

Protein requirement: An answer to Immerman

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Immerman claimed that the minimum protein requirement is from 15 to 25 grams per day. Lowe later asserted it is higher; at least 30 grams with an additional 10 or 15 grams as a safety margin. Immerman subsequently rebutted that the 30 grams was an unreferenced estimate by Guyton and, as such, could not be considered entirely reliable, especially considering that Immerman's estimate was based on research published in a reputable journal. In this paper, Lowe reports the sources of Guyton's estimate. He also examines the published research on which Immerman based his estimate and points out that Immerman either misinterpreted it or failed to properly emphasize a critical aspect of it. Lowe also answers another criticism of Immerman's: That no research supports the contention that stresses other than pregnancy and lactation increase the protein requirement. Lowe discusses how virtually any clinical or basic science textbook that deals with the role of the adrenal cortices in stress contradicts Immerman's statement.

PROTEIN REQUIREMENT
ANSWER TO IMMERMEN

Introduction

In the recent past, both Immerman and Lowe have published papers on intestinal toxemia.^{1,2} Both have presented evidence to support the hypothesis that this phenomenon occurs and can pose a serious threat to health.

Both focused on the relation of protein intake to intestinal toxemia. Although the authors apparently agree in general on the importance of this relationship, the subject has served as a point of disagreement in at least one respect: the minimum amount of protein required.

Immerman wrote³: "In light of studies on minimum protein requirements, we may even consider as sufficient intakes of 15-25 grams per day of high quality protein."

Lowe disagreed and wrote⁴: "According to Guyton,⁵ there is an obligatory loss of about 30 grams of protein per day; that is, if a person eats no proteins during a day, about 30 grams of his own body proteins continue to be degraded into amino acids, then

deaminated and oxidized. In light of this, Immerman's figure of 15 to 25 grams may be too low, especially when we consider that when various stresses are imposed on the body, the protein requirement may rise."

Immerman⁶ subsequently rebutted this view, and the points raised in his rebuttal warrant thoughtful replies.

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The Minimum Protein Requirement

Immerman took exception to Guyton's statement that there is an obligatory loss of about 30 grams of protein per day. He wrote,⁷ "Since Guyton does not give the reference for his figure of 30 grams, this can not be considered entirely reliable. This is especially the case in light of the fact that my figure of 15 to 25 grams is from research published in a reputable journal."

Guyton does not reference specific statements in his *Textbook of Medical Physiology*. Instead, he lists his references alphabetically at the end of each chapter. Guyton reported to this author⁸ that it would be highly impractical to include all sources he uses to update revisions. He stated that it is generally considered clinically that there is an obligatory protein loss of about 30 grams. He said this figure is derived from the protein studies of Moyer, Blalock, McChance and Wipple, conducted and published between the 1930s and the 1960s. Ordinarily if protein intake is **below** 30 grams, protein depletion occurs. He conceded that Immerman **could** be correct, depending upon factors such as the size of the person and the level of his glucocorticoid output: The smaller a person is, the less protein he needs to maintain his body mass and functions; and the less his glucocorticoid output, the less his need for protein intake.

The evidence indicates that for the average person of 70 kilograms (approximately 155 pounds), Guyton's estimate is accurate, Lowe's recommendation is probably justified, and that Immerman's recommendation is therefore too low. Consider this: Hegsted⁹ (the source from which Immerman derived his recommendation) has presented estimates of the minimum protein requirement calculated in two ways. According to the "conventional estimate," the minimum requirement is between 20 and 30 grams of highest quality protein per day. According to the "lower estimate," the minimum requirement is from 12 to 18 grams per day.

Hegsted emphasizes that these estimates assume that the proteins being consumed are of **maximal biological value**.¹⁰ The biological value of a protein is a measure of its ability to support nitrogen balance (the net result of all nitrogen gains and losses in the body).¹¹ The metabolic processes bring about a loss each day of a certain amount of nitrogen through the urine, feces and skin. This nitrogen is replenished mainly by the proteins eaten. Some proteins, like those from vegetables, are not well absorbed and used by the body. A relatively large amount of these must be ingested to compensate for the body's nitrogen losses. Other proteins, such as egg protein, are absorbed and used by the body very effectively. A relatively small quantity of these may be eaten to replenish the body's nitrogen losses.¹² It is said that in terms of biological value, these latter proteins are at the top end of the scale. Their biological value is 100%; they can replace the ordinary nitrogen losses gram for gram.¹³

And so for the 70 kilogram person, 12 grams (the lowest estimate) to 30 grams (the highest estimate) of protein of the highest biological value may support nitrogen balance. But as Hegsted has written,¹⁴ "If conventional dietary proteins were fed, say with a biological value of 70%, then these values (the gram estimates) should be multiplied by 100/70." Thus the lowest estimate becomes approximately 17 grams and the highest, 43 grams. This results in a median estimate of 30 grams — precisely Guyton's estimate!

Hegsted writes further,¹⁵ "Since cereal proteins have low values, in our experience from 20 to 35%, most low protein diets will have low nutritive values resulting in the need for high intakes." Here, the lowest and highest estimates should be multiplied by at least 100/35. The result shows that those receiving their proteins from plant food sources should ingest as much as 60 to 150 grams of protein daily to maintain nitrogen balance.

Immerman did specify that his recommendation of 15 to 25 grams was for high quality protein. This author feels, however, that Immerman should have emphasized the significance of "biological value" to **different sources** of protein.

Stress and the Protein Requirement

In his article,¹⁶ Lowe stated he would guess that at least 30 grams of protein with an additional 10 or 15 grams as a safety margin are adequate. He also wrote (as was noted above),¹⁷ "Immerman's figure of 15 to 25 grams may be too low, especially when we consider that when various stresses are imposed on the body, the protein requirement may rise."

Immerman disagreed and wrote¹⁸: "The 'stresses' referred to in Lowe's article, according to the source, are pregnancy and lactation; certainly, in these conditions, it would be wise to increase the protein intake to provide for the fetus and infant. However, this does not imply that there is benefit from an increased protein intake in the case of other stress situations; in fact, there is no research to support this contention."

This latter statement by Immerman was careless. Why? Because virtually **any** clinical or basic science textbook that discusses the adrenal cortices contradicts his statement. One of the main groups of hormones secreted by the adrenal cortices is the glucocorticoids. One of the main functions of these is "to enable the body to combat or withstand stress."¹⁹ In serving this function, the glucocorticoids stimulate gluconeogenesis, the breakdown of proteins to amino acids and conversion of these to glucose.²⁰

This increased breakdown of proteins reduces the protein stores in practically all body cells except the liver.²¹ This is seen in the extreme in the classical, fully developed case of Cushing's syndrome, a condition in which glucocorticoids are produced and secreted in excess. One of the effects is "central obesity which is exaggerated by loss of muscle from the limbs

due to the catabolic effect of the hormones."²² "The catabolic effect" referred to is the breakdown of tissue proteins. In addition, Ganong has written,²³ "Patients with Cushing's syndrome are protein depleted as a result of excess protein catabolism."

But primary pathology of the adrenal cortices, as in Cushing's syndrome, is not a prerequisite to increased glucocorticoid output and consequent proteolysis. As Selye has stated,²⁴ the secretion of glucocorticoids into the blood is one of the first hormonally mediated reactions that occurs non-specifically to stress — that is, "under any condition necessitating adjustment." And Guyton has written,²⁵ "Almost any type of physical or even mental stress can lead within minutes to greatly enhanced secretion of ACTH and the glucocorticoids, often increasing cortisol secretion as much as 20-fold."

During the initial or alarm reaction to stress, proteolysis and the use of amino acids for energy sharply increase. During the second or resistance stage of stress, the use of amino acids decreases, but still continues to a slight degree. When the stress has persisted long enough and the stage of exhaustion is reached, protein expenditure for energy increases again.²⁶ Moreover, during stress, the production and secretion of thyrotrophic hormone increases. This stimulates the thyroid to increase its output of thyroxine, and this accelerates the metabolism of all cells of the body.²⁷ One of the metabolic effects of thyroxine is to increase gluconeogenesis by mobilizing proteins from cells.²⁸

Ergo, as Guyton told this author,²⁹ anytime glucocorticoids are secreted, gluconeogenesis occurs in the liver. This adds glucose to the blood, even if adequate glycogen is present in other tissues. And — directly to the point! — because of this, stress from any source definitely increases the dietary amino acid requirement.

Conclusion

The conventional diet eaten by Americans necessitates an intake of some 30 grams of protein per day to maintain nitrogen balance. Because of the stresses of everyday life, however — and the gluconeogenesis they induce — additional grams are necessary, somewhat increasing the minimum protein requirement above 30 grams. □

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Protein requirement: A reply to Lowe

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Minimum daily protein consumption concerns many people. Nitrogen balance studies are used to measure protein requirements; such studies mainly reflect the quantity of protein a person has recently ingested: the greater the amount, the more protein needed to stay "in balance." Recommended daily allowances for protein are extremely high in the United States, since the average American consumes three to four times more protein than needed. When protein need is calculated to eliminate the effect of immediate past protein intake, the actual daily need is approximately twenty grams average, biological-value protein. The stress of daily life insignificantly increases the protein requirement.

The disagreement between Immerman and Lowe regarding minimum protein requirement necessitates that this subject be considered in depth. Doctors who desire to restrict protein intake to the minimum in cases of intestinal toxemia must have reliable guidelines. The present author will report certain facts uncovered as a result of a review of the scientific literature.

First, the reliability of Guyton's 30 grams per day figure¹ must again be considered. The present author reemphasizes his opinion that this is not a trustworthy figure for these reasons: evidence will be presented to show that this figure is too high; its source is unknown and impossible to evaluate. Since Guyton has found it "highly impractical"² to reference all the statements in his text, writers are advised to quote only from referenced texts such as Goodhart and Shils,³ Best and Taylor's,⁴ and primary sources.

Minimum Protein Requirement

The conventional technique used to measure protein requirement is the nitrogen (N) balance study. With this method, N requirement is determined by

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measuring N output from the body; the N value is then converted into protein (since protein is about 16% N, multiply N by 100/16 or 6.25 to convert). N equilibrium is that state of balance in which the intake of N is equal to that which is excreted. Positive N balance is that state in which the intake of N exceeds the excretion, and negative N balance is that state in which excretion of N exceeds the intake.⁵

Hegsted, in the article⁶ quoted by Immerman and Lowe, reports figures from N balance studies. As Lowe has noted,⁷ estimates are presented which have been calculated in two different ways. One has resulted in figures much higher than the other (20 to 30 grams protein as compared to 12 to 18). Lowe has derived his recommendation of 30 grams per day⁷ by averaging these two sets of figures. Such averaging is a mistake. These sets represent two different concepts of how protein need should be determined. One must choose between the two, not average them. Evidence will be presented to justify a choice of the lower figure.

In his article, Hegsted states that the higher figures are "probably not a real minimum since the excretion (of N) depends upon the length of time the subject is fed the N-free diet."⁶ It has been known for over 100 years that there is an immediate adaptation to a reduced protein intake consisting of a reduced N excretion (primarily urinary) so that a state of N balance is achieved at a lower level of intake (provided that the intake is not too low).⁸ Many experiments demonstrate this adaptation.^{9,10,11,12,13,14}

In choosing between Hegsted's two figures, the central question is: should N excretion be measured a short time after reducing protein intake (the "conventional estimate"),⁶ or should it be measured after a longer period on such a diet when considerable adaptation has occurred and N excretion has decreased (the "lower estimate")?⁶

The problem is that during the period of adaptation to lower N intake a large amount of N is eliminated from the body (called by some the "labile protein store"),¹⁵ and at some point physiological impairment will result. But, the fact is that the amount of N eliminated before balance is achieved depends upon the past level of protein intake.¹⁶ An average American consuming 94 grams of protein per day,¹⁷ if placed on a diet containing the minimum, but adequate, protein requirement, would eliminate large amounts of N (be in negative N balance for a considerable period of time) before coming into N balance at the lower level of intake.

The safe amount of N which can be eliminated must not be determined from the quantity of N excreted but from measurement of physiological parameters. Studies of subjects on low protein or protein-free diets have shown that plasma protein and hemoglobin levels have remained normal,^{18,19} levels of plasma amino acids have remained normal,^{20,21} and no deleterious signs or symptoms have manifested.¹⁸⁻²³ On the contrary, patients with kidney

failure²⁴⁻²⁶ and hypertension, coronary artery disease, and heart failure^{18,19} have improved considerably. An individual may excrete a large amount of N and not be deficient; one might describe him as "unsaturated but functionally unimpaired."²⁷

Consequently, in computing minimum protein requirement, scientific grounding is firm for the use of the lowest figures available for N excretion in the absence of deleterious signs and symptoms. Hegsted says: "if we assume that there is real benefit to feeding the lowest possible protein levels, one is justified in examining very carefully the very lowest estimates of N excretion."⁶ Both Immerman²⁸ and Lowe²⁹ agree that, in the dietary management of intestinal toxemia, there most certainly is a real benefit to feeding the lowest possible protein levels.

In computing minimum protein requirement, it is necessary to multiply by number of basal calories. Hegsted⁶ has used figures ranging from 1180 (smallest woman) to 1800 (largest man) as representative of a normal population, presumably consuming a normal American diet. Subjects on a dietary regimen designed to alleviate intestinal toxemia would hardly be on a normal American diet; in addition to protein restriction, caloric restriction would occur.²⁸ Caloric restriction lowers the number of basal calories.³⁰⁻³³

A reasonable decrease in basal calories would be about 10%. Recalculation of basal calories on this basis gives figures of 1062 to 1620. Computations, then, according to Hegsted⁶ are: 1.4mg N per basal calorie times number of basal calories times 6.25 plus 10% for fecal losses plus five percent for dermal losses equals 10.7 to 16.3 grams protein needed per day. To account for the fact that most people consume proteins of biological value of 70, multiply these figures by 100/70 and the range is 15.3 to 23.3 grams protein needed per day (average: 19.3). This is compared to figures of 17.1 to 25.7 based on the number of basal calories reported by Hegsted⁶ (average: 21.4). As is obvious, these figures are significantly lower than those recommended by Lowe.²⁹

The mechanisms by which the body adapts to a low protein intake are: increased synthesis of endogenous proteins,^{8,34} more efficient absorption of protein,³⁵ decreased excretion of protein,^{8,36} and utilization of waste urea for protein synthesis.³⁷ The body may further adapt to low protein intake by using a protein as if it were of a higher biological value.^{38,39}

Stress

It cannot be denied, as Lowe has stated,⁷ that stress modifies protein requirement via the action of thyroxine and glucocorticoid hormones. However, research indicates that Lowe's recommendation of an additional 10-15 grams protein per day²⁹ is an enormous overestimation and that Immerman was much closer to the truth when he wrote that there is no benefit from increased protein intake during stress.⁴⁰

In considering the effect of stress on daily protein

requirements, it is necessary to consider only those stresses which would be encountered on a daily basis. This would include stress of nervous tension and of alteration of daily living patterns, but not surgery, burns and infections. It is not advisable to consume protein every day in an amount which would be rarely needed. Such a diet would lead to daily protein intake far in excess of need and would help set the stage for intestinal toxemia.²⁸

Scrimshaw has studied the effect of nervous tension (final examinations) on protein requirement and found that students needed an average of four percent more protein to stay in balance.⁴¹ Sleep deprivation was also studied and the result of this stress showed no net increased need for protein.⁴² Finally, reversal of diurnal rhythms of sleep and work patterns was studied and rediscovered that an increase of six percent in protein intake was needed to maintain balance.⁴² The average of these three studies is 3.3%. 3.3% of 20 grams is .67 gram. If 20 grams is the true minimum protein requirement, an addition of less than one gram is needed to cope with stresses which might be encountered daily. An increase of .99 gram would be needed if the minimum protein requirement is 30 grams per day as Lowe has stated.²⁹ This falls far short of the 10 to 15 gram figure Lowe has recommended.²⁹

Conclusion

About 21 grams of average biological value protein (70) is adequate to maintain N balance in an American consuming a conventional diet. Approximately 19 grams would be adequate to maintain balance in a patient on a diet for intestinal toxemia, because of a decreased basal metabolic rate. Because of the stresses of everyday life, an additional gram of protein would be needed. Therefore, Guyton's estimate is inaccurate, Lowe's recommendation is not justified, and Immerman's recommendation (of 15 to 25 grams highest biological value protein)²⁸ provides a considerable safety factor. □

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