The Chlorides in the Urine.

Sodium Chloride is the chief inorganic constituent of normal urine and is the commonest chloride present in urine under ordinary conditions. The potassium salt also occurs normally, but in very small quantities only as a rule.

The tissues of the body maintain a fairly constant content of sodium chloride and the amount of chloride in the urine varies directly with the amount of chlorides ingested. The feces and sweat contain very small quantities of chlorides normally and thus the urinary chlorides indicate the chloride excretion for all practical purposes. In all soluble animal ash too sodium chloride is the chief salt and the quantity of sod. chlor. in the blood in the healthy state varies within very narrow limits as shown by Lehmann and others.
The average total amount in the adult human body is given by Schäfer as about 200 grammes and the average excretion by the kidneys as about 16 grammes daily in health. Normally however other factors besides the amount ingested in the diet occur as we shall see below - also pathologically the variations are very striking indeed.

The microscopic characteristic of sod. chlorid crystals are - in an aqueous solution regular pyramidal cubes but in urinary solutions octahedral and tetrahedral forms are also met. These irregular and varying formations also occur in the presence of most organic matter especially if the crystals formed are small.

Chemically sod. and other urinary chlorides are readily soluble in water, have a saline taste and
form a white precipitate with silver nitrate solution (of the chloride of silver).

Mohi's method of testing the daily quantities by solution of silver nitrate of known strength gives very satisfactory results and is the method used in my own calculations, for a description of which, vide (Hutchison and Rainy's "Clinical Methods", 1900, p. 279).

By this method I find 14 grammes daily as a fair average in health in the adult. Hutchison and Rainy (as above) give 12 grammes as their average and probably this and other differences are due to selection of different classes of patients or subjects and to personal variations in the definition of the end point in the testing process.

A. The Variations of the chloride excretion (in the urine) in health are very interesting indeed and a few will now be given below.
Chlorine amount in the diet is the main factor in causing variations and thus the chlorides excreted vary directly with the chlorides ingested in health as a rule. Tallek found that after eating salted food a gradual increase of the chlorides in the urine occurred and with a saltless diet the converse was the result. Also after the addition of a quantity of salt (not an excess) to the diet the hourly excretion of chlorine was increased in one subject from 4 to 1 and in another to 18 grammes. Schaefer says that if sod. chlor. is withheld the tissues retain their sod. chlor. tenaciously and this salt thus is excreted very slowly. If excess of salt on the other hand is given sometimes this is excreted in large quantities rapidly in others in small
quantities slowly. On ingestion in addition to my ordinary diet of 24 ounces of sodium chloride daily for a week I got the following results, in two experiments.

<table>
<thead>
<tr>
<th>Time</th>
<th>Before</th>
<th>1st Day of Salt-Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>2h</td>
<td>13.6g</td>
<td>14.8g</td>
</tr>
<tr>
<td>3h</td>
<td></td>
<td>14.6g</td>
</tr>
<tr>
<td>4h</td>
<td></td>
<td>15.4g</td>
</tr>
<tr>
<td>5h</td>
<td></td>
<td>15.8g</td>
</tr>
<tr>
<td>6h</td>
<td></td>
<td>15.6g</td>
</tr>
<tr>
<td>7h</td>
<td></td>
<td>16.2g</td>
</tr>
</tbody>
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Next day without salt-addition: 14.4g

Before taking salt addition 13.6g of salt daily were excreted

2h Before: 14.8g
These results vary very much indeed and the fact that other factors than amount ingested are of importance can never be forgotten. Thus addition of salt to the diet increases the thirst but some days I had more opportunities than others for experiencing this.

Barlow gives some very good observations with measured intakes of chlorine too. By reducing the amount of salt in my diet as much as possible by forbidding addition of common salt in cooking and by abolition of table salt for three days I found that the daily amount of chlorides 13 grammes became on first day decrease clay 12 grammes 2\textsuperscript{nd} " 6\textsuperscript{th} " 3\textsuperscript{rd} " 6\textsuperscript{th}5 " 4\textsuperscript{th} " next day with ordinary diet chloride amount rose to 10 grammes and on next to 11 grammes only.
Potash salts in the diet vary the chloride excreted and Bunge pointed out that sod. chloride was necessary in all diets which contain much potassium e.g. many vegetable diets. Thus many herbivores travel miles to the salt licks but the (human) vegetarian of today varies his vegetables so that many use neither cooking salt nor table salt to retain excellent health and vigour.

Bunge found experimentally that chlorine was increased in his urine on addition of a potash salt to his diet. Thus 18 pms of K$_2$O as phosphate or citrate caused the loss of an extra 6 pms. of sod. chloride. In his lectures he says that when pot. carb. say meets sod. chloride in the body or in solution a partial exchange occurs some pot. chloride and sod. carb. being formed. This pot. chloride is then
excreted and represents loss of extra chlorides.
I found a marked increase in my own chloride excretion when taking pot. citrate too. In a vegetarian athlete who used no cooking or table salt I found a daily average of 10 grammes chlorides only but the subject was then leading a very sedentary life.

Water in quantity in the diet excites the kidneys and the uraquine and chloride amounts are all increased temporarily.

Thus one subject drank 4 glasses of water in evening and the hourly average of chlorine which was usually .13 pm. night rose to .6 in first few hours and then fell to .12 and later to .1. In the morning before breakfast a ride was taken and the average rose to .5 gms. again. Thus we see that the chlorine in the food is not by
any means the only cause of the chloride excretion's variations but anything which increases renal activity seems to act similarly: e.g. as above - i.e. water in quantity. Exercise, I obtained a similar result. After drinking with my ordinary diet; 1 quart of water I found the daily amount of chloride excretion rose from 13 gms. to 16 gms and with ordinary diet fell next day to 11 gms. rising again on the following day to 14 gms.

Chromally also there are variations in the chloride excreted within the 24 hours and maximum occurs in afternoon, and minimum during the night. Thus Hegar gives mean hourly chloride excretes as:

- .57 in afternoon
- .28 at night
- .48 in forenoon.
So Hegar found that a night
brain worker had larger chlorine hourly excreted during night than by day.

The probable explanation of the afternoon average chlorine excreted may be the increased chlorine ingestion during the mid-day meal.

Thus two hours after lunch I found I excreted about the same quantity of chlorine as 2 hours after (evening) dinner. Hegar found that the forenoon hourly chlorine could be made greater than the afternoon by feeding the subject on salted meat on the evening before. Thus during the night the body must have contained an excess of chlorine and some factor being added in the morning this was got rid of in the forenoon. This factor is most probably exercise and coincidently with the chlorine increase we
find that exercise causes urine & urea increase also. Conversely during the rest of mind, body and circulation during the night the chlorine even in excess is very slowly excreted during the night.

The personal factor cannot be neglected in these estimations and different people show differences in their chloride excretion.

Bishoff's results vary from 8.64 gms. dd. Chlorid daily to 24.84 gms, and his daily average is 14.73 gms.

Ages Sex:
Bishoff also gives as mean daily chlorides for well fed man 8.78 gms.

" (act. 43) woman 5.5 "
" (act. 16) boy 5.3 "
" (act. 18) girl 4.5 "
" ( 3 ) boy .80

Hegar's mean daily chlorine excrete is 10 gms (6.76.5 gms female)
We must regard these differences as due to diet, habits, etc., and perhaps to constitution and idiosyncrasy. Thus in health many indeed are the points to be eliminated before the excrete of one subject can be compared at all with that of another. My own average is 14.8 mgs. Sod. Chloride daily as noted before in healthy adults' urine.

Now let us consider the very numerous and striking variations found pathologically. In almost all acute diseases there is found a constant decrease of the Chlorine excrete during the increase of the disease and an increase of the Chloride excrete usually indicates a decline in the disease. Thus if the Chlorine excrete goes below 15 grains daily the disease is very intense indeed unless
there is loss of chlorides otherwise
as into large exudation into
a serous cavity or by copious
diarrhoea.
After any chloride decrease in
disease an increase thereof
can therefore, other things being
equal, as a rule be used as
a favourable prognostic sign
and improvement in appetite
and digestion follow.
Thus too in chronic diseases
the amount of chloride excreted
indicates fairly truly as a
rule the state of the digestive
functions and anything between
10 and 15 grammes daily of
Sod. Chlorid. can be taken
to indicate no great
interference
with digestive processes.
If the Sod. Chlorid. excreted on
the other hand falls below
5 grammes and the chlorine
in the diet is in usual
amount and no great losses
of chlorides in exudations or
in watery stools are occurring
then general metabolism is
considerably upset.
In hydropenia and dropsey
similarly increase of the
chloride excreted after a fall
thereof is of great prophetic
value as a favourable sign.
Let us first look at some of
the conditions in which
I. decreased chloride elimination
occurs pathologically

In all cases of
infection and
starvation there is decrease in
amounts of all excreta and
urine urea and chlorides par-
ticipate in this. In faulty
metabolism due to improper
assimilation of food a similar
result occurs, and the blood
retains its chlorides tenaciously
evidently to keep up to the
normal standard amount.
Indeed the amount of chloride
excretion forms a very fair
gauge of the condition of the
digestive and absorptive processes.

In all acute febrile diseases there is a marked decrease in the elimination of chlorides as long as the disease is progressing. During retrogression of the disease and in convalescence the reverse occurs.

The "febrile state" seems to influence these changes and change to a less salty and febrile diet is not the whole cause thereof.

There is one notable exception to this rule: viz. - malarial fever, in which the rule is entirely reversed. Here the chlorides increase during the fever and decrease thereafter.

(1) In lobar pneumonia this decrease of chlorides is most marked and almost complete absence of chlorides frequently occurs. Thus on the 7th day of illness I found in an adult male 9 mns. Hall 5th " 6 mns. "
on 6th
7th
Crisis day
next

now let us consider why there should be such a very marked decrease in the chloride elimination — in all feverish states usually there are —

i. Loss of appetite
ii. Saltless kinds of food

iii. Decrease of urine amount

Should necessarily suggest decrease in chloride amount.

In pneumonia further there is marked exudation of fibrinous material into lung alveoli and considerable chlorides may be thus lost.
temporarily, to return later in excess. Robt. Hutchinson's recent researches seem to show that a true retention of chloride within the body takes place in eponous pneumonia.

The feverish state itself seems to Schaper to exert a specific effect on chloride retention, but no satisfactory explanation of this phenomenon has yet been given, he says. (3) Cf. acute pleurisy with effusion or empyema.

Offer directs attention to the diagnostic value of the absence of chloride in eponous pneumonia as compared to decrease only in the above two conditions. During the increase of the pydurations there is marked decrease in chloride excreted while the reverse holds good during reabsorption of prognostic value would
be found. The increase of chlorides found and in doubtful cases of post-pneumomial empyema in young children after one or more paracenteses the chloride estimation must be of considerable value. How much the decrease in chlorides is due to want of appetite, altered diet and feverishness might be estimated by repeated examinations after and before operations for empyema. I have only one estimation of my own but in this the chloride amount in a child aged 3 with empyema was 8.39 gms. daily only on first day examined and next “1 only. I withdrew 18 ozs. of non-purulent pus containing pneumo-
 cocci with aspirator and for next 24 hours amount of chlorides was still 1.
next day it was 2gm
1.4 1.2 1.2

The child rapidly improved & burns. Later, daily chloride was 1.2 gm. again.

1. In bronchitis bronchopneumo-

onia in children I find a very marked diminution
of chloride too and regard the variations as of pro-

nostic rather than diagnostic

value here just as in empyema

pleural effusions etc.

2. In typhus similarly complete

absence of chloride has been noted by Vogel

and so in typhoid very

marked decrease is seen.

The total urine amount
also falls with the progress
of these as with most

fevers and this acid chloride

decrease are certainly

of some aid in prognosis.

1 have from time to time
been suggested thus.

1. In acute yellow atrophy of the liver Butler says that 0.05p. chloride in 24 hrs. indicates a very serious condition of affairs indeed and includes under diseases with decreased chloride elimination—excessive diarrhoea (here the watery stools contain much chlorine), anaemia, nephritis, chronic plumbism, chorea, melancholia (marked decrease) gastric cancer, gastric ulcer with hyperchloremia and hypersecretion (chlorides may be absent), most cases of albuminuria and large effusions.

2. In increasing dropy or hydroaemia urine amount and chloride amount fall very considerably— the reverse occurs as the conditions improve (vide below).
Increased chloride elimination occurs pathologically also on the other hand in many condi-

1. In Malaria as we observed before, during the feverish stage the chloride excrete is actually increased and sometimes to a remarkable extent while it falls again between the attacks. Thus Vogel gives several very excellent examples of the hourly amount of soda chloride being increased 50 times even in one case and rapidly falling below the average after the feverish stage. Thus it would seem that increased temperature alone cannot determine the chloride decrease in all fevers and the cause of causes seem quite unknown at present.

During the intervals of
feverishness of course the appetite and digestion are usually good and moreover during a rigor the blood pressure being high causes greater activity of the kidney, hence here we at present must look for the causation of such an increase of chlorides even although the patient is feverish. As we noted above too there is a very marked increase of the chloride excreta in resolution stages of pneumonia during convalescence from most fevers and during absorption of exudations.

In diabetes insipidus Butler points out that a persistent increase of chlorides is constant. In Early General Paralysis of the Insane this persistent increase also occurs he says. Butler also observes an increase
in prurigo and in the post-
convulsive stage of epilepsy.
In these varied conditions,
of the cause of the chloride
increase little is known
and no satisfactory explan-
ation of this can be at
present given.

In _diuresis_ in _hydroemia_
the chloride amount increases
as the urine amount does
and seems to have some
important determining
relation thereto.

In a case of _hydroemia from_
cardiac failure due to
stenosis of the mitral
valve without the addition
of any extra chloride to
the diet a patient of
mine (female, aged 45)
excreted under digitalis and
diabetes, 30 gms of sod.
chloride in 24 hours, the
amount the day preceding
being only 6 gms.
It has been shown by some writers that the question of chloride ingestion and retention bears a very important and determining relation to the production of anaemia as this example too shows. Moreover, it has also been demonstrated that increased ingestion of chlorides during health causes a proportionate increase in the body weight, evidently due to an extra retention of water to dilute down the circulating chlorides to their constant and natural strength in solution.

That an isotonic state of chlorides in the tissues exists has been fully proved and thus the explanation of this retention of more fluids is simple enough, but as soon as
the excretory organs can, this excess of water and of chlorides is got rid of. With normal kidneys then a hypertonic state of chlorides except a very very temporary one is impossible.

In the B.M.T. of May 20th/05 Dr Dixon Mann summarises the main theories on this question of hypertones. Thus Bidal and Faval assert that sodium chloride is first retained and forms a prescedematous stage in anaearea. By hydration to reduce the saline hypertones oedema is produced.

Haplenz describes three stages of chlorine retention due to renal incompetence.

1st: a prescedematous stage when sod. chloride alone is retained

2nd: a Stage of latent oedema when the diluting water
is also retained but no visible oedema results for a time till the 3rd stage of visible oedema results.

H. Strauss believes that SOD. Chloride is retained first and water secondarily, the former due to renal defects.

Koziczkowski moreover asserts that SOD. Chloride does not follow the rules for excretion that other urinary salts do.

Widal & Tavol think that there is a special function in the elimination of SOD. Chloride and go on to prove that this chlorine-excreting function may be upset while the excretion of other salts may remain perfect.

Marischler on the other hand asserts that water is kept back first and secondarily retains the salts.
While Mohr asserts that there is no relation whatever between water retention and sod. chloride retention, Aehard and Cooper while recognising a retention of chlorides in nephritis think this is due to causes similar to those acting in pneumonia and the fevers &c. while experimentally this view is supported somewhat by Rumpf.

Dr. Mann believes as a result of experimentally adding varying amounts of chlorides to the diet that there is no constant relation between the amount of salt retained and the course and extent of the oedema. Though hesitating thus to attribute the increasing of the oedema to sod. chloride retention he is quite ready
to grant that the oedema of Bright's Disease can be greatly controlled by the salt amount in the diet in some cases, a few of which he describes. He found too that with the decrease of the dropy increase of the chlorides in the urine as well as the total urinary amount after or due to decrease in the dietetic chlorides, a proportional decrease in body weight occurred just as was noted in health. Widal & Lemiére observed several cases of nephritis who were taking large doses of sod. chloride and found that oedema resulted or was very greatly increased only in parenchymatous cases, those of interstitial nephritis escaping. They observed that in the latter too the extra
Sod. chlorid. ingested was rapidly excreted while in the former the sod. chlorid was retained to a great extent. Thus they thought that in some cases of nephritis (e.g. these parenchymatous ones) the kidneys were unable to excrete the sod. chlorid in excess; hence a hypertonic state of chlorides resulted till sufficient water was ingested and retained to reach the state of isotonic which they stated as about .9% NaCl. Gamble \(^\text{13}\) records a case of parenchymatous nephritis in which very marked improvement in the anasarca occurred by omitting salt from the diet although the urine continued to contain albumen. He also observed that subcutaneous
injection of normal saline solution embarrassed the patient and certainly had no diuretic action.

G. Lambeili gives some very interesting cases of the beneficent action of removal of salt from the diet in various conditions. In a case of parenchymatous nephritis his experiments are most lucid and remarkable and show that addition of salt to the diet caused increase of oedema and body weight while the reverse occurred on decreasing the diuretic salt. The second addition of salt to the diet again threw the patient back while the progress was again checked by similar means.

He also recommends decrease of diuretic salt in oedema.
of cardiological origin, and finds a similar chloride retention in ascites of hepatic origin for which he recommends the same treatment. Peritoneal effusions from tuberculosis and serofibrinous effusions of pleurisy he also shows are benefited by decreasing the chlorine in the diet. Dr. Bryant records the case of a medical friend whose oedema was evidently due mainly to excessive ingestion of salt in his diet (300 to 600 grains daily) the cure of which oedema was rapidly accomplished by decreasing the chlorides in the diet.

Amidst the conflicting opinions about chloride ingestion and retention and their relation to the production
Oedema there is a very
fair census of opinion
in favour of these being
cause and effect but
much has yet to be
done to elucidate the
why and the wherefore
of many of these freed-
ing variations in the
excretion of chlorides
which I have attempted
to describe here.
References:

6. Analysis of Urine, Neubauer & Vogel (transl.) p. 397.
10. Analysis of Urine, Neubauer & Vogel, transl. p. 399 et seq.
Il Morfagni, May 7, June, 1905.

Practitioner, Aug, 1905.