture, one cannot eat even the part without the mark, as the poison could permeate the moisture and spread throughout the fruit. Similarly, for the same reason, one cannot eat an animal if it has a snake bite: Rambam explained that the snake poison could spread to the limbs of the animal and kill the person eating the animal. Here we see that *Chazal* thought of ways by which toxins could infiltrate food and took steps to prevent danger from these toxins.

Similar concerns remain today about toxins produced by bacteria. “Certain fish and shellfish may also contain toxins--for example, ciguatoxin or scombroid poison--produced by bacteria or algae that fish feed on or that infect the fish, thereby contaminating the flesh for human consumption” [46]. Regarding fruits, “fresh produce is responsible for an increasing proportion of foodborne illness. For the period 2002 to 2011, fruits and vegetables caused more cases of illness than beef, poultry, and seafood combined. In 2008, the largest foodborne disease outbreak in the previous decade was attributed to *Salmonella*-contaminated jalapeño and serrano peppers imported from Mexico” [47]. *Chazal* would not have known about bacteria or algae, but their measures taken against snake venom resemble modern public health measures against toxins produced by bacteria and algae.

The mandate of *mayim achronim*--to wash one’s hands after eating bread--serves as another example in which *Chazal* established a religious enactment that protected against a toxin. In this case, *melech sedomite* (sodomite salt) used with the bread potentially could blind the eyes (*Chullin* 105a-b). According to Rashi, since *Chazal* in fact advised eating salt with food (*Brachot* 40a), they needed to warn against touching the eyes without initially washing, as small grains of sodomite salt within the regular salt could stick to the hands and blind the eyes.

## Healthy foods

Much as nutritionists today seek to pinpoint healthy foods, *Chazal* as well believed that certain foods provided health benefits. The Talmud in several places (e.g., *Brachot* 40a) detailed a list of various foods and their curative or harmful properties. *Chazal* viewed garlic, leeks, and radishes as beneficial to a person's health. Additionally, Rabbi Akiva maintained that a city that houses a Torah scholar must have various fruits, because a variety of fruit 'illuminates' the eyes (*Sanhedrin* 17b). Moreover, *Chazal* thought that some foods could prevent disease. For example, they attributed the fact that the Babylonians had neither *raatan* (mentioned above) nor leprosy to the fact that they ate beets and drank beer made with *hizmei* (*Ketubot* 77b) [48]. Apparently, *Chazal* believed in the curative power of certain foods. Similarly, many nutritionists today seek to find foods that provide health benefits or hinder disease. Regarding the statement in the Talmud about garlic, historically, including in ancient Greece, garlic served a medicinal role [49-50]. Intriguingly, it turns out that garlic has some antimicrobial properties [51-52]. Regarding the statement in the Talmud about fruit, many nutritionists recommend several servings of fruit per day; Moreover, fruits that contain beta carotene – such as mango, cantaloupe, and red/pink grapefruit [53] – have health benefits for the eyes.

## Conclusion

*Chazal* did not have modern methods to detect the underlying chemicals or biologics behind the damage that they saw caused by water pollution, air pollution, pathogens, or food contaminants. Likewise, they did not recognize the underlying mechanism behind the water and food that they viewed as healthy. They did not have microscopes with which to view bacteria or protists. They could not take measurements of air pollution to the order of parts per million. They did not have the means by which to determine vitamin content of

foods, nor did they have the science of food chemistry at their disposal. However, *Chazal* did make empirical observations of how things appeared and also had a familiarity with scientific knowledge of their time. Accordingly, when they detected that something might cause harm to the population, *Chazal* created regulations that resemble current public health practices and much of what they recommended still passes muster today. They recommended healthy water and created laws against air pollution. They created restrictions against pathogens and set up regulations against food contamination. They provided dietary recommendations. Just as *Chazal* determined fair practice in terms of air pollution and water contamination, we can learn from those guidelines that they established. Likewise, we can follow healthy dietary practices, just as they recommended. Bernstein et al. write, "the wealth of Talmudic medicine is best revealed when it is compared with the methods of modern medicine, for many of the views, hygienic rules and methods of treatment of the ancient Talmudic physicians stand inspection in the light of today's scientific knowledge" [54]. Similarly, the lessons that *Chazal* taught about public health still remain relevant and timely today.

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