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The History of the Salt Wars

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ABSTRACT

The "Salt–Blood Pressure Hypothesis" states that an increase in the intake of salt leads to an increased in blood pressure and subsequently increases the risk for cardiovascular events, which has been a point of contention for decades. This article covers the history and some of the key players pertaining to "The Salt Wars" during the first half of the 1900s, both in Europe and in the United States. Early studies finding benefits with salt restriction in those with hypertension were based on uncontrolled case reports. The overall evidence in the first half of the 1900s suggests that a low-salt diet was not a reasonable strategy for treating hypertension.

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KEYWORDS: Blood pressure; Cardiovascular; Hypertension; Salt; Sodium

In the late 1800s salt was not demonized as a cause of water retention, edema, and kidney disease. In fact, salt restriction was actually thought to cause some of these conditions.[1] According to an article published by Branche in 1885, salt depletion resulted in extreme weakness, anemia, albuminuria, and edema; and as early as 1909, heat and muscle cramps from sodium depletion were well recognized symptoms.[2,3] Other side effects of salt restriction included vertigo, headache, apathy, anorexia, nausea, feeble twitching of the muscles, abdominal cramps, and oliguria. More severe side effects included vascular collapse, cold extremities, and large drops in blood pressure (hypotension).[1]

Carrion and Hallion in 1899 were the first to suggest that excess salt in the body pulled water from bodily tissues, increasing plasma volume.[1] This theory was soon championed by Achard in 1901, who suggested that edema of Bright's disease (chronic inflammation of the kidneys) was caused by the retention of chloride, causing an over-retention of water to dilute excess chloride. Afterward, Achard went on to confirm that chloride was also retained in febrile disease, heart failure, and nephritis (inflammation of the kidneys).[1] It was thus argued that salt retention was the cause of numerous diseases rather than its retention being caused by the disease condition. This was essentially the beginning of the end for salt, being considered not a healthy natural substance providing 2 essential minerals (sodium and chloride) but rather a dietary blood pressure–raising demon.

Widal in 1903 and Strauss in 1904 were the first to test a low-salt diet as a treatment of edema, noting "peripheral, pulmonary, and even cerebral edema" with the addition of salt to the diet, whereas limiting salt intake "…occasioned a relatively rapid disappearance of the edema."[1] According to Widal, "Salt…in certain cases of Bright's disease is a dangerous article of diet"[1]; and Widal and Archard both claimed credit for the idea that chloride retention causes heart and kidney edema.[1]

In 1904, 2 French scientists named Ambard and Beaujard (sometimes spelled Beauchard) further promoted the idea that salt retention was a driver of edema and hypertension. These authors were credited for inventing the Salt–Blood Pressure Hypothesis and were some of the first scientists to spark The Salt Wars.[4] However, there was tremendous controversy at the time because "…the general German experience was opposed to a strict relationship between retention of chlorids and elevation of blood pressure."[5] In 1907, Lowenstein was unable to demonstrate a correlation between chloride retention and blood pressure in patients with renal hypertension, with only 1 of 10 cases having "a definite relationship between the fall in blood pressure and elimination of chloride from the body."[1]

During this time Ambard and Beaujard were testing salt restriction in patients with hypertension and found retention of chloride in hypertensive patients. They studied

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6 hypertensive patients (some with valvular heart disease and/or Bright's disease) with a low-salt diet consisting of 3 g of salt (1.2 g of sodium) and compared it against a high-salt diet (14 g of salt or 5.8 g of sodium). Despite the salt intake being approximately twice that compared with a normal sodium diet (ie, 5.8 vs 3.4 g of sodium), "The changes in blood pressure were not striking but *tended* to be downward when the low salt diet was given and upward when the higher salt intake was allowed."[1]

Ambard and Beaujard believed that both edema and hypertension were caused by a saturation of the body with salt, but even these authors realized that salt restriction did not completely normalize blood pressure in those with hypertension. However, the idea that salt restriction would prevent those with kidney disease from developing permanent severe hypertension made logical sense.[1] Soon after, Laufer came up with a diet that was even lower in salt compared with that recommended by Ambard and Beaujard. The diet contained just 100-720 mg of sodium/d (instead of 1200 mg) but provided a sufficient amount of calories and protein. Laufer's diet consisted of 200 g of rice, 300 g of wheat flour, 500 g of potato, 100 g of white cheese, 100 g of sugar, and 1 L of water. This diet was very similar to that which would be recommended by Walter Kempner 40 years later.[1] However, the "low-salt rice diet" was actually first invented in 1904 by Laufer (40 years before Walter Kempner's rice diet). Interestingly, both diets allowed fairly high amounts of sugar, because back then sugar was considered innocuous. However, the evidence is finally starting to shed light on the harms of sugar, suggesting that we may have blamed the wrong white crystal all along.[6-9]

Blum, in 1909, was the first to suggest that sodium (rather than chloride) caused water retention; and in 1921 Blum along with Aubel and Hausknecht studied the effects of sodium and potassium on water retention and concluded, "the dominant element is therefore sodium; it is the mineral which the kidney eliminates with difficulty. It is its retention that conditions the augmentation of weight, its elimination the dimunition of weight…. As for chloride, its role is subordinate to that of sodium."[1]

Magnus-Levy in 1920 was considered the first person to provide experimental proof of sodium's significance in the retention of water in patients with kidney disease. The Salt War waged on, and throughout the 1920s numerous authors continued to debate whether sodium or chloride depletion was of importance as a treatment for hypertension.[1]

CLINICAL SIGNIFICANCE

- Early studies finding benefits with salt restriction in those with hypertension were based on uncontrolled case reports.
- Results from well-designed, controlled studies indicated that the results of low-salt diets were effective in only approximately 25% of individuals with hypertension.
- The overall evidence in the first half of the 1900s suggests that low-salt diets were not a reasonable strategy for treating hypertension.
- During this time, low-salt diets were considered unpalatable by many clinicians and were found to lead to serious adverse consequences.

In the United States, salt restriction was not recommended to treat hypertension until 1918 by Meara, who "condemned its use as a condiment by patients with hypertension."[1] In the early 1920s, Allen et al were the most influential for getting interest in salt restriction as a potential treatment for hypertension. Their publications were the spark that lead to the "Salt Wars" in America.[1] Allen was noted to be "…one of the most outspoken advocates of salt restriction in the treatment of hypertension." According to Allen and Sherrill's case reports, approximately 60% of patients with essential hypertension had a clinically relevant benefit from salt restriction. However, at the same time, McLester, Strouse, O'Hare and Walker, and Mosenthal and Short, "were casting doubt on the efficacy of salt restriction in the treatment of hypertension."[1] These findings apparently did not deter Allen from recommending low-salt diets, as he "…continued to champion it in a thoroughly aggressive manner."[1]

Allen and Sherrill documented several instances in which low-salt regimens caused adverse events such as anorexia, lassitude (lack of energy), and oliguria, and even noted that giving saline solution actually cured these side effects. Gibbons and Chapman noted, "Allen's statement that '…nobody is known to have died from the salt-free treatment of hypertension'…was recently deprived of its validity when Soloff and Zatuchni reported *4 deaths presumably due to unrecognized salt depletion* (in all cases, italic indicates emphasis)."[1,10] Additionally, the earlier studies that had originally found benefit with salt restriction lacked pretreatment control observations. None were randomized controlled trials but rather case reports, mainly in hospitalized patients, and the simple act of being hospitalized was thought to provide much of the blood pressure—lowering "benefit" with salt restriction in these studies. So, although many of these studies were reporting significant falls in blood pressure with salt restriction, "a more critical study" performed by Berger and Fineberg in 1929 showed that low-salt diets were much less effective.[1,11] These authors tested various amounts of salt intake in 11 patients with essential hypertension using a pretreatment control period of 6-4 days (to avoid any random reductions in blood pressure). The low-salt diet (which contained less than 1 g of salt per day or approximately 400 mg of sodium) lowered systolic blood pressure in only 27% of patients, and "*no consistent effect on the blood pressure was observed when high salt intakes were instituted*."[1] Thus, when control periods were more adequate, low-salt diets were less than half as effective compared with what was previously reported.

By 1930 the *Journal of the American Medical Association* encapsulated the debate during this time, recommending *against* the use of salt substitutes due to "…our lack of knowledge whether it is the sodium or the chloride that is harmful."[1] That same year Strauss noted that salt restriction could lead to serious adverse consequences, such as uremia.[1]

Other investigators continued to report unimpressive results with salt restriction, and low-salt diets as a treatment of hypertension fell out of favor.[1] In fact, "By 1944, published comment on it had all but disappeared from the American medical literature."[1] That is, until Walter Kempner began publishing about his rice diet in the medical literature in 1944: "It stimulated the second great peak of enthusiasm in the United States for the low-salt treatment of hypertension."[1]

The low-salt Kempner era was an almost exact replica of what had occurred during the Allen and Sherrill era 20 years earlier, except this time it was on a much greater scale, with a much larger number of patients being tested (Kempner had 500 case reports). Moreover, the lay press during this time was more eager to report the benefits of the Kempner rice diet.[1] Kempner, like Allen before him, believed that an overworked kidney caused hypertension and that restricting sodium would relieve the work on the kidneys, preventing high blood pressure. This idea is still widely held today by many clinicians. Writing about Kempner, Gibbons and Chapman noted, "the possibility that human renal tissue, which for any reason is not receiving enough oxygen, releases a pressor substance into the blood is by no means established as the pathogenetic process in all types of hypertension but it is on this possibility that the author's rationale turns." "*Acceptance of any such view on the strength of the experimental evidence offered by Kemnper is not feasible*." In other words, Kempner's beliefs were not supported by the scientific literature.

In 1948, Goldring showed a lack of a significant effect on blood pressure with sodium restriction in those with hypertension and recommended against sodium restriction as a treatment for hypertension.[1] Again, a low-sodium diet was found to cause adverse effects; this time it reduced blood flow to the kidneys, reduced filtration rate, and increased the risk of renal ischemia.[12] In addition, 5 patients who were placed on the rice diet (which was low in sodium and protein) had their kidney filtration rates return back to baseline when given 30 g of salt per day.[12]

Perera and Blood noted that "normotensive patients… *developed incapacitating, and even dangerous, symptoms when denied salt*."[12] Despite the controversy, most believed that the rice diet worked for treating hypertension; and this somehow got translated to the idea that low-salt diets worked for treating hypertension.[12] However, when Schroeder, who had ensured a better pretreatment control period, tested the rice diet, the benefit of salt restriction was less favorable. Only 41%, compared with Kempner's reported 64%, found significant blood pressure lowering on a low-salt diet.[1,13]

Others, like Schroeder, continued to find less benefit with the rice diet compared with what Kempner had reported. Schwartz performed an additional well-controlled clinical study finding that the Kempner rice—fruit diet only benefited 4 of 14 patients (29%) with hypertension[1]; and Chasis et al reported virtually no benefit of the diet in 12 hypertensive patients. These authors also suggested that instead of improving kidney function, the diet actually *impaired* it.[1] Last, Loofbourow et al showed that the Kempner rice diet only benefited 19% of hypertensive patients.[1,14] Thus, the Kempner rice diet was less than half as effective as originally reported when tested by others.

Interestingly, the very cause of high blood pressure according to Kempner (ie, a lack of oxygen to the kidneys) is caused by low-salt diets.[12] Gibbons and Chapman noted, "In the final analysis, the rice—fruit diet is comparable to Allen's diet not only in that it is based on much the same *assumptions* with regard to the etiology of hypertension, but also in that *no fully convincing rationale has been established for it*." Because Kempner's experiments were uncontrolled, all of the results could have been due to a number of factors having nothing to do with salt restriction per se. It was documented that, "The environment itself, the rigorous discipline, and the close contact with other patients who have been or are undergoing treatment all combine to convince the patient that *success is in the offing if he adheres to the rules…. As an alternative explanation of Kempner's results, suggestion probably ranks second to none*." In other words, much of the benefit from Kempner's diet was thought to have little to do with the diet itself and more to do with the close contact between Kempner and his patients, but also due to the treatment during hospitalization, the "suggestion" of benefit, and random variability of blood pressure measurements (or all 4). Kempner was even known to whip some of his patients to keep them adherent to his rice diet (underlining the difficulty for adhering to the diet). Chapman and Gibbons went on to write, "Kempner concludes that these changes (retinopathy, decrease in heart size, changes in the electrocardiograms) were due in their entirety to the diet which, in turn, works by means of reducing the metabolic functional load of the kidney. *His data by no means support such conclusions*."[1]

The fact that others who had tested Kempner's rice diet, using better controls and showing less beneficial results, questioned the validity of the diet. Perhaps most importantly was that none of these benefits could be directly placed with salt restriction. In fact, the reduction in calories and subsequent improvement in obesity was certainly involved in the blood pressure reductions, as was the increase in dietary potassium.

Chapman and Gibbons also noted that low-salt diets were dangerous: "*Sodium and chloride* being virtually the cornerstones on which the mammalian biochemical structure is built, it is hardly surprising that *exclusion of these items from the diet ultimately results in undesirable, or even catastrophic, consequences*."[1] Peters, an expert on salt during the early 1900s, was documented in the following, "…it should be clear that *the regulation of the sodium chloride intake is not a matter for routine prescription* but one that requires the most critical consideration in each individual case."[1]

Chapman and Gibbons, looking at studies spanning from 1904 to 1949, found 21 "favorable" but 7 "unfavorable" studies regarding low-salt diets as a treatment for hypertension.[1] Thus, the evidence was not clear; in some instances salt restriction worked for treating high blood pressure, but other times it did not. Many times salt restriction caused serious adverse consequences, and it was extremely hard for patients to adhere to.

In summary, early studies finding benefits with salt restriction in those with hypertension were based on uncontrolled case reports. When better-controlled studies tested the low-salt diets results were unimpressive, being effective in only approximately 25% of those with hypertension. By 1944 the evidence for low-salt diets was so weak that it had fallen out of favor as a treatment for hypertension. Thus, the overall evidence in the first half of the 1900s suggests that low-salt diets were not a reasonable strategy for treating hypertension. Indeed, low-salt diets were considered unpalatable by most clinicians during the time and were found to lead to serious adverse consequences.

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