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# THE "IDEAL" BLOOD SUGAR: ITS BIGGER MEANING

by Emanuel Cheraskin, M.D., D.M.D.

## INTRODUCTION

Bring up "ideal" blood sugar and you bring out a bag of misconceptions and incredible contradictions worthy of TV news magazine coverage. In one report (1) we discover what is colorfully called the "panic ranges" of blood sugar, anything below 50 mg% and over 400 mg%, but the *nonlethal* spread for blood sugar is said to extend from 20 to 1500 mg% (2). There are also all sorts of semantic shenanigans. For instance, we are assured that the so-called normal blood sugar is anything less than either 115 mg% (3) or 140 mg% (4-6). Taking such statements literally, zero must be acceptable! Also, while we are here using blood sugar and blood glucose as synonyms, there are real and measurable differences (7).

As one might expect, most of the published material is routine, repetitious, and rubbish, probably because of cross-citing (8-15). Put another way, much of what appears in one book or paper has simply been lifted from what has been published elsewhere.

The principal emphasis has been on the delineation of the diabetic from the nondiabetic. To complicate matters, there is disagreement on whether to make judgments from fasting vs nonfasting blood sugars, postprandial vs post glucose challenge, and/or many other forms of glucose tolerance testing. Sharp differences exist between the ideas of the National Diabetes Data Group (NDDG) and those of the World Health Organization (WHO) (16).

To better appreciate what will transpire in previous and subsequent papers (17-23) one must realize, as discussed below, that the definition of well or ill is a function of where one draws demarcating lines. This apparent complexity of choice has resulted in a plethora of published material on what constitutes "acceptable and/or desirable blood glucose." Aging and blood sugar reports are plentiful (24-26), and in this connection much attention has been paid to the role of time as a potential contributor to blood sugar problems (27-28). One of the reasons for the quantity and diversity of publications stems from the fact that there may be at least seven different definitions for "normal." Murphy has outlined these possibilities (**Table 1**) (29). The last, the ideal in the sense of the most desired, has usually been accorded the least attention. What is glaringly not ordinarily considered is the ultimate, the perfect and pristine, blood sugar. Thus the purpose of this analysis: to consider the "ideal" blood sugar.

## REVIEW OF THE LITERATURE

Reported here are representative annotations to blood sugar assessments in healthy people. They are intended to provide us with the sources from which our current standards are developed. In other words, what kind of people are employed to create the gold standard for the most acceptable blood sugar?

E. Cheraskin, M.D., D.M.D.
Professor Emeritis
University of Alabama at Birmingham Medical Center

Park Tower 904/906
2717 Highland Ave. South
Birmingham, AL 35205

This discussion, along with others, is part of a series of essays collectively called *Medical Ignorance: Myths and Magics in Modern Medicine*.

Hale-White and Payne (30) indicated, as early as 1926, what has since become common practice that,

> ...In selecting subjects for the formation of normal standards, it has been thought inadvisable to take patients...Material...is available... among the students and laboratory workers...

Himsworth (31), about nine years later, described his criteria for normality and emphasizes the importance of the absence of diabetes mellitus as follows,

> ...The experiments were carried out on healthy young men...and had no history of diabetes mellitus in his family...

Moyer and Womack (32) (1950) utilized one of the then and still now most common sources for normality:

> ...The 103 control subjects consisted of hospital personnel and other ambulatory patients hospitalized for orthopedic conditions, uncomplicated duodenal ulcer, and otorhinologic disease...

Jackson (33) (1952) contributed another baseline source,

> ...for controls we took a series of...similar race and age distribution who were attending the hospital for various reasons, none of them being known diabetics...

In other words, sick people, provided they were not suffering with obvious diabetes mellitus were viewed as adequate controls for the study of blood sugar in healthy persons!

Two years later, Fajans and Conn (34) stated,

> ...Glucose tolerance tests were performed in 50 control subjects

**Table 1.** Murphy's seven definitions for "normal"

| | Paraphrase | Where Used | Preferable Term |
|---|---|---|---|
| 1. | probability function (bell-shaped curve) | statistics | gaussian |
| 2. | most representative of its class | descriptive sciences | average, median modal |
| 3. | commonly encountered in its class | descriptive sciences | habitual |
| 4. | most suited to survival | genetics, operations research | optimal, "fittest" |
| 5. | carry no penalty | clinical medicine | innocuous, harmless |
| 6. | commonly aspired to | politics, sociology | conventional |
| 7. | *most perfect of its class* | *metaphysics, aesthetics, morals* | *ideal* |

> without a known family history of diabetes...medical students, physicians, dietitians, and other healthy individuals...

Unger (35), in 1957, set out clearly his criteria (or lack thereof),

> ...The control group for this study was selected blindly from among negative-screening applicants for food-handler certificates at the Dallas City Department of Health whose blood sugars had "screened" below 130 mg% within one and one-half hours of a meal...

In other words, no attempt was made to regulate the composition of the group, other than to exclude persons with postprandial hyperglycemia.

Hagan (36) followed in 1961 and put it very simply,

> ...28 normal women were investigated...

O'Sullivan and Mahan (37) shortly thereafter sought the answer to "normal" blood sugar in pregnant women and excluded those with,

> ...(a) a family history of diabetes, (b) birth of baby nine pounds or more, (c) a history of fetal death, neonatal death, congenital anomaly, prematurity, toxemia (excess weight gain, hypertension, proteinuria) in two or more pregnancies, and (d) a venous blood glucose of 130 mg per 100 ml or more one hour after 50 grams of glucose orally administered in the afternoon of registration...

In order to study norms in children, Pickens, Burkeholder, and Womak (38) reported in 1967 that,

> ...Glucose tolerance tests were performed on 200 healthy children ...without a family history of diabetes ...the subjects of this study came from two groups...those below the age of six years were mostly recruited from students' families in a housing development for married university students...those between the ages of six and twelve were recruited from the University of Missouri Laboratory School...pertinent historical data were obtained and a physical examination was performed on each child...children with a recent infection or chronic illness were excluded...

Once again, we observe the broad and autocratic criteria for wellness.

From this review, it is very obvious that the bases for determining preferred blood sugar derives largely from a negative history for diabetes and a poorly defined assurance of health. Strangely we are comforted by the thought (not based on any facts) that the blood sugar is uniquely adequate in physicians, medical students, and the children of people in the so-called health professions.

## MATERIALS AND METHODS

This investigation of the "ideal" blood sugar is based upon two studies which differ in time, place, sample size, and participant composition. Also, the results have been analyzed by two distinctly different statistical methodologies.

The first study was executed at the then Olive W. Garvey Center for the Improvement in Human Functioning in Wichita, Kansas (39). It will be hereafter referred to as the Wichita Project. The other was part and parcel of the 1964 annual Diabetes Detection Drive in Birmingham, Alabama (40-46). In this report, it will be identified as the Birmingham Project.

*Wichita Project*: Two hundred twenty four persons participated in this study. One group consisted of 108 subjects in a private outpatient medical practice for the treatment of a variety of routine and commonly encountered complaints. They constitute the "patient population."

The other subset consisted of 116 persons recruited through newspaper and television media and by word of mouth. The criteria used were to (1) be within 10% of ideal body weight (Metropolitan Life Insurance Tables), (2) have not smoked cigarettes in the past three years, (3) consume less than three ounces of alcohol per week, (4) have an exercise program involving some form of body movement for at least 20 minutes three times weekly, (5) eat three meals per day in a regular pattern including breakfast, (6) sleep six to eight hours daily, (7) have not seen a physician for the purpose of treating an illness within the past 12 months, (8) have not taken any form of medication, including antibiotics, birth control pills, or hormones for one year, or antihistamines for two weeks. These represent the "healthy people population."

All participants, of similar age, were treated alike in regard to obtaining specimens for testing, including time of day, body position, and use of tourniquet. The glucose was determined on serum by a Technicon SMAC Analyzer using hexokinase methodology. Every subject completed a medical history including a review of systems (ROS) which consisted of 37 questions requiring a positive or negative response. The queries were so structured that an affirmative answer could be medically significant. Each person, after a minimum of 10 and a maximum of 14 hours overnight fast, underwent a comprehensive battery of biochemical tests which included a serum glucose determination.

*Birmingham Project*: In this standard and traditional annual diabetes detection drive, routine vital statistics (age and sex) along with number of hours since last dietary intake were collected. A fingerprick (capillary) blood sample was taken and analyzed on the premises by the then popular manual Dextrostix method, namely visual comparison with a manufacturer established color chart. Screenees with a capillary blood sugar level greater than 130 mg% were referred to a physician for confirmatory venous blood glucose analysis by the AutoAnalyzer method.

We are reporting on 7919 persons who participated during one week of a typical diabetes detection drive in Birmingham (32% males and 68% females). The volunteers ranged in age from one to 89. Not surprisingly, the majority were elderly.

Of the total, 1700 individuals 20 years of age and older additionally completed the Cornell Medical Index Health Questionnaire (CMI). People were asked to respond to 195 items by checking the "yes" option in response to a symptom description if they experienced that particular clinical problem. For the record, the CMI was originally created to satisfy the need for a device to collect a large body of relevant medical and

**Table 2.** Comparison of clinical state and fasting blood glucose in a patient versus healthy people population

| Line | Patient Sample | Healthy People Sample | Significance of the Difference Between Means | Significance of the Difference Between Variances |
|---|---|---|---|---|
| 1. sample size | 108 | 116 | --- | --- |
| 2. review of systems | 11.2 ± 6.3 | 5.3 ± 4.3 | p < 0.0010* | p < 0.0005** |
| 3. age | 42.1 ± 17.7 | 44.4 ± 15.0 | p > 0.2000 | p < 0.0500** |
| 4. blood glucose | 99.0 ± 11.0 | 97.3 ± 9.3 | p > 0.200 | p < 0.0050** |

* statistically significant difference between the means
** statistically significant difference between the variances

**Table 3**. Clinical state versus fasting blood glucose in a patient population

| Line | Review of Systems Groups | Sample Size | Mean Age | Mean Review of Systems | Blood Glucose (Mean and S.D.) |
|---|---|---|---|---|---|
| 1. | 14 - 28 | 34 | 40.9 | 18.8 | 97.9 ± 12.2 |
| 2. | 9 - 13 | 35 | 46.0 | 10.6 | 99.8 ± 10.8 |
| 3. | 1 - 8 | 39 | 39.8 | 5.0 | 99.3 ± 10.2 |

psychiatric information with a minimum of physician-time input. Over the five decades of its existence, this questionnaire has been more time-tested than any other history taking form. It has been used to study physical and emotional problems in and out of hospitals and outpatient admitting departments, in the military, industry, and sports medicine.

## RESULTS

*Wichita Project*: The findings will be arranged by raising, and hopefully answering, three points.

Question One: What, if any, are the clinical/biochemical differences between the "patient" (pp) and "healthy people populations" (hp)?

Three points can be made. First, utilizing the review of systems as a measure of clinical health (**Table 2**), the evidence is clear (line 2) that the number of "complaints" in the hp is just about half (5.3) that observed in the pp (11.2). The differences between the means and the variances of the two groups are understandably convincingly significant. There is no significant difference of the mean values (line 4) in terms of blood glucose (99.0 versus 97.3 mg%). However, there is a measurable contrast in the variances as shown by 11.0 versus 9.3 mg% in the pp versus the hp samples, respectively.

Hence, in answer to the final question, there is an understandably better clinical state (as judged by ROS in the people versus the patient population). Also, in the "healthy people group," the blood glucose values cluster significantly closer to the mean.

Question Two: Within the so-called patient population, some persons are more ill than others. Therefore, with regard to the second question, "Are glucose scores systematically related to number of symptoms?"

Once again, utilizing the ROS as a measure of clinical health/sickness, **Table 3** shows that the number of complaints for patients (n=108)

**Table 4**. Clinical state versus fasting blood glucose in a healthy people population

| Line | Review of Systems Groups | Sample Size | Mean Age | Mean Review of Systems | Blood Glucose (Mean and S.D.) |
|---|---|---|---|---|---|
| 1. | 7 - 20 | 39 | 44.6 | 10.2 | 92.6 ± 9.7 |
| 2. | 3 - 6 | 39 | 43.9 | 4.2 | 99.4 ± 9.4 |
| 3. | 0 - 2 | 38 | 38.0 | 1.1 | 96.2 ± 8.6 |

ranged from one to 28. They have been arrayed in three near-equal groups based on clinical conditions as judged by ROS. In line 1, there are 34 subjects with 14 to 28 signs and symptoms. On the average, there are 18.8 so-called complaints and the blood glucose is 97.9 ± 12.2 mg%. In the second subset (line 2), the ROS is of an order of 9 to 13 with an average of 10.6 and the blood glucose is 99.8 ± 10.8. Finally, in line 3, we observe the relatively healthiest of the patients with one to eight positive responses and with a mean of 5.0 and a blood glucose of 99.3 ± 10.2. The variance declines as one moves from line 1 to line 3 (12.2, 10.8, and 10.2 mg%). Hence, in answer to the second question, even within the patient population, those who are relatively healthier show a blood glucose range which clusters significantly most about the mean.

Question Three: Are glucose scores related to number of symptoms within the hp sample?

**Table 4** provides an analysis of this group similar to that shown for the patient subset (**Table 3**). Once again, even in this population, there are some who are obviously healthier than others. These have been arrayed utilizing the ROS. Line 1 shows those who are least healthy (7 to 20 complaints) versus line 3, the healthiest of the healthy (0 to 2). As in the case with the patient sample, the difference between the mean blood glucose levels in the three groups are not significantly different. However, in perfect order, the variance declines from 9.7 (line 1), in the sickest of the healthy group to 8.6 (line 3) in the healthiest of the healthy subset. Hence, in answer to the final question, the trend here is essentially that previously observed in the pp.

*Birmingham Project*: It is universally recognized that blood sugar is ordinarily a function of when food/drink was last ingested. **Table 5** (line 1) summarizes the findings for the blood sugar levels of the 698 subjects who consumed food or drink approximately four/five hours prior to blood draw. The mean blood glucose is 84 with a standard deviation of 23. What is most noteworthy is the blood glucose range. It extends from a nadir of 40 (clearly pathologically low) to a zenith of 200 mg% (obviously unacceptably high).

As one moves downward in **Table 5**, the sample size understandably shrinks in a logical

**Table 5.** The development of the "ideal" four-five hour postprandial blood sugar in a progressively symptomless and signfree sample

| Line | Sample Size | Number of CMI Complaints | Minimum/Maximum Blood Glucose Values mg% | Mean Blood Glucose mg% | S.D. |
|---|---|---|---|---|---|
| 1. | 698* | | 40 - 200 | 84 | 23 |
| 2. | 575 | <50 | 40 - 200 | 85 | 23 |
| 3. | 389 | <30 | 40 - 200 | 85 | 23 |
| 4. | 88 | <10 | 50 - 130 | 89 | 19 |
| 5. | 25 | < 5 | 50 - 130 | 90 | 19 |
| 6. | 9 | < 3 | 65 - 130 | 94 | 21 |
| 7. | 3 | < 2 | 65 - 90 | 79 | 7 |
| 8. | 1 | 0 | 80 - 80 | 80 | 0 |

* Entire sample

order as health requirements are stiffened. What is exciting is that with perfect regularity the lowest and the highest values are progressively eliminated. The point most to be emphasized is that, as health increases there is progressively greater glucose homogeneity. Obviously, there is always a problem with sample size since no one is perfectly healthy! This is borne out by the one presumably healthiest subject (line 8).

## DISCUSSION

From the literature survey, it is obvious that preferred blood sugar, however defined and measured, cannot be described as a single number. In other words, as we have underscored, it is always pictured as a range.

The study of healthy people and patients in Wichita and the presumably nondiabetics in Birmingham confirm these same conclusions, namely that there is no magic number and that a desirable blood sugar exists in a spread.

What is unique about this report is that the more sophisticated the definition of health, the more narrow is the range for acceptable blood sugar. As a matter of fact, it is exciting to note that, as one progressively develops the symptomless and signfree human creature, the more restricted is the optimal blood sugar. In all fairness, these conclusions are supported occasionally in the literature.

> ...The blood glucose level in a typical person after an overnight fast is 80 mg/100 ml (11)...
>
> In the normal person the blood glucose concentration is very narrowly controlled, usually in a range between 80 and 90 mg/ml of blood in the fasting person each morning before breakfast (2)...

Finally, we concluded from a symptomless/signfree model, that philosophically at least, there is a hypothetical endpoint rather than end-range (47).

How close can we come to that magic number?

There is reason to believe that no one is perfectly healthy (48). Secondly, the nature of the test procedure makes it impossible to reproduce the very same results. For example, all inter-and intratechnician studies show that there is an inherent variation in quality control. The numbers from different technicians using the same blood samples at the same time and/or the same technicians utilizing the same samples at different times, even under the most optimal circumstances, nets a blood sugar deviation of plus or minus 5 mg%.

It is claimed that food/drink will alter the blood sugar values as borne out in the following representative statements.

> ...The (blood glucose) concentration increases to 120 to 140 mg/dl during the first hour or so following a meal (2)...the blood glucose level during the day normally ranges from about 80 mg/100 ml before meals to about 120 mg/100 dl after meals (11)
>
> ...plasma glucose increases with the ingestion of each meal...The magnitude of the response and its duration depends on the size and the composition of the meal (15)...

The fact of the matter is that food/drink does not alter blood sugar; poor food/drink does (17).

Finally, mention was made earlier of some prevailing semantic shenanigans (7). In this report, thus far, blood sugar and blood glucose have been used interchangeably. Actually, blood sugar equals blood glucose plus other reducing substances. In some circles, it is said that one can arbitrarily assume that blood sugar is about 15 mg% higher than blood glucose. Not true.

> ...In evaluating the older literature, one must also be aware that some values are falsely high because they were based on nonspecific methods that included reducing substances other than glucose. Today almost without exception, plasma glucose is measured and measured

> specifically, *e.g.*, using enzymatic methods based on glucose oxidase (15)...

The fact of the matter is that the difference can range from 0 to as high as approximately 80 mg% (7). Fortunately, blood sugar is now rarely used. Hence, this may be an academic point. However, what should be emphasized is that here is another factor that obviates a single magic number.

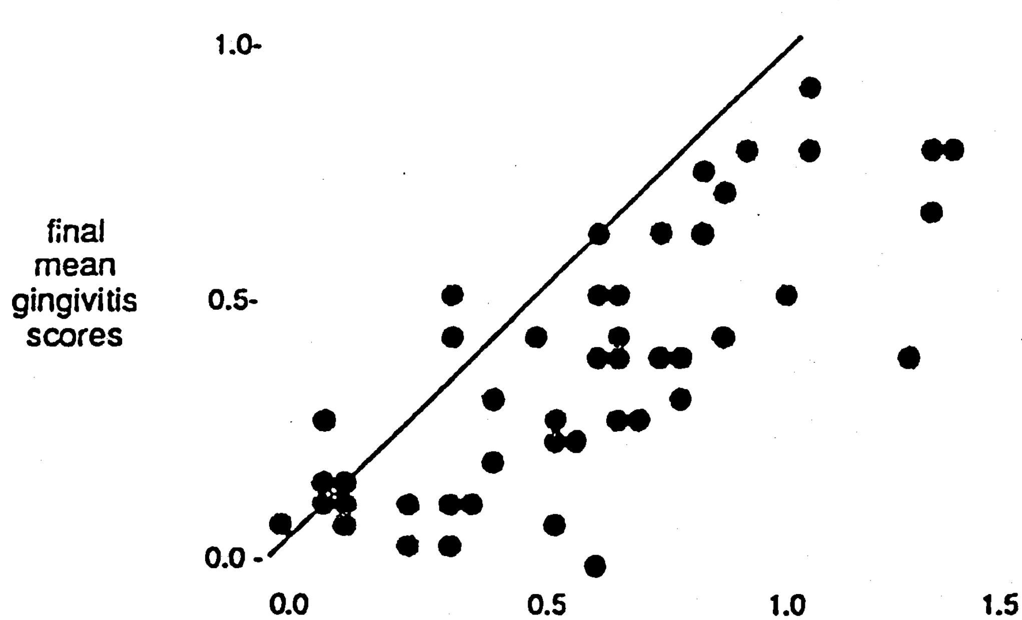
As we have pointed out already in the introduction, in the real world, blood sugar is principally employed to aid in the identification of the diabetic state and to monitor the course of the disease. The fact that this is (more often than not) not accomplished can be concluded by the persistent diabetic complications in the eye, kidney, and heart/blood vessels. This classical concept it captured in the following citations.

> ...The initial goal of treatment in all diabetic patients is the elimination of the symptoms that occur secondary to hyperglycemia. A second goal of therapy is the prevention of the long term complications of diabetes. At this time, there is no definitive evidence that a reduction in blood glucose levels will prevent the long-term complications of diabetes. Nevertheless, there is substantial clinical and experimental evidence that elevated blood glucose levels may be detrimental. It seems worthwhile, therefore, to attempt to normalize blood glucose levels in diabetic patients (5)...

It is the position of this discourse that normalization of blood glucose means this very narrow range...the approximation of the "ideal" state. In other words, a "controlled" diabetic should be, or at least behave like, a nondiabetic and, it would follow, free of the usual complications.

The dissatisfaction with the control of diabetes under present circumstances is one very good reason for seeking out a more realistic blood sugar.

**Figure 1.** Comparison of Gingival Response to Scaling in 45 Subjects



The other, the generic purpose, is to establish the ideal blood sugar that discriminates health and disease beyond the diabetic phenomenon.

In the practical world, what does all this mean? And how can it be demonstrated? Clinicians and even the rest of us know well that a seemingly similar problem treated seemingly similarly (even by the same therapist) often nets vastly different results. Thus, for example, scaling (the cleaning and polishing of the teeth) may yield different and sometimes unexplainable results in seemingly similar people.

We know that, and it is graphically portrayed (**Figure 1**). Shown on the abscissa are the mean gingival inflammation scores for a group of presumably healthy subjects prior to scaling. (As one moves from left to right the gums are poorer.) Depicted on the ordinate are the grades for the same group after cleaning and polishing of the teeth. (Proceeding upward the gingivae is worse at the end of the experiment.) It is obvious that most of the subjects demonstrated an improvement in gingival inflammation (shown in the dots representing patients below the diagonal line). A few were unchanged (on the line) and some actually worsened (above the diagonal line). Here is a graphic representation of what has just been described, namely the variability in response to a simple therapeutic experience.

Let's now back up and tell the whole story...the full meaning of the "ideal" blood sugar. The clinical element to be examined is periodontal disease measured by gingival inflammation (49).

Forty-five presumably healthy (deemed-to-be nondiabetic) males, ranging in age from 20 to 50 years, were employed for this demonstration. At the first visit, specific gingival areas were graded on a four-point scale ranging from 0 for no gingival inflammation to 3 for classical gingivitis. The numbers were then added and divided by the measured sites. Hence, 0.0 represents perfectly healthy gingiva; 3.0 the worst possible clinical state. Obviously, most of the numbers are somewhere in between. But, the most critical point to remember is that the higher the gingival score, the sicker the gums.

At this initial visit, venous blood glucose was measured. One half the mouth (right or left) randomly chosen was scaled. The other half was used as a control.

**Table 6**. Mean gingivitis scores before and after scaling

| Lines | Blood Glucose Ranges | Sample Size | Mean Gingivitis Initial | Final |
|---|---|---|---|---|
| 1. | 60 - 100 | 41 | 0.6 | 0.4 |
| 2. | <60 - >100 | 4 | 0.8 | 0.5 |
| 3. | 65 - 95 | 37 | 0.5 | 0.3 |
| 4. | <65 - >95 | 8 | 0.8 | 0.5 |
| 5. | 70 - 90 | 30 | 0.5 | 0.3 |
| 6. | <70 - >90 | 15 | 0.7 | 0.5 |
| 7. | 75 - 85 | 13 | 0.5 | 0.2 |
| 8. | <75 - >85 | 32 | 0.6 | 0.4 |

Two weeks later, each person was gingivally reexamined by the same clinician with no knowledge of the earlier scores. Blood glucose was also remeasured.

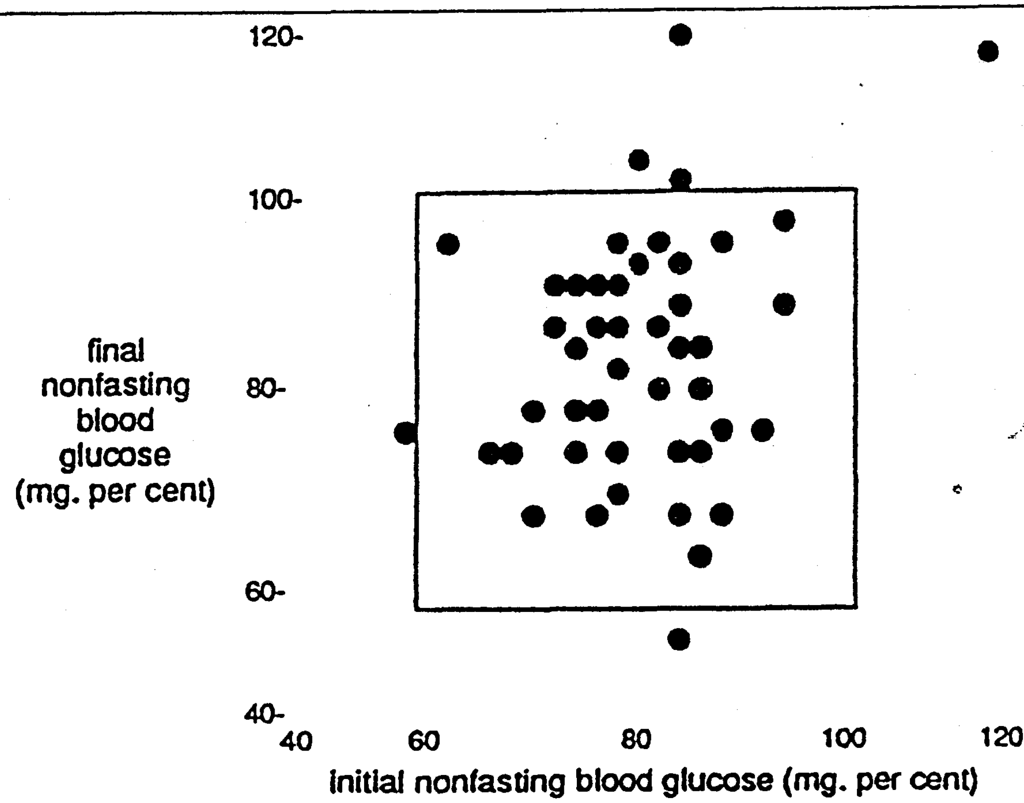
It's obvious that different subjects responded differently to the same therapeutic approach (in this case, scaling as shown earlier in **Figure 1**). Why? Certainly the oral environment was not the same in all the test group (some people had better gums than others initially). Perhaps with other local therapy (*e.g.*, consistently good oral tooth brushing on a daily basis), the gingival response might have been more consistent. Clinical experience says this is likely. But, the general observation also indicates that there may be other host factors.

**Figure 2** graphically portrays the initial blood glucose scores on the horizontal and the final values on the vertical axis. Think about it this way...being within the rectangle is better (suggests more desirable health than being outside).

**Table 6** shows the means for the two groups before and after scaling. Two points deserve special mention. First, the mean gingivitis score (line 1) for the subjects with the presumably better blood sugar (60-100 mg%) is lower and better (0.6) than the group (line 2) with the poorer sugar state (0.8) prior to scaling. Second, the better glucose state also showed a lower gingival score postscaling 0.4 versus 0.5 (lines 1 and 2). Thus it seems, within the limits of this pictorialization, that the responses to prophylaxis are different and more predictable when judged in view of a blood sugar marker.

Obviously, as we have learned, there is general disagreement among investigators regard-

**Figure 2.** Blood glucose levels before and after therapy viewed by different standards of normality



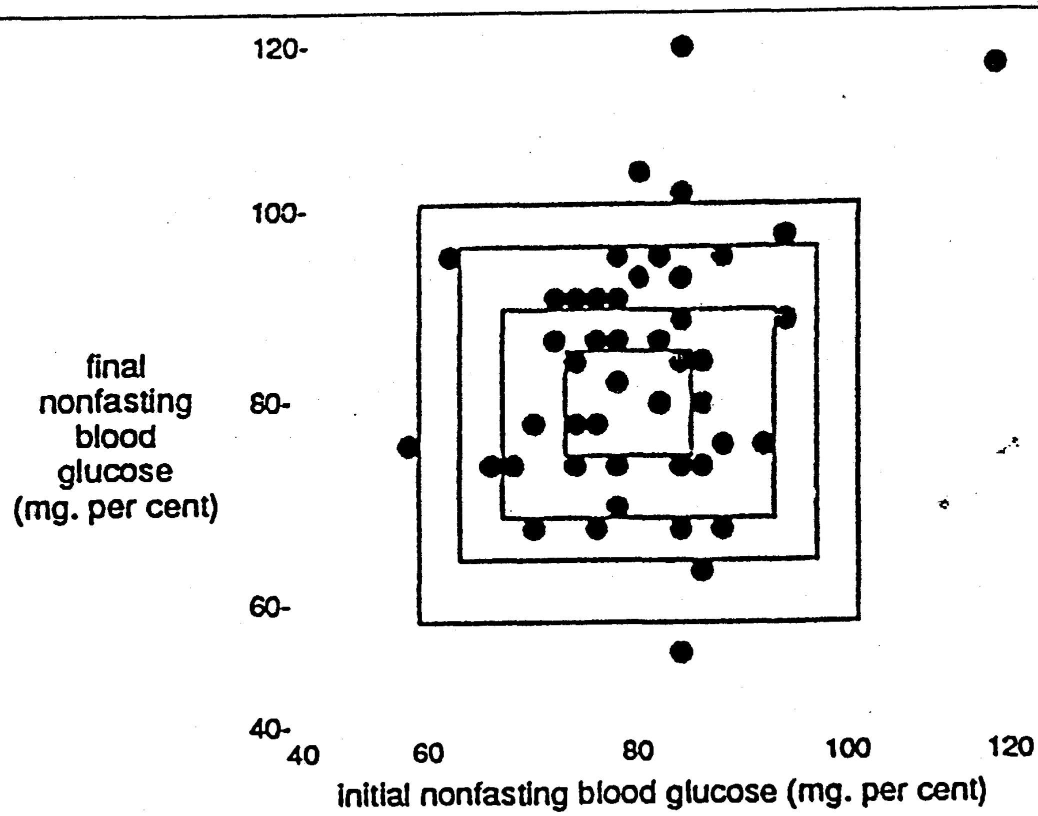
ing so called good and bad blood sugar. Therefore, let us restudy the observations in the light of other more restricted blood sugar parameters.

In **Figure 3**, the peripheral box describes the initial and final blood glucose levels for a slightly more compressed normal limit (65 - 95 mg%). By this delineation, now there are fewer so-called healthy people, 37 (line 3, **Table 6**) instead of 41, that fall within the physiologic area; eight now may be regarded as pathologic (line 4). The gingival findings are summarized in **Table 6**. First, it is well to point out that the mean gingival rating for those with the more satisfactory blood glucose range is less, 0.5 (line 3), than for the relatively more pathologic group, 0.8 (line 4). Second, the prescaling gingivitis score at the start is lower (better), 0.5 (line 3), for those with blood glucose levels of 65 - 95 mg% than for those with a conventional range of 60 - 100 mg%, 0.6 (line 1). Third, the final mean gingivitis score is lower in the 65 - 95 group than in those with blood glucose levels below 65 and above 95 mg%, 0.3 (line 3) versus 0.5 (line 4).

With decreasing size, the second and third squares of **Figure 3**, describe the patterns when one considers an increasingly more restricted blood sugar. The final conclusion is that those subjects (line 7) with the so-called best, the "ideal," blood sugar (75 - 85 mg%), show, following the cleaning and polishing of the teeth (0.2), the best gingival state (closest to 0).

This demonstration of the greater meaning of "ideal" blood sugar is presented because of its simplicity and the fact that it lends itself to reasonably precise measurement. We have reason to believe that this same relationship is noted in

**Figure 3.** Blood glucose levels before and after therapy viewed by different standards of normality



many other nonspecific clinical problems (*i.e.*, furunculosis) (50). Our laboratory has also demonstrated exciting electrocardiographic parallelisms (51-52). Finally, if and when the appropriate studies are accomplished, it is reasonable to expect that the blood sugar principles described here will obtain with such killing and crippling diseases as carcinomatosis (53-56).

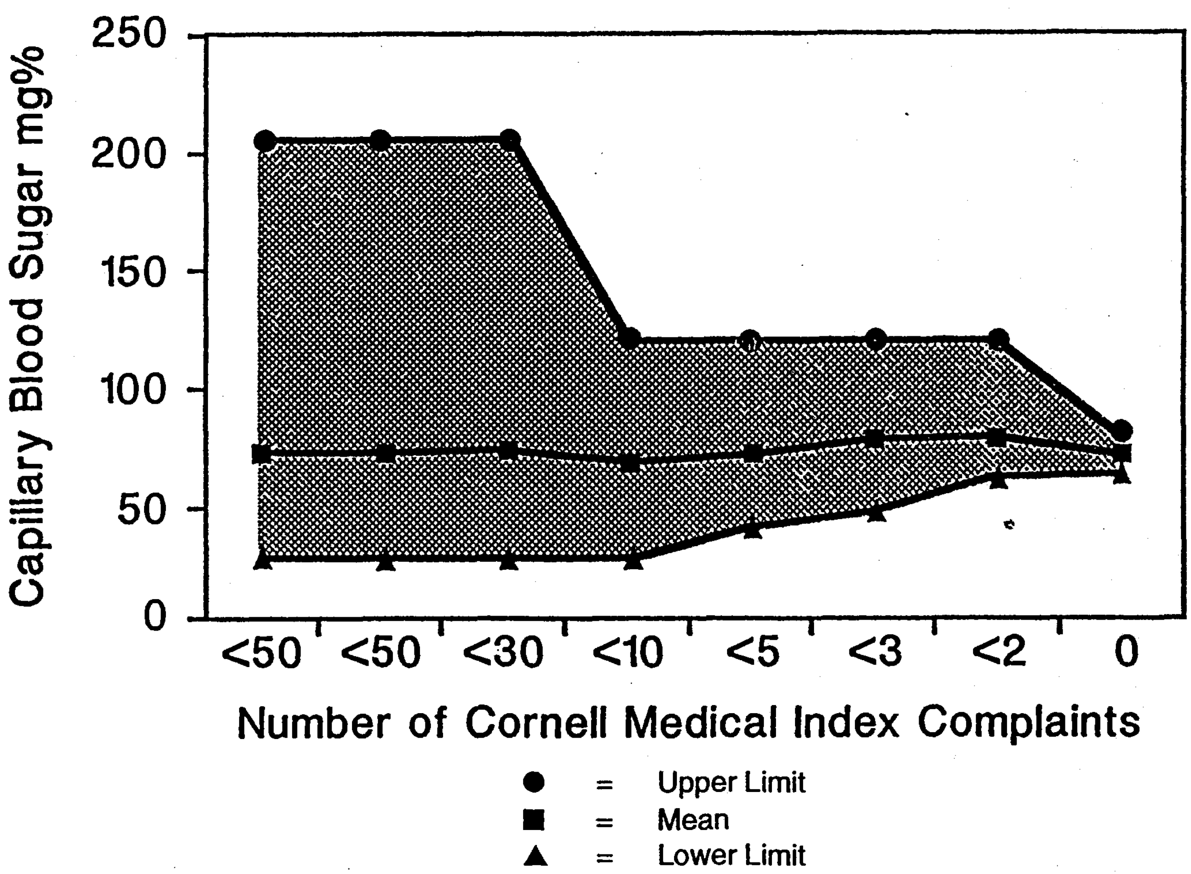
## SUMMARY AND CONCLUSION

For most of this century, sugar (and now more properly glucose) has been the number one blood biochemical test. The intent has been twofold: first, for the diagnosis and detection of diabetes mellitus. The second aim is to monitor the treatment course. The fact that diabetic complications are and continue to be epidemic raises the question of whether the present and prevailing control of this syndrome has indeed been achieved. From this report, it is reasonable to believe that viewing the "ideal" blood glucose state in a more restricted range would sharpen the definition of diabetes mellitus, make for earlier detection, allow more rigid control, and minimize the devastating sequelae.

What has also ordinarily not been seriously considered is the role of blood glucose in homeostasis. Rene Dubos, in his book (57), states:

> ...He (Claude Bernard) emphasized that at all levels of biological organization, in plants as well as in animals, survival and fitness are con-

**Figure 4.** Blood glucose mean and range at four/five hours in subgroups of patients reporting progressively fewer symptoms and signs of the CMI (moving from left to right)



> ditioned by the ability of the organism to resist the impact of the outside world and maintain constant within narrow limits the physicochemical characteristics of its internal environment.

There is reason to believe that one of the final common pathways for the steady state is blood glucose. The saga of earlier experiments emphasizes that the blood glucose range systematically shrinks with progressive healthiness. The data shown (**Table 5**) is now graphically portrayed (**Figure 4**). It will be noted, that moving from left to right on the abscissa stiffens the health requirements. Under these conditions, the blood glucose range (highlighted by the grey area) progressively and systematically shrinks, to a metaphysical point.

Let us exit with the statement from an advertisement by the American Diabetes Association published in *JAMA* (58). "If diabetes is a disease you can live with, why did 150,000 die last year?" It might well be that some of the answers are forthcoming from these new and more realistic definitions and the consequent clarifications of the "ideal" blood glucose. And, beyond diabetes, there is the bigger issue of the syndrome of sickness. It is our contention that if and when the problem is studied like it should be, the overriding significance of homeostasis will be recognized...and this will come to pass from a more sophisticated characterization of the "ideal" blood sugar.

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