had caused lead poisoning. The water might be acted on so as to prevent its action on lead service pipes (1) by passing it over a large bed of limestone; (2) also, if water contains a free acid like Bacup and Sheffield water, it might be neutralised by adding carbonate of soda; (3) another plan would be to make borings down to the abundant underground reservoirs which existed in Bacup in the millstone grit, and mix this with the water collected from the moors; this would make the water harder. The water-supply of all large towns ought to be under the control and management of the local sanitary authority. The sanitary authority should have control of all matters relating to fittings, cisterns, etc.; also have a register of plumbers. Dr. Brown then gave results of experiments made by himself.

1. Water was taken from the Rossendale Waterworks reservoir and was found free from lead, then placed in a tinned lead pipe for ten days; when tested it gave half a grain of lead per gallon.
2. Same water was kept ten days in lead pipe made from virgin ore, and it only dissolved one-tenth of a grain of lead per gallon.
3. Added a teaspoonful of carbonate of soda to half a gallon of water which was taken from a lead cistern; it contained over a grain of lead per gallon. Result: When tested, all the lead was removed. At the bottom of the vessel was a white deposit, which was lead—probably the carbonate of lead thrown down by the carbonate of soda.
4. Water as No. 3 was placed in a glass vessel in which were placed iron or steel filings; nearly all the lead was removed, but the water dissolved so much iron that it was not fit for dietetic purposes. Recently there had been several outbreaks of plumbism, due to water contamination from lead service-pipes, at Sheffield, Bradford, Rochdale, Huddersfield, Keighley, Darwen, Padiham, Pudsey, Norden, and other places. The extent of the epidemic and the amount of sickness and number of deaths, if investigated by a Commission appointed by the Government, would be simply astounding. Some steps ought to be taken to call the earnest attention of the Government to the advisability of appointing a Commission of inquiry.

Dr. HENRY TOMKINS (Leicester) argued that, although in some special districts water obtained from upland districts acted upon leaden pipes, yet this fact should not condemn the use of comparatively soft water supplies; that the use of hard spring waters is attended with great drawbacks, not only for manufacturing purposes, but also for domestic use. He suggested that in towns or localities where the water is known to have a solvent power upon leaden pipes, some form of pipe (several of which are in the market) should be used which are unacted upon by the water.—Dr. ROBERTS (Keighley) said they had had poisoning from drinking water in Keighley. He examined all the springs and streams passing into the reservoirs, and found most of them dissolved lead. Spring water dissolved lead. Charcoal filters removed lead, and the water which had passed through the filter would not dissolve lead. This was also proved by Dr. Tidy, and Mr. Rimmington, of Bradford. Some people preferred hard water, and when the inmates of the Keighley Workhouse had a new supply, which was softer, they begged to have their tea made of the hard water. Dr. Tidy told him that the health of the young soldiers in Paris who had been brought up from the country, where the water was hard, had materially suffered from the soft water. They had now, by neutralising the acid with lime, prevented lead poisoning in those districts where the water was so treated.—Dr. A. S. UNDERHILL called attention to the case of a clergyman in his district who declined to use the town's supply water, and preferred to use filtered rain-water which had been stored in a large iron tank. The water-supply in his district was conveyed by large iron pipes with leaden domestic supply pipes. The water was rather hard, full of carbonic acid gas, with very slight traces of chlorine, and practically free from organic matter. The iron pipes did not unduly rust, and lead poisoning was unknown.—Dr. WHITELEGGE asked if any of those members who had spoken from practical experience of contamination of water-supplies by lead had tried Barff iron as material for water-pipes. Its peculiar property of withstanding rust seemed to mark it out as specially adapted for such use, and the plan had proved most satisfactory when tried on the small scale.—Dr. SINCLAIR WHITE, in reply, defended moorland water as being best for cooking and domestic purposes, and also best for manufacturing purposes. He thought, however, this should be filtered before distribution. Loch Katrine water, in its passage to Glasgow, passed through a conduit lined with old red sandstone and limestone. To this it owed its immunity to lead.

PHYSIOLOGICAL VALUE OF MEAT FOOD FOR INVALIDS, AND WASTE IN METHODS OF PREPARATION.

Read in the Section of Public Medicine at the Annual Meeting of the British Medical Association, held in Leeds, August, 1889.

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IN the preparation of beef-tea it appears to me that there is considerable waste of material, which arises from a desire to give food of high nutritive value in small quantities, irrespective of its component parts combined in natural proportion. This idea has been fostered by an eminent chemist, whose preparation has not the object, as he himself states, of feeding the sick, but unfortunately adopted by the public for that purpose. Nature does one thing, man another; which is the preferable teacher I will endeavour to show.

Forty years ago patients were deluged with meat washings, under the belief they were being nourished; as they did not improve, brandy was adopted, so, between brandy and meat washings, their recovery was delayed, under a mistaken idea there was virtue in scent, salts, and brandy. Pounds of meat were, and still are, wasted in the preparation of beef-tea, whilst brandy is rightly enough tabooed. Medical men know perfectly well what good beef-tea should be, but patients complain that the doctors do not give them easy directions for its preparation. There is some truth in the complaint, for we are apt to forget that what we are familiar with, the laity, including nurses, is unlearned in. We accept the off-hand statement, "We know all about it," without inquiry.

One reason for waste in material is, that the fastidious palates of the sick are catered for whilst their bodily health is unintentionally neglected; this results from ignorance. Nurses, cooks, and patients all clamour for clear beef-tea. Clear beef-tea is of no use to anyone as food. It is true it is "just what the patients like," and what they "can be got to take;" but what is proper for sustenance is lost sight of. However well beef-tea may be made, the most important part is left at the bottom of the cup—"the grounds which are no good." The patient does not progress; the attendants "have done all that they can do"—which is just what they have not done by rejecting the "grounds as no good." When patients are sick, mental equilibrium is more or less at fault, and against their will must they be fed. Attendants, therefore, require instruction, and with requisite tact they will apply that knowledge.

I propose to bring together (1) facts relating to the nutritive value of meat and what becomes of it after ingestion; (2) to comment on the literature of the subject as found in various journals; and (3) to consider how waste may be remedied and a saving to public and private institutions effected.

Physiological Value.—Meat consists of 78 parts of water and 22 parts of solids, nearly all albumen or nitrogenous substances, which are easily assimilated, and from which a much more rapid metamorphosis of tissue takes place than from vegetable food. Hence, when meat fibre enters the stomach, the gastric juice converts it into a soluble crystalloid or peptone capable of diffusion through animal membrane. By osmosis it passes through the walls of the capillaries of the stomach, whence it is conveyed to the liver by the portal vein before entering the general circulation.

The duty of this nitrogenous substance is to develop and renovate the tissues, assist in the formation of secretions, and produce force. Every substance in the body in which any form of force is manifested is nitrogenous; and as nitrogen where function is performed is traceable throughout the world, such constancy proves necessity. "Nitrogenous substances composing the textures of the body determine the absorption of oxygen. The absorption of oxygen does not determine the changes in the tissues, but changes in the tissues determine the absorption of oxygen. In other words, without the participation of nitrogenous bodies no oxidation and no manifestation of force is possible."¹ Hence, if nitrogen be cut off from the body, the various functions languish and the body dwindles. "Gelatin is chiefly destroyed in the blood and gland-cells, and its energy therefore has a direction different from that

¹ Parkes.

of albumen." It is the least perfect kind of albuminous matter existing in animal bodies, and its nutritive value is one-quarter that of albumen. Submitted to prolonged ebullition, or 220° F., it evolves ammonia, becomes syrupy, loses the property of coagulation, and speedily putrefies. Hence, its nutritive property is destroyed and it impairs digestion.²

From the albuminates fat arises, so that the nitrogenous substance plays two parts; first, of the organic framework, that is, the regulation of oxidation and of the transformation of force; and, secondly, it forms a non-nitrogenous substance, which is oxidised and transformed. Fat stored up in fattened pigs cannot be derived from the fat given in the food, but must have been produced partly from nitrogenous substances, but chiefly from the carbo-hydrates. So also it seems now probable that the fat in milk is not derived at once from blood but from changes of albumen in the lacteal gland cells.³

The digestive system of man is so formed that fat either cannot be formed in sufficient quantities from albuminates or the body is poisoned by the excess of nitrogen which is necessarily absorbed to supply it, so that fat must be taken in addition. Excess of albuminates causes a more rapid oxidation of fat, while excess of fat lessens absorption of oxygen and hinders the metamorphosis of both fat and albuminous tissues.³

Chossat laid down as a broad principle, derived from experiments on many different creatures, that life ceases when an animal loses two-fifths of its weight, so that an animal weighing 100 pounds would die when its weight was reduced to 60 pounds. The daily loss amounts to one twenty-fourth part of its entire weight—a statement in harmony with the conclusions of Bidder and Schmidt that an animal to maintain its weight ought to take one twenty-third part of its weight daily in the shape of food susceptible of being assimilated, water of course included.⁴

1. An adult European, in moderate work and 150 pounds in weight, requires 22.866 ounces of water-free food, that is, 0.15 ounces for each pound weight, with which is mixed from 50 to 60 per cent. of water, or a total of about 40 ounces of ordinary food—about 305 grains of nitrogen. In addition a total water supply of from 70 to 90 ounces, or an average of 0.5 ounces per pound weight. 2. In rest the amount is about 16 ounces water-free food, equal to 240 grains of nitrogen, and is sufficient. 3. The smallest amount of nitrogen necessary for the inner movements of the body and bare maintenance of life is 138 grains, or 2 ounces.⁵ This may be considered to be the sick man's state.

The quantity of urea passed in twenty-four hours is said to be the measure of the ingestion of nitrogen, but this view seems somewhat defective, because in fasting or with non-nitrogenous diet urea is still secreted. The nitrogenous diet, therefore, cannot be its sole source. Hence the determination of the quantity of nitrogen to sustain life, or keep up the inner movements of the body of an adult, does not depend upon the amount passed as urea, since urea does not depend upon nitrogenous food for its sole production. The human body may be likened to a closed vessel full of liquid with escape valves; extra liquid added will escape by the valves and be a measure of the liquid added, but the drops which escape are not the drops that were added, for the overflow depends on the inability of the vessel to hold more than it can contain. So when extra nitrogenous diet is indulged in, this determines the passage out of the body of matters which have performed their functions, at a rate proportionate to the activity induced by fresh material, and is a measure of the mechanical energy throughout the body, but is not an index of what is required to sustain life.

A cubic millimetre of blood contains about five millions of blood corpuscles, each one of which Dr. Hunter considers to have a life-duration of, probably, three weeks. Many millions of corpuscles are doomed at every round of the circulation to destruction and conversion into urea and the like. This destruction, says Dr. Paton, must be considered a powerful stimulant to the secretion of bile, the liver having as one of its functions the elimination of effete hæmoglobin. By this same process urea also is increased. Hence, urea formed even in starvation continues to be secreted till there are no corpuscles left to secure the office of respiration, and go the round of the circulation. But when fresh albumen enters the portal circulation, the blood pressure is raised and pro-

ducts, ready formed for use in the direction assigned them, are passed on.

For the state of rest in health 240 grains of nitrogen are said to be sufficient; but a bed-stricken patient, whose muscular and mental efforts are reduced to a minimum, whose vital processes are carried on with much less energy than usual, and who loses comparatively little heat, requires a relatively small supply of food; and, as at least 138 grains must be supplied, this supply should be thoroughly wholesome, easily digested, and consist of nutritive material.⁶ Animal food especially rich in nitrogenous elements digests in proportion to the minuteness of division and tenderness of fibre sooner than farinaceous, so that it is better adapted for those who are only able to take small quantities at one time.

Meat peptonised by the gastric juice is absorbed by the vessels of the stomach; the blood in those vessels charged with constituents whose period of service in the economy has expired is on its way to the liver to be transformed into bile and urea. Arrived at the interlobular veins, it traverses the acini by fine capillaries which enter the intra-lobular veins for conveyance to the right auricle. This work constantly going is like the daily routine work in a manufactory in which, when new material is brought, there is increased energy in all departments; and the process is comparable with iron ore entered at the mouth of a smelting furnace, passed through several ovens, and which appears at the orifice of exit converted into steel; no one sees the conversion, but the highly finished product is far different from that of the raw material.

Literature of the Subject.—Extractum carnis, Dr. Beneké states,⁷ is made by chopping 1 pound of beef finely and mixing it with its weight of cold water slowly heated to boiling, then briskly boiled for a minute or two and strained. Six pounds of meat thus treated yield, after evaporation in a water bath, 3 ounces. Hence 1 ounce of this extract equals 32 ounces of meat.

Dr. Hassall⁸ exposes the fallacy of this supposed nutritive value, since fibrin, gelatin, albumen, and fat are absent, and that what remains consists of excrementitious substances and blood-salts.

Baron Liebig himself says that neither tea nor extract of meat is nutriment in the ordinary sense. "It will be well understood, therefore, that by the addition of extract of meat to our food we neither economise carbon for the maintenance of the temperature nor nitrogen for the sustenance of the organs of the body, and that, therefore, it cannot be called food in the ordinary sense."⁹ "Dogs fed exclusively on extractum carnis die sooner than those not fed at all, which seems to be due to the deleterious influence of the potash salts contained in the extract, for though these are indispensable in the economy, yet a larger dose of them is injurious in the absence of food whose metabolism it is their office to direct."¹⁰

A patient may be swallowing several ounces of extract daily, and yet be actually starving; he may feel better for it, but his strength will not return unless he can swallow something else as well. We have eaten half a pot of the stuff, and remained as hungry as ever, the only effect being to produce thirst, to heighten the bodily temperature, and to increase the nitrogenous waste in the urine.¹¹

Extracts of flesh, fish, and crab are prepared, and have been used for several centuries, and probably longer, says a writer in the *Medical Times and Gazette* for October, 1870, in different countries. In the Malay Archipelago certain meats, sea fish, and little marine crabs the size of a pea are reduced to extracts, and used extensively as flavours and to strengthen with these extracts celebrated native dishes.

These extracts, then, are good stimulants, and useful to bring up the flavour of poor soup, but have no nutritive value, and require as great, if not greater, caution in administration to the sick than wine or brandy.

Meat extracts are neither direct aliments, for they contain no albuminous matter, nor indirect aliments, for their azotised principles do not arrest disassimilation¹². In small doses they may be useful from the stimulant action of the potash salts, which aid digestion and circulation. In larger doses they have an injurious

² Power.

³ Parkes.

⁴ Guy.

⁵ Power.

⁶ Power.

⁷ *Lancet*, 1851.

⁸ *Lancet*, 1865.

⁹ *Lancet*, 1869.

¹⁰ *Medical Times and Gazette*.

¹¹ Editor of *Medical Times and Gazette*, 1871.

¹² M. Muller in *Medical Times and Gazette*, 1872.

effect. In prolonged illnesses, when the powers of life are enfeebled, the salts of potash may, in place of favouring nutrition, impede it (1) by direct action upon the blood globules, causing a diminished absorption of oxygen; (2) by the predominance of salts in the serum, which exert no special solvent action on carbonic acid, and do not permit the exhalation of the normal quantity of this gas, and consequently the introduction of oxygen. To give these extracts alone is to keep the patient in a state of inanition.¹²

A piece of beef, one or two drams in weight, ground to a very fine pulp, is placed in a cup with two tablespoonfuls of water, with a pinch of salt; this can be warmed by the fire in ten minutes. The whole (grounds and fluid) is to be swallowed every four hours. Given in this way it is regarded as a medicine, and will be taken when, as beef-tea, it would be rejected. This process is only intended for cases of emergency, and when delay would be injurious.¹³

Dr. Leared describes a digester; in this he places 1 pound of beef finely minced, with 4 ounces of water, or preferably 8 ounces, from which he produces 9 or 13 ounces.¹⁴ He does not say how he disposed of the remainder.

In the *Gazette Médicale*, 2 pounds of beef are directed to be taken, chopped up and placed in a litre of water with a small quantity of hydrochloric acid; this is to be boiled for fifteen hours, then strained, the mass crushed, emulsified, and boiled again for fifteen hours. The whole is then neutralised with bicarbonate of soda, and evaporated to the consistency of pap.¹⁵

Dr. Leared macerated 1 pound of crushed muscle for three-quarters of an hour with a pint of cold water, boiled for two hours, and strained.

In the JOURNAL for 1880 is described a complicated process, the last of the various methods described in the journals. Except the French method, which is peptonised beef-tea, only one aims at presenting to the stomach meat fibre in its natural condition, small in bulk, and of physiological value when swallowed; the rest are highly scented and highly salted specimens of broth of little nutrient value, and extravagant waste in production.

Waste of Meat.—Private individuals and public institutions have various ways of making beef-tea, some boiling for long periods and others adding "stock," and equally varied ways of disposing of the remainder when they have, as they term it, "extracted all the goodness out of the meat," which means they have wasted half or two-thirds of the quantity of meat employed, and double salted what they have retained; the effect of which concoction is to produce thirst, heighten the bodily temperature, and increase nitrogenous waste; these results arise from the salts being out of proportion to the albuminates. The half or two-thirds of discarded fibre, termed refuse, is by some sold with "hogs' wash." In one institution alone I know that over 20 pounds were thus daily thrown away; others charitably (?) give it away. If the goodness has been extracted where is the charity? Surely actions belie words. Each thus satisfies the conscience that subscribers' or ratepayers' money is not wasted. Private individuals throw the remainder into the ash-pit. There are others, however, in both classes who, more thrifty, use the remainder in soup or other ways.

In the Metropolitan area—not counting cottage hospitals, private and public asylums, Poor-law infirmaries, numbering 28, workhouse infirm wards and military hospitals—there are no fewer than 87 establishments, including Bethlem with 11,100 beds, which necessarily use fluid meat food more or less. On the supposition that 2,220, or one-fifth of the whole number, may require fluid food, and allowing 12 ounces of meat to each pint, in the course of one week 5.2 tons of solid meat would be required for this purpose alone. I venture to think that this amount is two-thirds in excess of what is necessary to be used. The cost of this quantity will depend upon the quality of beef used; and for the larger establishments, where 100 or more pints are used daily, this is a subject for inquiry, since not only is there waste of food, yearly loss of revenue, no benefit to the sick, but habits of extravagance fostered amongst a class of persons who, of all people, should practise economy.

Of course, the present system is continued on the plea of succouring the sick person with "the best beef-tea that can be made," whilst his starving brother lies outside vainly wishing for

what the pigs are fed upon. But admitting that the present method is continued—as I am sure it is—from honest conviction that it is the best, may it not be worth while to inquire if it cannot be improved by putting on one side preconceived notions, and the dull round of routine, and adopting a method which does not countenance waste, does not injure or defraud the sick, and reduces the butcher's bill?

If albuminates are essential to health, and animal food digests in proportion to the minuteness of its division, how much meat-fibre can be suspended in a given quantity of water to make such a draught of nutriment agreeable in swallowing? After many trials I find that 4 ounces of meat can be suspended in one pint (20 ounces) of water, and be taken without disgust, that is, "grounds" do not collect on the palate nor remain in the gullet to annoy the patient; and that from 2 to 4 ounces of such fluid given every three or four hours is sufficient for any sick man. So that if a patient receives a pint and half of such food in twenty-four hours he gets a very large supply of nitrogenous food, and enough for a healthy man in a state of rest. If the food is made stronger than this proportion a very sick man will refuse it, and this is the very difficulty which will be overcome by a good nurse.

One ounce of the best meat contains 14.22 grains of nitrogen; 6 ounces will contain 85.32 grains; and, as 138 grains of nitrogen are supposed to be required, the remainder has to be made up from eggs, flour, and other matters. But the question has frequently arisen in my mind, whether a sick man does really require so much nitrogen daily. Theoretically he may, but practically he does not, nor does he get it. On many occasions I have witnessed very remarkable results from much smaller quantities of meat food—very far below the physiological quantity—so that I cannot help thinking there is some fallacy in the quantity of nitrogen required to keep up the inner movements of the body, particularly if urea, as hitherto maintained, is not the measure of nitrogen required, but in part the measure of the disintegration of blood corpuscles.

In making fluid meat food there should be neither refuse nor remainder. Say 100 pints is required, 25 pounds of good beef well chopped up or minced is placed in a digester with 100 pints of water and boiled for three hours, being frequently stirred and rubbed about with a wooden masher. At the end of this time the fibre is cooked; it should then be passed through a colander to ensure evenness of size and that no fibres adhere. If the process is properly managed there will be no remainder. If required, it can then be seasoned with a little salt, onions, and so forth. The better the quality of meat the less gelatin and better flavour. Prolonged ebullition has not destroyed whatever nutritious properties the gelatin may possess. The food of nature is thus simply cooked and suspended in a given quantity of water. The addition of stuff called "stock" is not required, for, besides being injurious, owing to prolonged ebullition, it gives a disagreeable flavour. The salts are in proportion to the albumen; the draught is thoroughly wholesome, and if administered not more frequently than every three or four hours the stomach will have suitable intervals of rest.

If rectal alimentation has to be employed only half or one-third of water need be used, or even less, so long as the fluid food can be passed through the tube.

For workhouse infirm wards the cut up "shin of beef" can be placed upon a strainer of nine meshes to the inch within an ordinary meat boiler, and by frequent stirring the disintegrating fibres will drop through. In one institution this process answers its purpose admirably, and gives the cook no trouble.

Last year Dr. Laffan obtained from Sir C. Cameron an analysis of the old and new processes as follows:—

	New process.	Old process.
Water	94.65	98.45
Albuminates, crystalline bodies, kreatin, etc. ...	4.25	0.90
Fats	0.20	0.07
Salts	0.90	0.55

The fluid from the new process was thick; in the old clear.

I confess I was not prepared to find my notion of an increase of salts in the old process so at fault, but the increase in the new process is more than compensated by the increase in the albuminates, while disproportionate in the old.

For travellers and urgent use at any time water-free beef, pounded and sealed hermetically in small tins, would be very advantageous; but all fluid extracts are disappointing and expensive. Poor folks require food within their means, and for such the above method is advantageous, let alone the saving to public institutions.

¹² M. Muller in *Medical Times and Gazette*, 1872.

¹³ *Lancet*, 1869.

¹⁴ *Lancet*, 1874.

¹⁵ *Lancet*, 1873.