Nutritional Studies in Victorian Prisons

Kenneth J. Carpenter

Department of Nutritional Sciences, University of California, Berkeley, CA 94720-3104

It was controversy over the feeding of prisoners that forced the British Government by the middle of the 19th century to consider what was already known and what more could be ascertained concerning the nutritional requirements of humans. This appears to be the first time any government had felt it necessary to study such questions.

On one side of the controversy were humanitarians who insisted that prisoners be maintained in ways that would keep them strong enough to compete for honest work when their sentence was complete; because the existing conditions were not doing this, the ex-convicts had little choice but to return to crime. On the other side were administrators who were concerned that “crime should not appear to pay” and that conditions in prison, including the diets provided, must therefore compare unfavorably with the standards that were practicable for people of low income who remained honest despite being unskilled and near the bottom of the social scale (1). Another factor that made it practicable to study whether diets were adequate was that prisoners were fed the same specified rations for long periods.

Some dramatic failures to keep inmates healthy had led to the standardization of orders concerning the composition of their rations. This was a new problem because, until this period, periods of imprisonment had been relatively short, with more serious crimes being punished by hanging or transportation to a distant colony.

Surprisingly, the studies to be described not only led to improved knowledge of nutrient needs, but also to the overturning of a current basic dogma in nutritional science, and to the first estimate of the energetic efficiency of human muscles. To put the time scale into perspective, this work was being done 20 y before W.O. Atwater, considered the father of nutritional science in the USA, obtained his first grant to work on the chemical composition of foods in 1879, and 30 y before any important consideration and in contrast to practice in the United States where convicts, in addition to receiving standard amounts of beef soup, coffee, and molasses could satisfy their appetites with unlimited potatoes and corn “mush” (3).

SCURVY WITHOUT POTATOES

In 1822, after complaints had been made that the Millbank convicts were being fed extravagantly with considerable waste, the rations were reduced, with the elimination of all meat except for a small quantity incorporated into soup, and removal of the previous ration of 1 lb (0.454 kg) of potatoes/d. In the following year, there was increased sickness and general debilitation among the prisoners, and physicians called in to investigate concluded that the problem was a combination of infectious dysentery and sea-scurvy (4). They noted that, although scurvy (characterized by sponginess of the gums and blotches on the legs) was seen in one-half of the 860 inmates, none of the 24 who worked in the kitchen was affected, and they concluded that the problem had been brought on by undernourishment. The meat ration was restored, each prisoner was given 3 oranges/d, and the scurvy rapidly disappeared, although not the dysentery.

Eighteen years later, there was another outbreak of scurvy in the Penitentiary, but only among the small proportion of military prisoners now housed in the prison; these prisoners were fed different rations from their civilian counterparts (Table 1). William Baly, the new prison physician, saw that those affected had been receiving a good quantity of meat and that the main difference from the civilian ration was the absence of potatoes. He noted that this had also been the case at the time of the earlier outbreak, although no particular importance had been attached to it then. He ordered that the military prisoners too should begin to receive potatoes and no further cases of scurvy developed. In his report, he referred to outbreaks of scurvy in county jails having also consistently been associated with the omission of potatoes from the rations, and argued that these were a more economical and regularly available source of the antiscorbutic factor than green vegetables, and that the factor survived ordinary boiling (5).
LIEBIG’S NEW DOGMAS

In 1842 Justus von Liebig, the justly famous German chemist, decided that chemistry was now sufficiently advanced to form a scientific basis for nutritional science also and, without any significant experience of nutritional studies, he published a dogmatic book that had extraordinary influence in both Europe and the United States (7). With hindsight, the best that can be said for most of his ideas is that they stimulated others to do the work necessary to prove him wrong (8). But for at least a decade, his ideas dominated and we see his influence in the interpretation of the next appearance of scurvy in a British prison.

In 1846 the disease began to appear in a large prison in Perth, a city in Scotland, and Robert Christison, a professor of medicine at the University of Edinburgh, was called in to investigate (9). He was abreast of the new ideas in nutrition, including Liebig’s assertion that protein was “the only true nutrient,” and that the sole function left for fats and carbohydrates was to provide combustible material for oxygen so that protein was not lost as a result of air being admitted into the body from respiratory cooling, although their heat of combustion also helped to keep the body at a desirable temperature (7). It followed, of course, from the assumption that “protein is the only true nutrient” that any disorder known to be related to diet had to be the result of a lack of utilizable protein in the diet.

Christison discovered that there had been one deliberate change in the prisoners’ diet in the previous year, i.e., the replacement of skimmed milk (served as a supplement to oatmeal porridge at breakfast and supper) by “treacle water” (molasses syrup). Proximate analysis of the common foods had been published by this date, so that he could calculate the content of each of the different classes of nutrients in the prison diets. These diets were similar to those listed in the footnote to Table 2 (which refers to a later study) although most prisoners received more oatmeal and bread. When skim or buttermilk was supplied, it contributed 40 g/d of nitrogenous material, whereas the treacle water provided none. However, the modified diet still contained 135 g/d of protein, a level accepted as being adequate to maintain health. Therefore, as a slight modification of Liebig’s idea that “protein content” was the sole measure of a diet’s quality, Christison suggested that gluten, which made up 83% of the total protein in the modified diet, might not be freely convertible to the animal proteins of human tissues. On this basis, he could still suggest that the protein contributed by the skimmed milk had been responsible for previously keeping the prisoners free from scurvy (9).

Christison accepted that green foods had also been found useful in the prevention of scurvy, but explained this by stating that the vegetable albumen contributed by green foods was more easily converted to animal proteins than was gluten (9). This was quickly answered by another Scottish physician who pointed out that scurvy responded uniformly to a daily dose of 4 oz (115 g) of lemon juice that contained <2.5 g dry matter with almost no nitrogenous content (10).

Christison had mentioned, but only in passing, that potatoes had previously been used as an occasional substitute for cereals in the Scottish prisons, but not since 1845 when they had become scarce and expensive. It is extraordinary that he makes no further mention of this factor because he refers to having corresponded with William Baly whose paper had demonstrated the potato’s importance as an antiscorbutic (5). Of course, 1845 was the first year of the potato blight that caused famine in Ireland and also destroyed most of the potato crops in the remainder of the U.K. In England, the loss of energy and protein that they had contributed previously could be offset by cereal consumption; however, scurvy (but not famine) was

<table>
<thead>
<tr>
<th>Table 1</th>
<th>The weekly diet scales for military and civilian prisoners at the Millbank penitentiary in 1840 when only the military prisoners were suffering from scurvy (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Military</td>
</tr>
<tr>
<td>Bread, kg</td>
<td>4.76</td>
</tr>
<tr>
<td>Meat, kg</td>
<td>0.34</td>
</tr>
<tr>
<td>Cheese, kg</td>
<td>—</td>
</tr>
<tr>
<td>Gruel, L</td>
<td>9.7</td>
</tr>
<tr>
<td>Soup without vegetables, L</td>
<td>1.14</td>
</tr>
<tr>
<td>Soup with vegetables, L</td>
<td>0.57</td>
</tr>
<tr>
<td>Potatoes, kg</td>
<td>—</td>
</tr>
<tr>
<td>Onions, n</td>
<td>0</td>
</tr>
</tbody>
</table>

1 At each prison the basic dietary contained (g/d) oatmeal 285, bread 170, meat 28, barley 57, peas and other vegetables 85–115. This was supplemented with either 625–700 g buttermilk (Group 1) or 57 g treacle (Group 2).

2 Mainly muscular farm workers.
reported from many parts of the country without any disruption in the supply of cow's milk (6,11).

LUXURY OR DEPRIVATION?

Some members of the public continued to believe that long-term prisoners were being coddled. This is reflected in the humorous magazine *Punch* that quoted in 1850 from a contract for the supply of prisoners that the beef must be from good ox or heifer, and bread "the best wheaten." The article continued, sarcastically, that in order to refine the inmates from their bad blood, they apparently needed to receive a diet that no honest, hard-working laborer could afford (12). Some of the writings of ex-prisoners suggest that what they actually received was very different: "On tearing the potatoes in half the interior was often found to be a mass of foul, black, spongy disease" and "I used to have to hold my nose when I tried to eat the meat" (13).

Also in 1850 the General Board of Directors of Prisons in Scotland began a wide-ranging enquiry "as to whether their dietary was sufficient, but not more than sufficient to maintain the health and condition of the prisoners." The dietary for prisoners in the first 3 mo of imprisonment was more or less standard throughout the prisons except that governors had the option of replacing the skim or butter-milk with treacle water, as already described for Perth prison.

Observations were made from December 1850 until the following March on >1600 individuals entering 8 prisons. For the following 10 wk on average, their weight was measured every 2 wk and their general condition noted. Overall, 66% of the prisoners maintained or gained weight in this period and at least maintained condition. However, the proportion losing weight varied greatly from one prison to another. Professor Christison, who was again in charge of analyzing the findings, saw that in the prison at Ayr only 29% had maintained weight and condition; but the governor had noted on his report that the typical prisoner here was a large and muscular agricultural laborer whose needs were presumably greater than those of typical prisoners in other areas (14).

Christison, therefore, put those results aside. However, using the data from the other prisons, he was able to relate the differences to whether the buttermilk (or skim milk) in the standard diet had been replaced with treacle water. As seen in Table 2, 50% of those receiving treacle water lost weight, but only 27% of those receiving milk. Again, he assumed that it was the extra protein provided by the milk that had the favorable effect. His overall conclusion was that the diet with skim milk included contained no excess, and was adequate as a standard, provided that prison doctors could prescribe supplements for those deteriorating in general health (14).

The absence of any mention of scurvy in this report may be explained by the relatively short period for which the new prisoners had consumed the diets and/or a return to the practice of replacing some bread with potatoes after the blight problem had receded.

SHORTER-TERM DIETARIES

There were no standard diets in the many county jails used for prisoners whose sentences were for no longer than 3 y, and there was great variation from jail to jail (spelled "gaol" at that time) (15). In 1843 the government published a series of suggested dietaries for different classes of these prisoners (although they were still not enforceable because these prisons were in the charge of local magistrates), and stated that diets should not be part of the punishment, in the sense that they should not prevent prisoners from retaining their health and physical condition. In summary, it was recommended that very short-term prisoners be given just fixed amounts of bread and gruel, and that those with sentences > 21 d receive in addition small fixed quantities of soup, meat, and potatoes; those imprisoned for > 4 mo also would receive 1 pint (0.47 L) of sweetened cocoa 3 d/wk (16).

The first critic of this attempt at a standardization of dietaries was Edward Smith who will feature prominently in this story from here on. He was a physician on the staff of the London hospital for diseases of the lungs, 38 y old in 1857, interested in social questions and apparently an "antiestablishment" activist by temperament (17). Smith asked "Why is the diet varied according to the length of the punishment? Is it because prisoners are deliberately underfed in the shorter term, or is it believed that the depressing effects of imprisonment result in impaired utilization of food so that the need is correspondingly increased?" (16). He showed that the longer-term diets provided greater quantity as well as quality, at first in terms of gross weight, and then (in a later paper) as estimated quantities of carbon and nitrogen (18). His estimates, converted to more accustomed units by assuming 10 kcal (41.9 kJ)/g carbon and protein as "N × 6.25," are set out in Table 3, together with some contemporary standards for comparison (19–21). We see that the shorter-term diets fall well short of all recommendations, and contributed not much more than one-half of the energy and protein provided by the diets for those imprisoned for at least 4 mo.

In practice, it had probably been intended that the "bread and gruel" diets should be only of inferior palatability, and in that sense, part of the punishment, but that, even if they would not sustain health indefinitely, consuming them for 2–3 wk would do no permanent harm. Although there was no knowledge at that time of vitamins or of other micronutrients, there was a general feeling, to quote from the French scientist François Magendie, who had failed to keep dogs healthy by feeding them single foods, that: "Diversity and multiplicity of aliments is an important rule of hygiene which is...indicated to us by our instincts" (22).

### Table 3

Edward Smith's estimates of the daily contributions of protein and energy from recommended diets for prisoners given sentences of differing lengths compared with contemporary standards for the requirements of moderately active men (18).

<table>
<thead>
<tr>
<th>Class of diet</th>
<th>Sentence length</th>
<th>Protein g</th>
<th>Energy kcal [kA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1–7 d</td>
<td>51</td>
<td>1840 [7.71]</td>
</tr>
<tr>
<td>2</td>
<td>7–21 d</td>
<td>70</td>
<td>2480 [10.39]</td>
</tr>
<tr>
<td>3</td>
<td>21 d–4 mo</td>
<td>77</td>
<td>2740 [11.48]</td>
</tr>
<tr>
<td>4</td>
<td>≥4 mo</td>
<td>91</td>
<td>3130 [13.11]</td>
</tr>
</tbody>
</table>

Standards: Authority (Citation)

<table>
<thead>
<tr>
<th></th>
<th>Protein g</th>
<th>Energy kcal [kA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith (18)</td>
<td>81</td>
<td>2790 [11.69]</td>
</tr>
<tr>
<td>Moleschott (21)</td>
<td>126</td>
<td>3010 [12.61]</td>
</tr>
<tr>
<td>Vierordt (22)</td>
<td>113</td>
<td>2500 [10.48]</td>
</tr>
<tr>
<td>Playfair (23)</td>
<td>119</td>
<td>3020 [12.65]</td>
</tr>
</tbody>
</table>

1 It is interesting that Smith's own standard for protein requirement is much closer to modern ideas than that of Lyon Playfair or those of the two German authorities cited by his contemporaries.
A parliamentary committee looking into the matter recommended that, when someone was repeatedly imprisoned within short periods for minor offenses, their total time consuming "bread and gruel" should be no longer than 3 weeks (15,23). They also recommended that long-term prisoners too should begin their sentences with 3 wk of "bread and gruel"; otherwise, they would seem to be receiving preferential treatment despite the more serious nature of their crimes.

**HARD LABOR: THE ENERGY COST**

It had been one of the basic ideas when long-term penitentiaries began to be built that the prisoners should, whenever possible, be engaged in some form of labor, and preferably hard labor. This was difficult to combine with the other ideal of isolating prisoners to prevent the corruption and "hardening" of the younger ones. If an inmate had a skill such as tailoring or mat making, this could be carried on in an individual cell. Without such a skill, an isolated prisoner sometimes had a crank wheel installed in his cell and was given the thankless task of turning it so many thousand times each day with the total recorded on a meter (Figure 2).

Another machine on which a group of men could labor was the treadmill, consisting of a long wheel with paddles that a team of 5 or more prisoners could operate, stepping up from paddle to paddle as the wheel rotated and the paddles fell beneath them. It is pictured elsewhere in The Journal of Nutrition (24) and was, in principle, analogous to the "stair-master" in a modern gymnasium. The prisoners were separated from each other in some prisons by panels, but in others merely ordered to keep silent. For 3 alternate days each week, the men climbed each day the equivalent of nearly 1.4 miles (2.25 km) in 14 stints of 15 min each, interspersed with 15-min rest periods in which a second team worked. It had been hoped that the machines could be used to do useful work such as grinding cereals or pumping water or sewage, but this generally proved to be impractical.

In 1857 Smith had been able to report the volume of air that he had respired (through a facemask attached to a respirometer) while he carried out the various kinds of labor in use at different prisons, and reported that it was similar for crank turning and climbing on the treadmill (16). By 1859 he had been able to go a stage further by adding 2 boxes to his respirometer, the first containing an absorbent for water vapor and the second containing layers of barium hydroxide that absorbed carbon dioxide. By measuring changes in the weight of the second box, he was able to calculate his rate of carbon dioxide expiration (16). Smith, who weighed 196 lb (89 kg), reported that at complete rest he expired ~0.39 g CO$_2$/min, while walking on flat ground at 3 mi/h (4.8 kg/h), 1.67 g/min, and while working on the tread wheel at a London prison, 2.79 g/min (25).

An important scientific spin off from Smith's measurements was that Hermann von Helmholtz, a pioneer contributor to the concept of the conservation of energy, was able to estimate in 1861 that the work achieved by Smith climbing against the force of gravity amounted to only about one-fifth of the energy released by combustion of the body materials responsible for the CO$_2$ exhaled; in other words, that his muscular system, considered as a heat engine, was operating with about 20% net efficiency (26). This, the first estimate of its kind, was based on only approximate values for the gross heats of combustion of foods and of the mechanical equivalent of heat, but it demonstrated that most of the energy released during muscular contraction appeared as heat rather than mechanical work.

**THE PROTEIN COST OF LABOR**

Smith went on to study the effect of different forms of activity on the rate of protein metabolism. It was one of Liebig's dogmas that the energy needed for muscular contraction all came from the breakdown of protein, and that the extent of this breakdown could be measured by the resulting excretion of urea (7). Smith first measured his own urea excretion under many different conditions and concluded that it reflected mainly his rate of protein consumption. He then secured the cooperation of authorities in London, and of 4 convicts themselves, to obtain 3 wk of 24-h urine collections for days (and subsequent nights) during the 3 d/wk on which they worked the treadmill, and for their intervening rest days. The overall average 24-h excretion was 15.5 g nitrogen in the form of urea, equivalent to ~97 g protein. However, analysis of his data shows that the average urea excretion on treadmill days was <1% higher than on rest days, a nonsignificant difference, and in sharp contrast to the estimated increase of >50% in total carbon dioxide production over 24 h (27,28).

It appeared, therefore, that physical exertion led primarily to the combustion of additional carbohydrates and fat, rather than of protein; this was confirmed by 2 Swiss physiologists who measured their urea excretion during and after a mountain climb while consuming only protein-free snacks (29,30). It was extremely important for those responsible for feeding people engaged in heavy labor, or soldiers on maneuvers, to know whether their additional "energy food" should be supplied mainly as protein (as Liebig believed), or whether starch and fat served equally well. The British Army School of Medicine was finally persuaded, after a further series of trials, that Liebig was wrong (31).

Another physician interested in factors affecting prisoners' weight and condition was W.R. Milner, Surgeon to the Convict Prison, Wakefield, who by 1858 had carried out 44,000 weighings over a 10-y period. He attempted to relate the changes to the season of the year and to how long the men had been imprisoned, but the most significant factor appeared to be the kind of labor in which they were engaged. Use of the treadmill had been abolished at Wakefield and the heaviest form of labor was weaving heavy matting, in which 185 prisoners had been engaged over the years; they had lost 7 lb (3.18 kg) on average, despite most of them having been ordered supplementary rations by Milner once their loss of condition had been recognized. In contrast, most of the 1700 men who...
had been doing lighter work had gained a little weight even though they had not been given supplements (32). These findings confirmed Smith’s concerns that, although prison diet plans did make some allowances for the extra food required to balance the expenditure during hard labor, they were inconsistent and usually inadequate (18). At one prison, the supplement consisted merely of 1 pint (0.47 L) of soup/wk (28).

**WAS MEAT ESSENTIAL?**

Another question under discussion was whether meat was an essential component of any long-term diet. Liebig had written that the special value of meat came not just from its protein, but also from its juices that contained creatinine and also "so-far unidentified substances (that had)... the matters required for the production of cellular tissues and nerves" (33). If this were the case, then cow’s milk might not be a complete replacement for meat even though it clearly provided everything needed by the rapidly growing young calf.

It was known that agricultural laborers in many parts of the country, and particularly in Scotland, ate meat only rarely, but drank quite large quantities of milk (usually skim or buttermilk) (23). As we have just seen, it was already known that this could provide protein in plenty. The medical officer in a Scottish prison would refer to "our excellent national dietary... a combination of milk and meal (cereals)" and add that "Englishmen who referred to it disparagingly as being "a combination similar to that which is successfully used to fatten pigs in England," showed pitiful ignorance of the subject" (34). However, there was no hard evidence that people would thrive indefinitely with absolutely no meat and, as Smith was to point out, laborers would obtain a little lean tissue even from eating fat bacon (23).

But did milk too provide something special? Smith and Milner (35), in a paper to the British Association, reported that giving prisoners just one-quarter of a pint (0.118 L) of skimmed milk/d seemed to improve their condition. After giving this small supplement, the proportion of prisoners judged to need extra rations because of their poor condition declined from 23 to 10%. Because this quantity of skimmed milk contributed <3 g protein, they believed that: "it was acting in an indirect manner by improving the general nutrition of the system."

At one English prison (Devizes) a diet consisting only of bread, potatoes, and a purely vegetable soup had been found to keep prisoners jailed for 12–18 mo in good health and mostly gaining a little weight, so that it appeared adequate at least for this period (20).

**DEPRESSION AND IMPAIRED DIGESTION**

John Howard, the 18th century prison reformer was cited as writing: "I am sensible that persons confined, whose minds are depressed, need more nourishment than such as are at liberty" (20). And it was still a common idea in the 19th century that physical inactivity over a period would reduce the efficiency with which food was digested and "assimilated," so that a greater quantity of food had to be supplied to have the same final value; it was believed that physical labor would have the opposite effect. These ideas go back to the period in which assimilation was pictured in mechanical terms, with absorbed food particles having to be rubbed together in the heart until they were small enough to slip into and fill the spaces left in tissues where worn out bits had dropped out, but not so finely ground that they were lost through the kidneys. Thus coarse food was natural and suitable for active laborers in whom the particles would rapidly be ground down to usable sizes, whereas the "idle rich" actually needed a more refined diet that required less vigorous grinding to be assimilated (8,36).

Smith and Milner (35) did measure the fecal and urinary N losses in 2 prisoners engaged in light labor and 2 in heavier labor, but indoors in each case, and found that those doing the heavier labor actually excreted more N. This was apparently in contradiction to the idea of labor improving assimilation of N but, unfortunately, the 2 groups also differed significantly in both body weight and in N intake (with supplements being provided for those engaged in heavy labor) so that no general conclusion can be drawn.

**WILLIAM GUY FOR THE DEFENSE**

We must now introduce William Guy (born in 1810) who was the leader and spokesman among the prison medical officers at this time. He had also been Professor of Forensic Medicine at King’s College, London since completing his studies at Cambridge, Heidelberg, and Paris; he had already served as Secretary and Editor for the Statistical Society, and would later become its president as well as Vice-president of the Royal Society, obviously the credentials of someone well accepted as part of the Establishment. Although his role in the present context was one of defending the status quo, he was also known as reformer in the fields of sanitation and the improvement of conditions in workshops and hospitals (37).

Since 1859 he had been medical superintendent at Millbank, now a depot prison where convicts were held in solitary confinement for the first 5 mo of their sentence, and then at the end of 9 mo transferred, if judged fit for it, to Portland prison where they would labor outdoors, trimming stones for use in government buildings (23).

In 1863 Guy published a long paper that he had read to the Statistical Society. The first section reviewed current nutritional knowledge, and how foods could be combined to provide the nutrients necessary in an adult diet, for example with 1 lb (454 g) bread, 1/2 lb (227 g) potatoes, 1/2 lb (227 g) oatmeal, and 1 pint (0.47 L) milk (20).

His next section, “Teachings of experience” began with an account of the “disastrous experiment” at Millbank in 1822–1823 (i.e., the reduction and simplification of the dietary) that had resulted in the development of scurvy. He agreed with Baly’s conclusion (described earlier) that it had resulted from the omission of potatoes from the revised diet, rather than, as originally thought, from a general reduction in the quantity of food supplied.

He then reviewed the rations that had been found satisfactory for able-bodied paupers living in workhouses, typically for a period of 2–3 mo. It had been found in Scotland that a daily dietary containing 20 oz (567 g) solid food (bread, meat, and oatmeal) and 3 oz (85 g) liquid food (buttermilk and broth containing meat and vegetables) was adequate for working men. In contrast, the diets recommended for prisoners serving sentences of 3 mo contained, on average, 29 oz (822 g) solid food and just over 2 oz (57 g) liquid foods. And even the “punishment diet” at Millbank was more liberal than those found adequate for paupers (20).

Guy concluded that the scale of diets in English prisons was generally excessive, first because of the lingering fear that the epidemic of scurvy at Millbank back in 1822 had been caused by the general reduction in rations, and second by the idea, for which there was really no evidence, that the stress of imprisonment in some way increased the need for nutrients. (20).
He then went on to consider the findings from experiments at different prisons in which changes in body weight had been used to assess the adequacy of a diet. In Scotland 8 different diets had been compared over a period of 1 mo, but the results had been difficult to interpret. In one comparison, the only difference between 2 diets that each included 3 lb (1.36 kg)/d of potatoes was that in one they were boiled and in the other baked. Those consuming the former gained 4 lb (1.81 kg) on average; with the latter, they lost 1.5 lb (0.68 kg). Guy felt that these and other inexplicable results in his own studies at Millbank indicated that the weights of prisoners could rise or fall from obscure causes and could therefore not be trusted as guides to a sufficient diet (20). This was, of course, in sharp contrast to the views of Smith and Milner who had been relying on weight changes for just that purpose.

THE EXPERTS QUESTIONED

Still in 1863, because of continued public concern over conditions in prisons, another parliamentary committee was set up to investigate and then publish their evidence and conclusions, and the witnesses included Edward Smith and then William Guy who each answered >200 questions (38).

Smith told the Committee that (like Guy) he believed that some convict diets were excessive. At 2 London prisons the highest diets contained at least 5000 grains (324 g) carbon, whereas he had estimated the daily requirement of adult men to be no more than 4300 grains (279 g). He thought it useless to express quantities merely as weights of “solid foods” when their water contents could be so different, for example ~0.75% in potatoes and ~0.35% in bread. On the other hand, the lowest class of diet for short-term prisoners contained only 2800 grains (181 g) carbon, a quantity so low that it could not sustain the system, and it would be particularly dangerous for individuals repeatedly imprisoned for short periods (38).

Smith also referred to recent work in Germany using dogs that confirmed his own observations with prisoners that physical activity did not increase nitrogenous excretion (39). He concluded from this (although the German workers did not) that physical activity did not increase the requirement for protein or a need for more meat or other animal food (23). Physical labor, however, greatly increased the need for the “carbon” foods, i.e., fats and carbohydrates.

Smith said that he believed that being indoors and inactive led to reduced assimilation of food, and that he and Milner had already found that inactive prisoners produced ~10 oz (284 g)/d of feces, whereas the general population at liberty produced no more than 4 oz (113 g). He was in favor of white bread because the bran in brown bread “hardened the material through the bowels and so made assimilation worse.” In reply to further questions, he said that it should be possible in 12 mo to complete a further series of studies with 5 prisoners to determine how much exercise was needed for there to be a normal assimilation of foods (38).

Guy was questioned similarly at a later date. He agreed that hard labor improved assimilation of nitrogenous foods, and that experience had shown that prisoners could thrive for at least 12 mo without meat; he did not think that mental depression in itself increased the need for food (38).

The final report of the Committee included the following statements:

“We are not prepared to recommend positively that the rations for these (convict) prisons should be diminished, but we think it desirable that experiments should be tried in order to ascertain whether any reduction can be safely made.”

“It appears that there are still medical and scientific questions as to the effect produced by confinement upon prisoners, and as to the necessity of certain ingredients in the food, which require further investigation. Under these circumstances, the Committee recommend that a Commission be issued to enquire into these questions, with authority to determine by experiment the points referred to them” (40).

Edward Smith must have felt that, at last, he was going to be given the opportunity to continue his investigations with official support and financing. But it was not to be.

AN END TO EXPERIMENTS

Parliament could legislate and committees could “recommend,” but they could not give orders to the executive power. What actually happened was that the government minister responsible referred the report to the 2 official “Inspectors of Prisons,” and they in turn recommended that the Medical/Scientific Commission consist of 3 prison medical officers with Guy in the chair. In view of Guy’s earlier statements, the following paragraphs from their report are not entirely surprising:

“It is true that these diets of the shorter sentences do not satisfy the requirements of theories based on experiments made upon persons very differently circumstanced; and that they are open to adverse comment from those who, not satisfied with the absence of disease and the preservation of health, insist also that the prisoner shall suffer no loss of weight. But the facts which have been placed at our disposal, have satisfied us that scientific data have but a limited and uncertain practical application, and that gain or loss of weight is not to be trusted as an indication of health, or as a test of the sufficiency of our diets. It is to experience, therefore, that we must turn for guidance.”

“...there is no experiment, or series of experiments, which we could devise, or which we could hope to obtain facilities for making, which would show the true effect of confinement upon prisoners. ... We must be content, therefore, to adopt and act upon certain prevailing opinions respecting the influence of health and the counteracting effects of certain kinds of food and certain diets.” (41)

Smith had been deliberately kept “out of the loop” and responded with some heat: “A committee of medical gentlemen, not known in chemico-physiological research...were informed that they had to conduct experimental researches” (42). Not surprisingly perhaps, their reply, in essence, was that they knew only how to rely on experience. Questions were asked in parliament but the matter was then allowed to drop. Smith must have seen that he was beaten. He had carried out his work up to that point without any special funding and it now appeared that he would be denied even the facilities that had previously been extended to him. Perhaps because of this, he took up a salaried position as medical officer to the Poor Law Board, which meant that he was no longer free to criticize other government actions or publications (15,17).

ONE LAST STUDY BY THE NEXT GENERATION

There continued to be enquiries into whether prison diets should be modified, both in 1878 and 1899 (43–45). These included calculations concerning the composition of the different diets and their energy values, but they were all estimated from published tables of food composition. However, Scotland was to some extent independent from policy in London, and one Scottish study was reported in 1899 in which the nitrogen balance of 7 prisoners was determined over periods of 5 d (48). The results are summarized in Table 4. The author
concluded that, given the inherent errors of the procedures, the subjects consuming the rate IV dietary (of highest protein content) could certainly be judged to have been in balance, whereas the results with the other 2 diets were marginal. Attention was drawn to the unexpectedly high level of fecal N loss, especially in the subjects consuming the highest rate diet. Thus, with the rate IV diet there was 2.5 g more fecal N than with the rate II diet, and the extra N consumed was 7.6 g N. This corresponded to 33% of the extra N being apparently indigestible. The author suggested that these high values might have been caused by the diets containing a high proportion of vegetable proteins that had a relatively low digestibility.

Unfortunately, the results cannot be used to verify the old idea that digestion was worsened in subjects who were sedentary and kept indoors, and conversely improved by hard labor in the open air. All of the subjects in the balance study were engaged in moderate indoor labor such as plaiting coir yarn or repairing sacks (48). However, those consuming the higher diets had presumably been in prison longer; thus, their poorer digestion could be attributed to the effect of imprisonment, just as well as to the extra vegetable protein that they contained. It remains unfortunate that the questions raised in 1864 were never tested critically.

IN RETROSPECT

It was clearly impossible for authorities to set levels of diet that would match the individual requirements of each prisoner in groups varying widely in size, age, and metabolism. The problem would not have arisen if British prisons could have followed either the American system of allowing a basic food such as potatoes to be taken according to the individual appetite, or the French “canteen” system of allowing the purchase of additional bread or fruit with money earned from prison labor (3,48). When the solitary or “separate” system was finally abandoned, it did become practicable to have communal meals with some items unlimited, so that the old problem of specifying total quantities finally disappeared.

In the Victorian period, however, governments were forced to direct attention to nutritional questions for the first time; as we have seen, the pioneering studies in prisons led to new questions. The period in which the prisoners had been in prison increased. The daily protein intake, g

**TABLE 4**

<table>
<thead>
<tr>
<th>Dietary scale</th>
<th>Rate II</th>
<th>Rate III</th>
<th>Rate IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects, n</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Daily protein intake, g</td>
<td>91.3</td>
<td>117</td>
<td>138</td>
</tr>
<tr>
<td>Urinary N, g/d</td>
<td>13.3</td>
<td>16.3</td>
<td>18.0</td>
</tr>
<tr>
<td>Fecal N, g/d</td>
<td>2.0</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Total N out, g/d</td>
<td>15.3</td>
<td>19.8</td>
<td>22.5</td>
</tr>
<tr>
<td>Total N in, g/d</td>
<td>14.8</td>
<td>19.4</td>
<td>22.4</td>
</tr>
<tr>
<td>Estimated N balance, g/d</td>
<td>-0.5</td>
<td>-0.4</td>
<td>-0.1</td>
</tr>
<tr>
<td>Apparent indigestibility of N, %</td>
<td>13.5</td>
<td>18.0</td>
<td>21.4</td>
</tr>
</tbody>
</table>

1 The “rates” of feeding the prisoners increased from II to IV as the period in which the prisoners had been in prison increased.

to potatoes being a reliable staple for warding off scurvy when the dietary contained neither fruit nor green vegetables.

Another lesson from these experiences, and one that may still apply today, is that someone who has established him (or her) self as an authority in a particular field, should not be regarded as equally authoritative when they venture, with little experience, into another field. Here we saw that Justus Liebig, established as the world’s leading organic chemist by the 1840’s, made serious mistakes when setting out to be equally authoritative in the fields of physiology and nutritional science. He asserted that protein must be the only fuel for muscular contraction, and that lack of it in the diet must be the cause of any deficiency disease such as scurvy. Sir Robert Christison who established his reputation in toxicology, and particularly in arsenic poisoning, was willing to modify Liebig’s concept slightly by suggesting that not all sources of protein were equally antiscorbutic, but ignored the repeated observation that scurvy could be cured with small quantities of lemon juice, which contributed negligible amounts of protein (49).

Last, we have seen the understandable reluctance of people in established positions (in the present instance as medical officers in prisons) to have the assumptions behind their practices put to the test by actual experiment, when they are comfortable with them, even if those at the receiving end are not, because to do so would be to question their authority and expertise.

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