Acta Medica Scandinavica. Vol. CXIX, fasc. VI, 1944.

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The Value of Ascorbic Acid as a Prophylactic against »Common Colds».[1]

By

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(Submitted for publication August 25, 1944).

Introduction.

The so-called catarrhal infections are, from a medical viewpoint, generally not of a serious nature, even though lengthy and serious diseases may ensue in a number of cases. However, the great frequency of these infections entails the loss, wholly or in part, of a considerable number of working-days within schools, at places of work, and in military camps. Such infections are consequently very important from social and military viewpoints.

A not uncommon opinion nowadays is that the increased frequency of catarrhal complaints during late winter and spring is associated with an increased receptivity to infection, due to hypovitaminosis and certain other nutritional derangements. Experiments on animals and clinical observations bear out the widespread view that Vitamin C possesses bactericid and some kind of immunobiological properties, and can therefore be regarded as

[1] A preliminary report of this work was published in Nordisk Medicin, 1942, 14: 1616.

We beg in the first place to thank Kungl. Armeforvaltningens Sjukvårdsstyrelse for affording us the possibilities of making this investigation. We have furthermore received support from Apotekarnas Kemiska Fabriker A. B. Astra, who also placed tablets at our disposal. Finally, we have also received support from the Regnell Fund of the Medical Faculty at the University of Upsala. For all this assistance we beg to tender our warm thanks.

an anti-infectious vitamin. Other authors do not think there is sufficient support for this view; the increased receptivity to infections attendant on clearly manifested Vitamin C deficiency is probably not caused by the vitamin itself, but by the decline in the body's powers of resistance, a state which characterizes nutritional derangements in general. The problem is not easy to solve, since in practice an inferior diet is, as a rule, inadequate in more than one respect, even if a deficit of one constituent may dominate. For the extensive literature on the subject, we refer to text-books and general articles (Stepp, Kühman and Schroeder, 1939; Bichnell and Prescott, 1942; Seidenstücher, 1943; and others).

The extent to which a mild C hypovitaminosis (or, more correctly, perhaps, mixed forms of hypovitaminosis, where the lack of Vitamin C dominates) occurs in Sweden has not been sufficiently clarified, no doubt due to the difficulty of diagnosing with certainty an incipient lack of this kind. Investigations have yielded divergent results, which are difficult to interpret; in most cases the materials were small, the control material inadequate, and the statistical treatment unsatisfactorily carried out.

At the time our investigation was planned (1940), this ambiguous situation was being more and more exploited commercially. The advertisements for medicines and patent foods not infrequently cited publications where more or less over-hasty conclusions had been drawn.

We therefore thought ourselves justified in examining afresh the question as to the value of ascorbic acid as prophylactic against catarrhal infections; in so doing we have endeavoured to obtain a sufficiently large material and satisfactory control-material, and sought to apply suitable statistical methods.

Our investigations were completed in 1940 and published in a preliminary form in 1942; since this time, others dealing with the same questions have appeared. Most of these have been made without controls and on too mixed a material for the results to have any crucial value. The following works in particular should be of interest to our approach.

Demole (1943) gives a general survey of the C hypovitaminosis observed in different armies, and suggests that the deficiency be met by daily administration of 25 mg of synthetic ascorbic acid per person during the winter and spring months. Data collected by

Roff and Glazebrook (1939) from the English Navy shows a C deficiency of up to 4 g. Reports as to the Vitamin C standard in the German army show there to be a deficiency varying between 1.1–3.6 g (Stutz and Reil, 1938; Kramer, 1937; Stutz and Weispfenning, 1939; Kraft, 1940). According to an investigation by Sobecki (1939) the C deficiency for the Polish army amounts to about 2.0 g. As far as we have been able to discover, no controls were used in these investigations to establish whether the Vitamin C deficit proved detrimental to the persons in question. Obviously, it is this question which is of crucial importance.

Bergquist (1940) found reason to suspect that a combination of ascorbic acid and quinine prevents catarrhal diseases. Hamne (1941) disagreed with this and Bergquist (1943) later on took up the question for fresh testing. This time his material comprised 855 males aged 20—60 years, employed at a Swedish ironwork. Of these, 136 were controled, and received tablets without ascorbic acid or quinine. 141 persons received a daily dose of 9 cg quinine sulphate, 128 received 9 cg ascorbic acid, and the remaining 146 workmen were given 9 cg quinine sulphate + 9 cg ascorbic acid, all in tablets. The investigation proceeded for 3 months under as similar experimental conditions as possible for the different groups, and the results were treated statistically at the State Institute for Human Genetics and Race Biology. The investigation showed that, neither with nor without quinine, does Vitamin C have any prophylactic effect in catarrhal complaints.

As against this result there is an investigation carried out in Holland by Oskam (1942) on 392 factory-workers. Oskam used exactly the same division of the material into 4 groups, and the same dosage of ascorbic acid and quinine, as did Bergquist.

A statistical treatment by us of the figures, Oskam submitted for the number of cases of disease within each group, shows that only the combination 'Vitamin C + Quinine' had a statistically significant difference. On the other hand, the effect on the number of working-days lost was statistically significant within all 3 groups receiving respectively ascorbic acid, quinine and ascorbic acid + quinine, when compared with the control-group. The divergent results thus obtained by Bergquist and Oskam might perhaps be explained by the different standards of nutrition probably existing in Sweden and Holland during the war years.

Hjärne (1942) investigated the concentration of Vitamin C in the blood plasma of Swedish schoolchildren aged 7—14 years. No difference could be found between boys and girls, or between the different ages. The highest values were obtained in October, and the lowest in April—May. There was no connection between the number of cases of disease and days of absence, and the vitamin concentration.

Hammar and Schröderheim (1942) investigated 1000 elementary-school children for the effect of dog-rose hip extract on catarrhal infections. During the period February—June 1941, 500 children were given hip extract in apple-juice (corresponding to 50 mg of ascorbic acid per day), while the remaining 500 only received apple-juice. No difference could be observed between the two groups as regards the frequency, intensity or length of common colds.

Korbsch (1938) claimed to have obtained good results from treating colds with large doses of ascorbic acid (1 g daily); however, he got just the same result from the control group, which were given inactive tablets containing citric acid. Glazebrook and Thomson (1942) were similarly unable to observe any decrease in the intensity or course of common colds after the administration of Vitamin C.

Comprehensive investigations were carried out in Germany during the winters of 1941 and 1942, to discover the effect of extra administration of ascorbic acid (Ertel, 1941, 1942). The investigation comprised 3—4 million people (expectant and nursing mothers, infants and schoolchildren) whose diet had been supplemented by ascorbic acid for more than 5 months. The results showed increased powers of resistance to infection in the infants; the mothers showed less sickliness, better appetite and more milk when nursing, and the schoolchildren showed improved output of work, and less colds. Unfortunately, it has nevertheless been impossible to carry out the investigation satisfactorily, i.e. with control groups of persons not receiving extra ascorbic acid. The results are based mainly on the subjective judgments of the test subjects, and the conclusions are also of a subjective nature.

Plan for the investigation.

In the first place, a Vitamin C deficiency is to be expected in Sweden during the late winter and spring. Further, the popula-

tion in the most northerly parts ought to be more exposed to such a deficiency than the population in the rest of Sweden. For this reason our investigations were arranged to cover the period February-May 1941, and the material taken was an infantry regiment stationed at an isolated region in northernmost Sweden, some Swedish miles south of the Arctic Circle.

The regiment went to the camp in question round about 15th January. The material comprised about 2,500 men, most of whom came from upper Norrland. The investigation did not include officers, non-commissioned officers, or persons who had left the camp before March 24 for reasons other than illness.

The diet was the regular one for troups stationed in Northern Sweden, but also including 4 g of skorbon per week. Two weeks before the experiments began, the skorbon and food containing hip was left out, and all the skorbon on the premises withdrawn. The provisions sold at the canteen were placed under control, ensuring that no Vitamin C worth mentioning was supplied through .this channel.

As the primary aim of our investigation was to establish the value of ascorbic acid as prophylactic against colds, it may well have been practical to have rendered the normal diet poor in Vitamin C, thus producing a considerable difference in the Vitamin C standard between the control group and the group receiving an extra supply of ascorbic acid. In order to obtain an answer to the vexed question as to whether so-called normal military fare in Sweden is sufficient to keep the troup at a desirable Vitamin C standard, or whether the addition of extra ascorbic acid might decrease the frequency of colds while raising the general condition otherwise, we nevertheless thought it wisest to alter the fare of that time only as regards the remedy skorbon and hip. It would seem from a study of the feeding list (Suppl. 1—4) as if the content of Vitamin A is relatively low. A year later, Engel, Granström, Lindgren and Nordlander (1942) made investigations comparing the Vitamin A standard of soldiers with practically the same fare as the one we used (1700—1800 I.U. Vitamin A), with that of soldiers receiving in addition an extra supply of 3,700 I.U. Vitamin A; the results obtained showed both groups to present normal serum values for Vitamin A and for B carotins and that both the groups had normal ocular perceptivity, both at the beginning of the

test period and at its termination, 24 days later. Thus, the Vitamin A standard maintained by the fare used by us can be denoted normal.

The administration of ascorbic acid was begun on March 3, and continued to May 31 inclusive. On account of the special circumstances,, we were in a position to obtain control material which is completely suitable from a statistical viewpoint. All soldiers with odd identity numbers were given tablets containing ascorbic acid, and soldiers with even identity numbers were given control tablets, to which a suitable amount of citric acid had been added, to disguise any difference in taste. The tablets were kept in bottles with yellow and blue labels respectively, and their composition was kept secret both from doctors and soldiers. The tablets were dispensed at the first meal of the day, and special steps were taken to see that they were consumed there and then, and did not go to the wrong person. The soldiers were told what the investigation was for, and w[r]ere requested not to eat any other food or other medicines during the time of observation than what was provided in the camp. The ascorbic group, who were put on 'yellow' tablets, received 200 mg of ascorbic acid daily during the first 24 days, and 50 g during the whole period of observation subsequently. The control material received a corresponding number of citric acid tablets.

A registration card was drawn up for every soldier who fell ill; on this, necessary data as to the disease were entered (see below).

Ascorbic acid titrations with loading tests were made according to a modification of the Tillman test. In addition, capillary resistance tests were carried out according to Dif's (1940) modification of Göthlin's procedure, which proved most suitable for our working conditions.

We should have liked to have obtained a more exact gauge of the Vitamin C standard by more thorough means, e.g. ascorbic acid titrations *on* blood, but the military field conditions made such plans completely unfeasible. The results we obtained nevertheless give relative values for a comparison between the 'control[5] and the Vitamin' groups, and these values seem to bear out the conclusions we have drawn.

Professor G. Westin has been good enough to make a histopathological investigation of teeth extracted from this soldier mate-

rial. His material" is too small to allow of definite conclusions, but it nevertheless seems as though this method were not fitted for assessing the Vitamin C standard in investigations of the kind in question. The histo-pathological diagnoses did not agree in a number of cases with the real character of the individuals — we have therefore considered it unnecessary to publish the data here.

Results of the investigation.

a) Ascorbic acid titrations.

After 23 days, when the 'yellow' soldiers had received a total of 4,600 mg of ascorbic acid, the titrations showed a mean reduction value for urine of on fasting 3.5 ± 0,87, and one of 13.4 ±2.4 two hours later, after a further 200 mg. The difference was thus 9.9±2.6, and may be denoted statistically significant. The corresponding values for the controls were 1.1 ±0.13 and 1.1 ±0.12. There is also a statistically probable difference between the fasting values for 'yellow' and 'blue' subjects (i.e. 2.4±0.89).

In so far as ascorbic acid titrations of urine can be assumed to constitute a gauge of the Vitamin C standard, we were thus able to establish a material difference in these standards between the ascorbic acid group and the control group. According to the current opinion, the controls can probably be presumed to have been suffering from a considerable Vitamin C deficit at the time of the investigation.

Despite precautions, there were periods after April 6th when several companies, or some proportion thereof, in certain camps did not always take the tablets regularly.

In the treatment of the material, therefore, we divided it up into two groups: Group I, where, as far as we could ascertain from careful checking, the soldiers had taken the tablets regularly the whole time, and Group II, where most of the soldiers had in all probability taken the tablets for the greater part of the observation period, but only *regularly* during the time 3/3—6/4. However, the material in Group I was sufficient by itself to yield statistically significant results.

At the end of the test period ascorbic acid titrations were made with loading tests. These latter were begun on May 21 with 300 mg of ascorbic acid daily. On May 26, the difference between the

fasting values and the reduction values two hours after taking the tablets was, for the 'yellow[5] soldiers, probable and, on May 30, it was significant (Difference: 12.6±2.8). The corresponding difference for the 'blue' controls did not show even a tendency to become probable (Difference: 1.5 ±1.3).

Summing up, then, we can say that, in so far as one can judge from ascorbic acid titrations, there was a significant difference as regards the Vitamin C standard, both during the first part of the observation time and at its termination.

b) Capillary resistance tests.

The capillary resistance tests were carried out at the end of the observation period on 127 'yellow' subjects and 124 'blue' controls. The average number of petechiae were 4 for the former, and 6.2 for the latter, with a statistically probable difference. The difference is slight, however. The results are outlined in diagram 1. Only 5 men had more than 20 petechiae, namely 2 'yellow' sub-

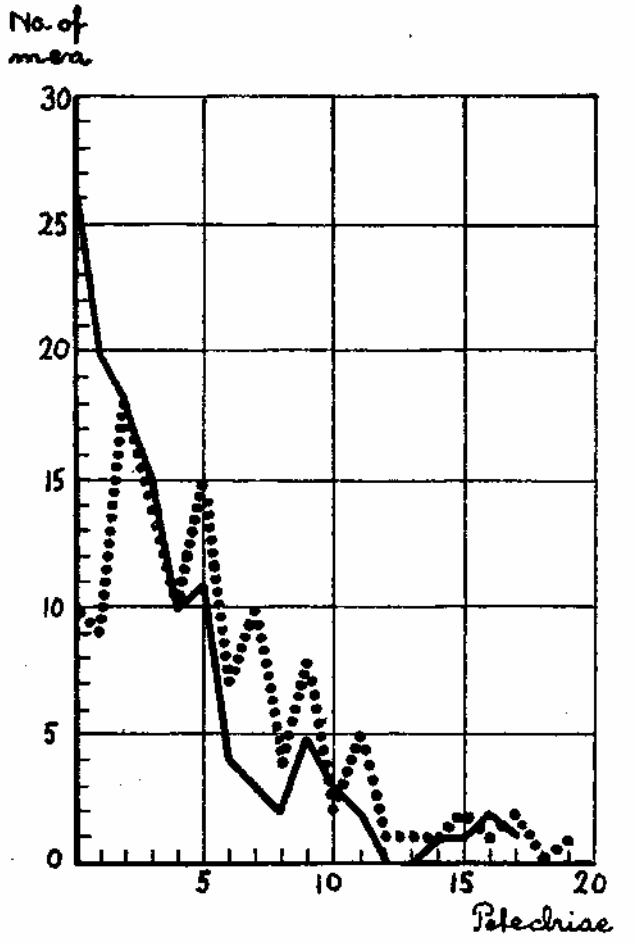

Diagram 1. Distribution of number of petechiae at capillary resistance tests on 127 men who got ascorbin acid (whole line) and 124 men who did not get ascorbin acid (pointed line).

Table 1.

Registered cases of disease.

	Group I		Group II	
	Ascorbic acid cases	Control cases	Ascorbic acid cases	Control cases
All persons	526	545	733	721
Registered cases of disease	77	82	68	80
Diseased persons	68	74	63	68
Diseased at least twice	7	8	5	10
of these not reg. as ill	4	5	2	6
reg. as ill	3	3	3	4

Table 2.

Number of persons with »common colds» distributed with regard to the state of the disease and fever.

	Group I.				Group II.			
	Ascorbic acid cases		Control cases		Ascorbic acid cases		Control cases	
	n	%	n	%	n	%	n	%
All persons	526		545		733		721	
Diseased persons	63	12.0±1.4	65	11.9± 1.4	63	8.6±1.0	65	9.0±1.1
State of disease:								
not reg. as ill	19	10.2±5.8	20	30.8±5.7	17	27.0±5.6	16	24.6±5.3
reg. as ill	44	69.8±5.8	45	69.2±5.7	46	73.0±5.6	49	75.4±5.3
Fever:								
none	29	46.0±6.3	28	43.1±6.1	27	42.9±6.2	29	44.6±6.2
slight	26	41.3±6.2	29	44.6±6.2		47.6±6.3	31	47.7±6.2
moderate	7	11.1	6	9.2	2	3.2	1	1.5
high	1	1.6	2	3.1	3	4.8	2	3.1
unknown	—	—	—	—	1	1.6	2	3.1
The case is labelled as:								
mild	54	85.7±4.4	50	76.9±5.2	54	85.7±4.4	57	87.7±4.1
medium-severe	5	7.9	6	9.2	4	6.3	2	3.1
severe	—	—	1	1.5	1	1.6	—	—
unknown	4	6.3	8	12.3	4	6.3	6	9.2

Table 3.
Highest temperature observed during the disease.

	Group I		Group II	
	Ascorbic acid cases	Control cases	Ascorbic acid cases	Control cases
Number of cases	55	65	55	57
Temperature in ° C	37.7 ± 0.1	37.9±0.1	37.8±0.1	37.8±0.1

jects (28 and 51 petechiae respectively) and 3 'blue' (23.39 and 75 petechiae respectively). As the curves show, it looks as if the control material did not have very many individuals with 0 and 1 petechia, whereas those with a moderate number (more than 4) were rather more numerous. No significant difference up towards clearly pathological values can be established, however.

Table 4.
Number of persons with other acute infections distributed with regard to the state of the disease and fever.

	Group I		Group II	
	Ascorbic acid cases	Control cases	Ascorbic acid cases	Control cases
All persons	526	545	733	721
Diseased persons	5	8	—	2
State of disease:				
not reg. as ill	—	1	—	—
reg. as ill	5	7	—	2
Fever:				
none	2	3	—	—
slight	—	2	—	—
moderate	2	2	—	1
high	1	1	—	1
unknown	—	—	—	—
The case is labelled as:				
mild	3	5	—	—
medium-severe	2	3	—	1
severe	—	—	—	—
unknown	—	—	—	1

Table 5.

Number of diseased persons distributed with regard to the state of disease and fever.

	Group I				Group II			
	Ascorbic acid cases		Control cases		Ascorbic acid cases		Control cases	
	n	%	n	%	n	%	n	%
All persons.....	526		545		733		721	
Diseased persons	68	12.9±1.5	73	13.4±1.5	63	8.6±1.0	67	9.3±1.1
State of disease:								
not reg. as ill	19	27.9±5.4	21	28.8±5.3	17	27.0±5.6	16	23.9±5.2
reg. as ill ..	49	72.1±5.4	52	71.2±5.3	46	73.0±5.6	51	76.1±5.2
Fever:								
none	31	45.6±6.0	31	42.5±5.8	27	42.9±6.2	29	43.3±6.1
slight	26	38.2±5.9	31	42.5±5.8	30	47.6±6.3	31	46.3±6.1
moderate ..	9	13.2	8	11.0	2	3.2	2	3.0
high	2	2.9	3	4.1	3	4.8	3	4.5
unknown	—	—	—	—	1	1.6	2	3.0
The case is labelled as:								
mild	57	83.8±4.5	55	75.3±5.0	54	85.7±4.4	57	85.1±4.4
medium-severe	7	10.3	9	12.3	4	6.3	3	4.5
severe	—	—	1	1.4	1	1.6	—	—
unknown	4	5.9	8	11.0	4	6.3	7	10.4

c) Morbidity investigations.

We have studied the frequency and course of certain acute infectious conditions in the two groups.

Our intention was in the first place to carry out a statistical treatment of the groups of diseases which can be covered by the heading 'catarrhal complaints', to which we assign: 1) Acute infection of the upper respiratory tract (rhinitis, pharyngitis, laryngitis, tracheitis); 2) Angina tonsillaris; 3) Bronchitis; 4) Pneumonia; 5) Sinusitis; 6) Otitis. We further noted certain other acute diseases of an infectious nature, such as parotitis, vulneral infections, etc. A record was also made of whether the patient was feverish, and to what extent, as also the highest temperature observed during the

Table 6.

Partakers in competition and result of individual field competition.

	Ascorbic acid cases		Control cases	
	Number	Median[1]	Number	Median[1]
Group I				
All persons	526		545	
Number of partakers	167		187	
» » » , %	31.7±2.0		34.4±2.0	
of these 1. comp.	48	50.0	48	48.5
2. »	54	49.0	48	52.0
13. »	50	62.5	72	61.5
1. plutoon	15	15.0	19	18.0
Group II.				
All persons	733		721	
Number of partakers	190		172	
» » » , %	25.9±1.26		23.9±1.6	
of these 4. comp.	59	57.0	51	53.0
5. »	42	39.5	35	37.0
6. »	34	33.5	32	33.5
8. »	55	56.0	54	50.5

[1] Median signifies the position wich half of the partakers exceeded and half did not attain.

illness. When the period of illness was over, the physician noted down whether he considered the case slight., mediumly serious,, or severe. Finally, we registered the number of days the patient was on the sick-list, and how many days, if any, he had been treated in hospital.

When assessing how severe the individual case and the fever are, a certain subjectivity inevitably creeps in, but since the physician did not know to which group the case belonged, and as he examined all cases from both groups, the materials should be comparable.

There were no cases of epidemic influenza during the period of observation. The different kinds of other diseases have each been grouped separately, but field conditions did not permit of sufficiently certain diagnoses to allow of statistical treatment. In any case, the number of cases in the different groups was too small.

An analysis of the material yielded the following results:

In Group I (where the tablets were taken regularly during the entire period of observation) catarrhal infections were contracted by 12.0 ±1.4 % of the 526 soldiers given 'yellow' ascorbic acid tablets, and by 11.9 ±1.4 % of the 545 soldiers given 'blue' control tablets. No probable or significant difference between 'yellow' and 'blue' soldiers was to be observed, as regards the character of the fever (tables 1—3). Statistically, the agreement is good.

Over half the cases of illness consisted of acute infection of the upper respiratory tract. The distribution was the same in 'yellow' and 'blue' subjects. As regards other diagnoses, the number of cases was every time too small for statistical treatment; no noteworthy difference was to be observed, however (table 4).

The above conclusions on Group I also apply to the soldiers belonging to Group II; that is to say, those who only took the tablets regularly for the period March 3—April 6.

The tables show that we were in no respect able to obtain any difference for the frequency and course of the registered diseases between the soldiers receiving ascorbic acid and the controls.

d) Testing of the general condition of the soldiers.

With a view to obtaining an idea of the physical and mental condition of the soldiers, we collected the results from individual field competitions for the two groups (i.e. ski-running, shooting, path-finding, judging of distances). We have not been able to show any difference between 'yellow' and 'blue' soldiers in these achievements (table 6).

Discussion.

There is a widespread opinion to the effect that no small part of the Swedish population lives on a diet which, for a great portion of the year, does not provide the necessary Vitamin C. Thus, commenting in 1938 on the report of the Population Commission on the question of nutrition, the Royal Medical Board maintained that large groups of the population within different parts of the country are under-nourished. The so-called Norrland investigation, with others, suggests that the primary deficiency is one of Vitamin C. If this is so, the present scarcity and rise in price of food has further

increased the risk of C hypovitaminotic states. A further contribution is the fall in the standard of living since,, apart from potatoes, the most important sources of Vitamin C are in the more expensive foodstuffs.

Our investigations of soldiers, half of whom received for some months a daily dose of 50 mg of ascorbic acid per person in,addition to the regulation fare, showed that those soldiers not receiving ascorbic acid suffered from a considerable C Vitamin-deficit, to judge from the ascorbic acid titrations. Compared with results and conclusions from earlier publications, our results would seem to indicate the presence of a C hypovitaminosis, which should be dealt with by administering ascorbic acid or food rich in Vitamin C, When these last-mentioned soldiers were compared with those given ascorbic acid tablets, however, they were found not to suffer from this 'pathological' deficit, either as regards the frequency of disease or when tested as to physical or mental condition. In our opinion, therefore, there is no reason to regard this deficit as pathological, and to complement the diet with extra Vitamin C.

In the investigations prompting the notion of a relatively widespread Vitamin C deficiency, ascorbic acid titrations or capillary resistance tests have in many cases yielded analysis values deviating from those considered normal. On the other hand, practically no attempt seems to have been made, to investigate more closely whether persons showing a C deficit at the above laboratory tests differ in any other respect from healthy persons presenting normal values at ascorbic acid titration and capillary resistance tests. In this connection we may mention Hultgren's investigation (1933) into the normal variability in capillary resistance tests, which variability proved unexpectedly large. It is possible that factors influencing the capillary circulation in the skin, such as bodily exertion, diet — above all, spices — etc., may be of importance here. In any case, capillary resistance tests did not, in our material, yield any differences large enough to indicate incongruities between those who had been given ascorbic acid and those who had not. Only a few persons in either group had more than 10 petechiae. This implies that capillary resistance tests put the occurrence of pathological Vitamin C deficit in a more correct light than do the ascorbic acid titrations.

Summing up, it may be stated that earlier publications as to the

Vitamin C standard in Sweden cannot be taken to prove the occurrence of extensive Vitamin C deficit among the population of Norrland or other parts of the country. Our investigations show that, in point of fact, a diet such as that provided in the Swedish army satisfies the demand for Vitamin C, even during that season, spring, when the Vitamin C content of the foodstuffs is lowest.

Our results have been borne out by later investigations by Bergquist (1943) on factory-workers, by Hjärne (1941) on schoolchildren from the country, and by Hammar and Schröderheim (1942) on schoolchildren from Stockholm, all of which have been carried out with control material and statistically analysed. Contrary to what was assumed earlier on, therefore, a Vitamin C deficit sufficient to affect the public health does not seem to be very common in Sweden.

Our ascorbic acid titrations confirm the opinion, often found in present-day literature, that one should not judge the results on the absolute titration values, but should take only the relative values for comparison between different series of experiments within the same investigation. We gave our soldiers 200 mg of ascorbic acid daily from 3—27 March, and 50 mg daily up to May 20 inclusive. The loading tests were begun on May 21 with 300 mg of ascorbic acid daily; not until May 30 did they yield a significant difference between the fasting values and the reduction values 2 hours after taking the tablet. If the deficit obtained from our loading-tests is compared with the above-mentioned deficits among soldiers and sailors of certain foreign countries, ours is found to be somewhat higher, though our soldiers were alone in receiving extra ascorbic acid. This example thus shows that titration results obtained from different materials (individuals living in dissimilar milieu) do not immediately lend themselves to comparison.

The results of the individual field competitions showed no difference between soldiers receiving ascorbic acid tablets, and controls. This fact may well have special implications, since an impaired capacity for mental or physical work is thought to be a characteristic symptom of insufficient Vitamin C, and usually precedes scurvy proper.

An increased consumption of Vitamin C takes place during physical labour. If the fare contains insufficient Vitamin C, then an investigation along our lines which concentrates on soldiers to

whom strenuous physical labour is assigned, and who live on a certain standard diet for months, should be able to demonstrate differences in the Vitamin C standard between the ascorbic acid group and the controls. As no difference has appeared, despite the bodily labour, we receive further confirmation of our statement that the diet adopted is satisfactory. Investigating Swiss soldiers for lack of Vitamin C, Demole (1941) found a marked deficit in 57 % of those who had served for 9 months, but in only 10 % of the recruits. Demole explains this partly by the increased physical exertions, which increases the need of the vitamin, and partly by the mass cooking, which is peculiarly adapted to reduce the Vitamin C content of the food.

As was stated in the Introduction, the importance of the Vitamin C as anti-infectious factor has been the subject of lively discussion in the literature of most recent years. Thus, ascorbic acid is considered able to increase immunity in several ways, e.g. by enhancing the bactericidal power of the blood and acting as a cell-stimulating means. According to Peters (1940) and others, Vitamin C does not decrease receptivity to infection, but it is able to have a favourable influence on the course of the disease. Children given extra Vitamin C fell ill as often as other children, but the former recovered earlier.

The presumed power of Vitamin C to increase the body's ability to resist infection has prompted extensive recommendation of extra supplies of ascorbic acid, with a view to preventing catarrhal complaints even in those cases where absolutely no symptoms of deficiency or other signs of disease or weakness were to be found. This idea of Vitamin C as a prophylactic is still very widespread in Sweden, both among teachers and the general public, largely thanks to unreliable medical advertisements from abroad.

On the evidence of our own and other recent Swedish investigations, with trustworthy control material, we do not consider an extra supply of Vitamin C is justified solely on the grounds that the individuals in question show a C deficit in ascorbic acid titrations or capillary resistance tests. The prescribing of extra Vitamin C calls in each case for other symptoms which can be assumed to be associated with C hypovilaminosis, or which usually precede manifest scurvy. In this connection we should like to stress the inadequate familiarity which must still be assumed to obtain for the clinical

Supplement 1. Food list 15/1—14/2 1941.

Nature of food		Quantities per day						
		1	2	3	4	5	6	7
Dry food								
German sausage, boiled	g				40			
» » smoked	»		40					40
Cheese, whole-fat[1]	»	40		40		40	40	
Warm provisions								
Black puddings	»				250			250
Brown beans	»			100				
Chocolate, sugared	»	25					25	
Fish, fresh *	»						2–300	
Pork, salt or fresh	»			190		110		
Fruit mousse	»			60				
Oats	»	20		20		40		20
Barley kernels	»				10			
Semolina	»		20		20		30	
Sago	»		5					
Sausage, »falu-»	»			210			210	
» German, boiled	»	150						
Meat, fresh	»	275	275		275			225
Timed meat	port.					½		
Red whortle berry jam	g				75			75
Onion powder (or onions)	»		10			10		
Macaroni	»		80				80	
Potato flour	»	15	15	15				15
Wheat flour	»	15			15	30	15	
Horse radish	»				5			
Potatoes	»	500	300	300	300	600	300	100
Herrings, salt	»		200					
Syrup	»			10				
Prunes	»		15					
Dried vegetables	»				12			12
Concentrated apple-juice	»		12					
Peas, green	»							10
Lentils	»					100		
Eggs	No.	3						

In addition, daily: Milk, 0.3 1. fresh, or 0.5 1. separated, or corresponding amount of dried milk (ordered). *Dry food:* Bread, hard, 50 g, soft (fine or coarse) 230 g. Butter 20 g, marg. 20 g.

Warm provisions: Bouillon cube, 5 g. Coffee, roasted, 10 g. Lump sugar 25 g, castor sugar 25 g (in 4—5, 20 g). Frying oil 5 g (omitted in 3), Table salt and spices as required.

Alternatives: 1) »Palt»bread 100 g, salt pork 190 g, wheat flour 20 g, replaces midday meal (or: dinner) in 3 every other week.

2) Smoked pork 150 g, may, when available, be exchanged for the 190 g salt pork in 3.

3) Salt meat 250 g, exchanged when supplies permit for fresh meat 275 g.

4) Dried blueberrries 15 g, for blueberry soup exchanged for fruit soup when supplies permit.

5) When eggs are scarce, these and 200 g potatoes are omitted in 1, being replaced by 100 g green peas.

[1] Half-fat cheese, 50 g.per portion.

[2] The size of the fish portions depends on whether the fish is served whole or in fillets.

Supplement 2. Food list 15/2—14/3 1941.

Nature of food	Quantities per day						
	1	2	3	4	5	6	7
Dry food							
German sausage, boiled g				40			40
» » smoked »		40					
Cheese, whole-fat[1] »	40		40		40	40	
Warm provisions							
Black puddings »				250			250
Brown beans »			100				
Chocolate sugared »						25	
Fish, fresh[2] »						2–300	
Pork, salt or fresh »		50	200		125		
Fruit mousse »			60				
Oats »	20		20		40		20
Barley kernels »				10			
Semolina »		20		20		30	
Sago ' »		5					
Sausage, »falu-» »			210			210	
» , pork »					210		
» breakfast »	150						
Meat, fresh »	275	225		275			225
Red whortle berry jam »				75			75
Onion powder »		5					
Macaroni »		80				80	
Potato flour »	15	15	15				15
Wheat floiir »	15			15	30	15	
Horse radish »				5			
Potatoes »	300	300	300	300	600	300	100
Fruit juice »		30					
Herrings, salt, or mackerel, or salt Baltic herrings »		200					
Syrup »			10				
Prunes »		15					
Dried vegetables »				10			10
Peas, green »	100						10
Lentils »					100		
Apples, dried »	40						

In addition, daily: Milk, 0.3 1. fresh, or 0.5 1. separated, or corresponding amount of dried milk. *Dry food:* Bread, hard, 50 g, soft 230 g. Butter 20 g, marg. 20 g.

Warm provisions: Bouillon cube 5 g (omitted in 1). Coffee substitute 10 g. Lump sugar 25 g. Castor sugar 25 g (in 4—5, 20 g). Frying oil 5 g (omitted in 3). Table salt and spices as required.

Alternatives: 1) »Palt»bread 100 g, salt pork 190 g, wheat flour 20 g, replaces midday meal in 3 every other week.
2) Salt meat 250 g, exchanged for fresh meat 275 g, when supplies permit.
3) Dried blueberries 15 g, for blueberry soup exchanged for fruit soup when supplies permit.
4) When eggs are plentiful, 3 eggs and 200 g of potatoes are substituted in 1 for 100 g green peas.

[1] Half-fat cheese, 50 g per portion.

[2] The size of the fish portions depends on whether the fish is served whole or in fillets.

Supplement 3. Food list 15/3—29/4 1941.

Nature of food		Quantities per day						
		1	2	3	4	5	6	7
Dry food								
German sausage, boiled	g			50		50		
» » smoked	»	50						
Cheese, whole-fat [1]	»		40		40		40	40
Warm provisions								
Black puddings	»	250			250			
Brown beans	»		100					
Fish, fresh*	»						2–300	
Pork, salt or fresh	»		200			125		50
Fruit mousse	»					50		60
Oats	»	20		20		40		20
Barley kernels	»				10			70
Semolina	»				20		20	
Rice	»						40	
Sago	»		5					
Sausage, »falu-» or polony	»						210	
» , pork	»			210				
» , »stang»-	»		210					
Meat, fresh	»	275			275			75
Tinned meat	port.							1
Red whortle berry jam	g	75			75			
Onion powder	»	5				5		
Macaroni	»						80	
Potato flour	»	15	15	15				15
Wheat flour	»		25		15	100		15
Horse radish	»				5			
Potatoes	»	300	300	300	300	300	300	600
Raisins	»		10					
Fruit juice, sour	»		30					
Herrings, salt, or mackerel, or salt Baltic herrings	»				200			
Syrup	»		10					
Prunes	»	15						
Dried vegetables	»				10			
[3]eas, green	»			100				
Dentils	»					100		
Apples, dried	»	25						

In addition, daily: Milk, 0,3 1. fresh, or 0.5 1. separated, or corresponding amount of dried milk. *Dry food:* Bread, hard, 50 g, soft 230 g. Butter 20 g, marg. 20 g, or marg. mixed with butter 40 g.

Warm provisions: Coffee substitute 10 g. Lump sugar 25 g. Castor sugar 25 g (in 4, 20 g). Frying oil 5 g. Table salt and spices as required.

[1] Half-fat cheese, 50 g per portion.

[2] The size of the fish portions depends on whether the fish is served whole or in fillets.

Supplement 4. Food list 30/4—31/5 1941.

Nature of lood		Quantities per day						
		1	2	3	4	5	6	7
Dry food								
German sausage, smoked	g						50	
Cheese, whole-fat[1]	»	40	40	40	40	40		40
Warm provisions								
Black puddings	g	250			250			
Brown beans	»	100						
Bouillon cube	»			5				
Fish, fresh[2]	»						2–300	
Pork, salt or fresh	»	200	100			100	50	
Fruit mousse	»		50			50		
Oats	»	20		40		20		20
Barley kernels	»			10			70	
Semolina	»				20		20	40
Rice	»						40	
Sausage, »falu-» or polony	»							180
» , pork	»				200			
» , »stang-»	»		180					
Meat, fresh	»						75	150
Tinned meat	port.			1		1/2		
Red whortle berry jam	g	75			75			
Union powder	»			5		5		
Macaroni	»							80
Potato flour	»	15			15			10
Wheat floiir	»		125			100		
Potatoes	»		350	700	350	350	700	300
Raisins	»	5						
FrUit juice	»							20
Herrings, salt, or mackerel, or salt Baltic herrings	»			175				
Syrup	»	10						
Prunes	»	15						
Dried vegetables	»			10				10
Lentils	»		100			100		
Peas, green	»			5				5
Apples, dried	»	20						
Milk, fresh [3]	dl			3			3	
» , separated [3]	»	5	8	2	5	8"	7	8

In addition, daily: Dry food: Bread, hard, 50 g, soft 230 g. Marg. mixed witlx butter, 40 g.

Warm provisions: Chocolate, sugared, 25 g. Coffee mixture 10 g. Lump sugar 25 g. Castor sugar 25 g. Frying oil, 5 g. Table salt and spices as required. Packets of ready-mixed spices not allowed to be issued.

[1] Half-fat cheese, 50 g per portion.

[2] The size of the fish portions depends on whether the fish is served whole or in fillets.

[3] With gruel, 3 dl sep. milk, with chocolate 2 dl sep., with baiter pudding, 3 dl sep. with »fruit-creams» 3 dl sep., with rice pudding (in the cooking) 2 dl sep., for porridge 3 dl fresh. Dried milk 10 g = 1 dl milk (substituted as required).

course of C hypovitaminosis, as also the consequent obstacles to its satisfactory diagnosis.

We should like to emphasize that the aspects presented here as to the administration of ascorbic acid for prophylactic ends apply to large groups of persons. When it comes to the individual case, the physician has to study other aspects, also, which fall outside the scope of this investigation.

The material investigated is large enough for the agreement found to be regarded as fairly conclusive proof. It is, of course, not out of the question that a still larger material might yield differences, but even if it did, they could not be large ones: otherwise they would already have appeared in our investigation.

Summary.

In order to establish whether Vitamin C has a preventive effect on common colds, conscripts in the North of Sweden were given tablets from March 3rd to May 31st, 1941, half the number receiving strong doses of Vitamin C, and the other half in active tablets. The groups were chosen at random (odd and even numbers). A definite difference between the categories with regard to the 'Tillman test' was established both at the beginning and the end of the period.

No difference could be found as regards frequency or duration of colds, degrees of fever, etc. Military competitions, arranged to relieve the tedium, disclosed no difference between the two groups. Thus, the soldiers who only received the diet of the Swedish army, and who showed a 'pathological deficit', did not differ in any respect from those who had been given ascorbic acid during the entire period of investigation. Consequently, there is no reason to assume Vitamin C to be at all instrumental in preventing colds when supplementing the degree of vitamin deficiency existing among soldiers in the North of Sweden.

Recent investigators working on our principles have shown that our conclusions also hold for other groups of the Swedish population.

The fact that an individual has a Vitamin C deficit does not necessarily mean that he must show symptoms of disease, or that

he has an impaired constitution, with an increased disposition to diseases. Special investigations are required to establish how great a vitamin deficit must be to set up trouble of some kind. The problem is not easy to solve, for one thing because the limit between health and sickness may be at a different Vitamin C level for different individuals. The fact that certain groups of the Swedish population show a Vitamin C deficit during certain parts of the year does not,, however, imply that their vitamin supply is below the limit for a normal state of health. This investigation has established that the vitamin C deficiency in a group of the population, living under particularly unfavourable circumstances, does not descend to the pathological.

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