

Speaker Notes

Biological Age Measurement - Clinical Applications

The background of the creation of a software tool to measure biological age, based on scientific knowledge and clinical records.

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1. Introduction

2. Introduction

People have been writing about ageing and rejuvenation since the beginning of recorded history, recent advances in medical intelligence and technology have greatly improved the ability and feasibility of controlling the aging process, this is reflected not only by the number of “how to” life extension books, but by the number of books relating to this topic written for the professional medical community. In addition, the interest and need for people to look younger and feeling better demanded by our society, has seen the interest in anti aging and preventative medicine grow dramatically over the past years.

However, there seems to be a lack of interest by the medical community to move into this area, this maybe because few physicians have any training in preventative medicine, or training on how to manage a patient that does not have a pre existing serious disease, therefore, most physicians tend to be reluctant to encourage their patients to pursue such programs, even the few physicians that venture into preventative medicine understand fully what advice to provide to the patient, this is not because of lack of information in the general market, but a lack of understanding of what really works and what they should be advising to the patient.

In regards to assessment, the lack of method to assess the patient in the area of anti-aging or preventative medicine, has had an almost universal shortcoming. What is needed, and will be talked about and shown in this presentation, is a system of health measurement, capable of quantitatively assessing biological age and health status, with sufficient accuracy and sensitivity, to reflect ageing changes over a relatively short period of time.

Without such a system, the only way to evaluate the effectiveness of potential anti-aging drugs and preventative medicines on humans is to perform human life-span studies using various combinations of these substances, then after 40 or 50 years, scientists will be able to evaluate if those using the anti aging

medicines lived longer than those who did not, unfortunately by the time the results are obtained the information will be of little use to us living now.

So what is the purpose of biological age?

The purpose of biological age is to assess a patient at a current point in time relative to their age group, to provide a baseline for their current state of health, however, whilst comparison to a person in their age group provides a benchmark for them against the population, the more important factor of use for biological age is to evaluate age rate or health improvement of a patient over a relatively short period of time, by testing, treating, then re testing, we have a mechanism to evaluate the effectiveness of the treatment, and a further benchmark for future improvement.

By using biological age to treat or find problems before they become critical, will enable a better quality of life, and maybe even an extension of life years

It should become apparent that it is essential for anyone embarking on an age retarding program, or health improvement program, to conduct periodic evaluations of biological age to determine the efficacy of the treatment or program, and identify any negative as well as positive effects the program may have

3. Biological Age

Biological age, sometimes referred to as *physiological age* or *functional age*, is the *objective assessment of a person's health status*. Theoretically, a “normal” person's biological age in terms of appearance, performance and functional capacity, should be the same as his or her chronological age.

The medical dictionary defines biological age, as “the age determined by physiology rather than chronology. Factors include changes in the physical structure of the body, as well as changes in the performance of motor skills and sensory awareness”

Therefore, Measurement of biological age needs to include physiological tests (including motor skills), blood, urine and cognitive function tests, to provide a true picture of a persons biological age.

It is not uncommon to encounter people who do not “Look their age” they may appear much younger or much older than either chronological age. The results of many measurements of biological age indicate, that most older appearing individuals, are indeed older biologically than their chronological ages. Likewise, those who appear younger than their ages are usually *really* younger in biological terms. In some studies researched, those who appeared older or had hyper-tension, diabetes, or other chronic health conditions related to ageing usually scored significantly older than their chronological age. Also, in several long-term follow-up studies, *those who scored the oldest biologically died the soonest.*

The Importance Of Measuring Biological Age

In order to assess the benefits of any antiaging protocol, it is essential to accurately measure biological age and aging rates. Otherwise, there is no way to know whether the program works or not. While routine clinical lab tests are very useful for diagnosing clinical disease, they are almost useless in evaluating biological age or age-retarding programs, especially *when presented as they*

usually are as a mass of unrelated data. The I-M health software provides a structured frame work for organising much of this random data into a signal objective quantitation of biological age, as well as a means of longitudinally evaluating individuals parameters.

4. Criteria for selection

A sophisticated ageing measurement system should :

include values known to change with age

be capable of evaluating one's health status and aging rate

detect subtle changes in the age rate – either positive or negative

the tests should cause minimal trauma and be relatively non invasive

the tests should provide highly reproducible results and reflect physiological age

the clinical function being measured should display a significant alteration over a relatively short period of time

the clinical function being measured should be crucial to the maintenance of health and prevention of disease in a woman or man

the degree of aging assayed should correlate with longevity

the makers should be easily assayed

the set of markers should be nonredundant

5. Normal Ageing

The aging process is very subtle and results in only minor decrements in functional capacity and appearance from year to year. Healthy individuals in their 80's or 90's score within the normal range for many routine laboratory tests. For example, there is essentially no change in the red and white blood cell counts, haemoglobin, and some blood tests between the healthy elderly and the young.

A normal healthy person with a reasonably good genetic background, average diet, who exercises moderately and doesn't smoke, should have a biological age that coincides with his chronological age, and which should, increase at the same rate. In other words, for every year of chronological age, the biological age should also increase one year as displayed in this slide

6. Accelerated Ageing

A sedentary person who smokes, regularly drinks more than two alcoholic drinks per day, thrives on “junk-burgers”, and who probably has one or more chronic illnesses as a result of his or her lifestyle, would probably score older biologically than his or her chronological age, and would probably age biologically faster than one year, for each additional year of chronological age, as displayed in the slide

7. Corrected Accelerated Ageing

If this same person saw the error of his or her ways and began to exercise regularly, eat more complex carbohydrates, and less sugar and fat, take nutritional supplements and quit smoking, he or she would probably significantly slow their rapid aging rate, and restore their biological age to normal as shown in the slide

8. Ageing Rate Retardation

Aging-reversal even more than aging retardation remains in the theoretical realm. True reversal of aging requires the identification of the genetic loci that control the aging process, and the manipulation of these genes by genetic engineering techniques. This should cause the DNA to restore “old” cells to an optimum state, and essentially rejuvenate the organism.

It should be noted that the only really “old” cells in an elderly person are the non-dividing cells in the brain, heart, and other organs. Even these cells in an elderly person’s body are not much older than those of a young person, but may be of poorer quality.

While aging reversal by genetic engineering is a theoretical possibility, the knowledge and technology to accomplish this is not currently known but is well on its way. In the meantime, we must endeavour to take advantage of current “state-of-the-art” aging intervention techniques, such as avoidance of risk factors, optimum nutrition, adequate exercise, caloric restriction, anti-oxidant therapy, immune restoration, hormonal manipulation, and other potential techniques

9. Ageing Measurement Systems

Many attempts to measure biological age have been made during the past 30 years by scientists throughout the world. In most cases, the researchers studied large population samples, and attempted to find physiological or biochemical variables correlated with chronological age. The results were combined into a system or an equation to calculate biological age.

The major problem with most of the aging measurement systems is that, with a few notable exceptions, they were “one-shot” studies. That is, the experimenters studied large numbers of people, calculated their measurement systems, published the results, and then abandoned their research for other projects.

Few researchers meticulously followed up on their own or others measurement systems in a comprehensive longitudinal or comparative evaluations. However, I-M health has done exactly this, we have combined studies and created an age measurement system that can be used in a clinical environment.

10. Health Hazard Appraisal

I just want to talk about Health hazard Appraisal for a few minutes, in an age-retarding program, it is obvious that every potentially hazardous habit or action should be identified and eliminated.

While there is no proof that any of the theoretical life-extending protocols and techniques currently being followed by many people will keep their promise, there are many well-known life-shortening habits, such as, smoking cigarettes, not wearing seat belts, overeating, abusing drugs and alcohol, and inadequate exercise. Clearly, it is absurd to waste money and energy on a life extension program, if a life-shortening lifestyle is indulged – especially one that is largely correctable.

There is a practical means of identifying and quantifying life-shortening habits. It uses a computerised system known as *Health Hazard Appraisal*, *Health Risk Index*, *Health Risk Profile* or other similar terms depending upon the organisation which prepares the report. These similar analytical systems are computerised or hand-calculated evaluations of environment and lifestyle, which may have an adverse effect on life expectancy. The Health Hazard Appraisal quantifies both the life-shortening effect of these detrimental habits, and the increased life expectancy attainable if the habit is eliminated.

The concept of Health Hazard Appraisal was developed in the early 1960's by Drs. Lewis C. Robinson and Jack Hall at the Methodist Hospital of Indiana in Indianapolis. It is based on statistics derived from the monumental Framingham study in Massachusetts, in which Dr. Robbins was a participant. In this ongoing study, medical teams monitor the health and lifestyle of some 5000 residents of Framingham, Massachusetts. They carefully record weight, serum cholesterol, blood pressure, and other factors. When members of the community die of heart disease, stroke, and other ailments, the medical teams analyse the relationship between living habits and causes of death.

The study clearly shows that cigarette smoking, elevated cholesterol, and high blood pressure are linked with heart disease and stroke. The computer analysis also gives numerical values for the influence of each factor. It shows, for example, that someone with a systolic blood pressure of 160 is four times more likely to have a heart attack than someone with a systolic blood pressure, less than 120.

In 1970, Robbins and Hall published a book for physicians entitled *How to Practice Prospective Medicine*. Their program provided a means to determine the relative risk of dying from various diseases or accidents during each decade of chronological age. It highlights the 10 major causes of death for each decade, identifies lifestyle factors that contribute to increased risk, and calculates a relative risk age. The “risk age” is determined by comparing an individual’s chances of dying with others in the same chronological age group on identified risk factors.

In the market place we see many systems that profess to calculate biological age, based on risk assessment through answering a set of questions of life style. This is not biological age but risk age, risk age is not related to biological age. Nevertheless, the identification and elimination of potential life-shortening hazards, greatly improves the chances of achieving one’s maximum life span. It seems only reasonable, that those interested in extending their lives, should be interested in avoiding behaviour that might shorten them.

Mounting evidence indicates that the quantitative information and recommendations concerning personal health, presented in a Health Hazard Appraisal dramatises the dangers of unhealthy lifestyles, and motivates people to make positive changes. In summary, Health Hazard Appraisal tells what changes one is taking with his life, and how the odds of surviving the next 10 years can be improved.

11. Clinical Application - Approach

Aging is a highly individual process which requires the intelligent analysis and interpretation of a wide range of physiological, biological and mental indicators in order to draw a reasonable conclusion about the health of an individual. A system needed to be designed that could be used in a clinical environment to provide a set of markers of aging, 'biomarkers', that can be used to repeatedly measure the biological age and aging-rate of an adult.

I-M Health have achieved this through the development of software that can be used in a clinical environment. Through the use of the system the derived IM-Health score describes the age of a person relative to others in a sample, yet does not reflect the probability of death at any given chronological age.

Each age-measurement taken allows a comparison of biomarker results with a previous baseline, be that against the sample group or against themselves, thus providing visibility of the rate of change, and hopefully aging reversal in some areas after treatment.

A cross-sectional study based on measurements obtained at one point in time, cannot indicate the rate of aging directly. Therefore, the process must allow for repeated measurement and comparison.

In repeatedly measuring each biomarker, the rationale adopted is, that within an individual, if a deviation from an expected result occurs, then that change may be attributed to an aging effect. The pattern of differences between chronological age and the series of biological ages that have been determined can be demonstrated and compared.

Of course, departures from the age-norm data may be due to disease, but we typically class cancer, diabetes, hypertension and Alzheimer's as age-related diseases. If we accept that these age-related diseases cause vulnerability and dysfunction, characteristics of health impairment, and health impairment as a

part of aging, then there is no reason to exclude their contribution as an aging-effect.

The rate of aging, once determined, allows the effectiveness of attempts to change the aging-rate to be measured.

The rate of aging, along with the computed overall biological age of the individual, may have significance as a health measurement in their own right. However, one should not lose sight of the fact, that the discipline of measuring a wide ranging set of biomarkers, allows for a health analysis of the individual to be performed ahead of any overall biological age calculation.

While the I-M Health measurement of biomarkers across subjects can be seen as random occurrences, I-M Health collect results anonymously and stores them in a centralised data base, the collective analysis of these tests will allow the identification of evolutionary weak-points, and aging trends in the general population of the world. This will increase our detailed knowledge of the processes involved in aging, and allow a better understanding of the effectiveness of anti-aging interventions to be made.

Furthermore, the centralized collection of the data, will allow for validation studies in which the calculated biological score, compared with chronological age, is mapped against subject distinctions, such as occupation type, achievers vs. non-achievers etc.

It is also important to understand, those variables which do not show any significant variation from the age-norm data. It maybe that a particular influence, for example, diet or smoking may effect the biological age of some physiological markers. The individual marker profiling allows these comparisons to be made, and thus allow further analysis of trends or particular aging characteristics.

12. Marker Groups

In creating the measurement of biomarkers in a clinical environment, the first step is to decide the marker groups to be used, those already in frequent use within the clinical environment were identified as the most appropriate to use in a battery of biological age measurement tests. As part of the inclusion process, each biomarker was qualified alongside tests which had been useful in deriving a functional age in other studies, of course, the parameters must be applicable for the estimation of the biological age of the individual and their rate of aging.

The tests included, provide a broad mixture of physical fitness, flexibility, cardiovascular (including hypertensive), cognitive, clinical as well as biological, and even oxidative stress.

Not all health groups have been included, possibly one health group that is not covered by a biomarker, is that of vigour, in particular the cardiovascular measure of maximum oxygen uptake VO_{2max} , which is generally considered to be an appropriate measure of physiological health. However, this has purposely not been included, due to the fact that its measurement can be problematic in elderly populations. Thirty percent of subjects over 60 years of age are unable to attain the oxygen plateau required for VO_{2max} determination. In addition, the pre-requisite medical criteria to allow subjects to participate, even in submaximal exercise tests, mean that studies of physical fitness in the elderly have been restricted to a healthy set of individuals. This in effect, excludes more infirm subjects, from the research, and prevents a more generalised population comparison.

13. Biomarker Included

The chart shows the biomarkers included in the I-M Health system

14. Health Importance

While the biomarkers listed, allow for a determination of a biological age by marker, and a rate of aging for an individual, any marker results that display values significantly outside of the normal reference ranges, may provide an even greater insight to the health of the individual, than the biological age determination itself.

If we take the Oxidative Stress biomarker of Albumin as an example, then lower than normal levels, may indicate oxidative damage, or a lack of available defence against free radicals. Given the current interest in oxidative stress, implicated as a cause of aging, as well as contributing towards such age-related diseases as carcinogenesis, diabetes and neurodegenerative disease, clearly any reduction in antioxidant levels would be cause for concern.

Due to the high amount of albumin present in the body, it is considered to be one of the primary antioxidants. It is a dual antioxidant in that, it contains many very active thiol groups that act as potent antioxidants, and albumin also has a strong prooxidant metal binding capacity. Albumin is also known as a sacrificial antioxidant, as it has no recycling pathway, and the consequences of its own oxidative damage do not directly affect the cellular function.

As a further example, the use of very large normal populations to establish DHEAS age-norm biomarker data, has also provided clinically meaningful normal DHEAS ranges. While the clinical usefulness of DHEAS measurement has been limited up to now, there have been statistical associations of abnormal DHEAS values with breast cancer, coronary heart disease, and Huntington's chorea. Low serum concentrations of DHEAS, have also been associated with the presence of Alzheimer's disease, and cerebrovascular dementia. Therefore, the biomedical significance of the DHEAS measurement, should not be overlooked as a health marker, as well as an age marker. While using each of the biomarker results to measure and report an individual's biological age, one must also use

the measurement from each biomarker, to understand more about the health of the individual.

15. Selection Methods

The biomarker selection for the I-M Health system, is based upon the understanding, that aging is characterised by the sum of a large number of physical, and biological changes, occurring throughout adulthood leading to decreased functional ability. The initial selection of biomarkers, was taken from the work of Dr Ward Dean and his book titled Biological Age Measurement.

Dr Dean determined, a set of biological tests that correlated closely with chronological age. The approach assumed, that those traits which vary most closely with age, are the best indicators of the aging process. The biomarkers were further qualified, by analysis based upon criteria identified in the 1987 primate study, at the National Institute on Aging:

In looking at the inclusion of Biomarkers of aging, the variables should show a clear directional change, being positive or negative slopes, during adulthood, evidenced by cross-sectional study data.

Where a biomarker failed to demonstrate, a consistent positive or negative slope over time, then the marker was not considered for inclusion. A good example of this is, Total Cholesterol for men, which despite a strong mean increase to the decade 35 – 44 years, then demonstrated a slowing of the rate of increase, to decline slightly after 65 years, given the I-M Health analysis window represents the ages 30 through to 70, then this late decline, prevented the marker from being included in the I-M Health programme. On the other hand, female levels of Total Cholesterol, show a much later decline than men and as such, Total Cholesterol for women is included as a valid marker of aging within the I-M Health programme.

Longitudinal research studies were reviewed to identify, those biomarkers that exhibited longitudinal change, in the same direction as cross-sectional studies. Examples of the biomarkers which met this criteria and the supporting research studies are displayed in this slide.

16. Criteria of Biomarker Inclusion

Within the I-M Health system the biomarker determination had to conform to the following criteria:

1. The biomarker must determine biological age
2. The biomarker must show a clear directional change
3. Be a result of a human clinical assessment
4. Be a significant representative sample
5. Have a relatively narrow standard deviation
6. Be based on multiple complementary research studies
7. The biomarkers themselves should have an effect on the functional ability of the individual. An exception to this is the biomarker of hair greyness. Hair greyness does carry a significant correlation with age, but does not make a significant contribution to the overall biological age determination of an individual, some would say, therefore, it should not be included as a biomarker, but this is open to discussion, especially when the discussion is in regards to overall biological age, hair greyness may greatly inflate the overall age of the individual with no association to health.
8. The selected biomarker test should provide the same, or very similar results from an individual, when applied over relatively short time intervals. While the measurement of a biomarker is guided, by the publication of a standard practice clinical protocol issued to all I-M Health subscribers, some markers which do correlate closely with age, will provide varying results, when repeatedly measured over a short period of time. A good example of such a marker which fails I-M Health's inclusion, is Melatonin. Melatonin varies

throughout the day according to the circadian rhythm. While plasma Melatonin peak levels show a significant age-related decline, and would thus be an obvious biomarker candidate, the practical problem of gaining reliable peak values, as a measurement value precludes, Melatonin from becoming an I-M Health biomarker.

9. A biomarker measurement test, should be applicable to subjects through the age window of 30 and 70, and there must be complimentary research papers, which provide reference data values across this age range. In addition, the biomarker data values, should be representative of the general populations. An example of a failed biomarker in this regard, is PSA total. PSA Total in a study showed a direct correlation with age, however, the study could not be used within the I-M Health data model, due to the fact that the study lacked, age-matched cancer-free controls, without evidence of benign prostatic hyperplasia.
10. The biomarker tests must be non-invasive, relatively painless and not be dependent on the motivation of the subject.
11. The biomarkers themselves, should only require tests, that can be performed in a non-hospitalised environment, and not require long test timeframes. As an example, GFR fits the profile of a biomarker in terms of relationship with age, and one could use the urinary clearance, of an ideal filtration marker, such as insulin or iothalamate, as the 'gold standard' for the measurement of GFR. Unfortunately, these measurement methods prove inappropriate, for the standard clinical practice in terms of ability, and time

required to perform the test, and as such, prevent GFR from inclusion into the I-M Health programme.

12. A biomarker should require a test that is not overly financially expensive to conduct. While 'Vibration Perception Threshold' (VPT) could be introduced as a marker of aging, the need to determine application pressure as well as amplitude, pushes the equipment requirement beyond a price point which is commercially viable.
13. The biomarker should be, such that it can be treated in an upward or downward direction as appropriate.

The battery of biomarkers included is typical of those mentioned in other studies. They have been validated in cross-sectional and longitudinal studies, and shown to have statistically significant data, reliability between age-bands. Further validation criteria has been applied to each biomarker, to take into account the more practical considerations of the test environment, treatments and cohort samples.

The selected biomarkers do not measure the rate of change of aging as a predictor of lifespan, but they are used to show objectively, through the implementation of clinical, and laboratory tests what is readily apparent to everybody, the differences between a young and old person. In turn, by using a measure of central tendency, the I-M Health™ system estimates an overall I-M Health™ score.

17. Biological Age Calculation

Many researchers have detailed methods to calculate biological age. The most common approach has been to combine a large number of markers of aging, biomarkers, in a multiple regression equation, to predict a result deemed to be the biological age of the subject.

This methodology has not been adopted by I-M Health due to the lack of an agreed, consistent method, we wanted the most scientific method to calculate biological age

The I-M Health system calculates a biological age for each of the biomarkers, using appropriate 'age-norm' data.

Derived Biomarker Curve

The lowest level of data used is that of a chart displaying mean values, for a biomarker across differing age bands. These mean values may be taken from cross-sectional or longitudinal studies, and map to calculation points within the central I-M Health database. A calculation point reflects a 5-year increment from 30 to 70 years of age.

This mapping requires the determination of a curve across, the calculation points, which is then used, by the calculation engine, to calculate a biological age, for a particular biomarker. This is the level at which the biological age calculations are made.

Due to the fact that much of the research data is based upon age bands (for example, mean values for 25 – 34 year olds, mean values for 35 – 44 year olds and so on), the mid-point of these age bands (i.e. 30 and 40) is used to represent the group mean score. Extrapolation (based on a piece-wise linear approach), is used to create the curve between the age band mid-points, to ensure a continuous curve as displayed. The mean scores describing the curve are then mapped directly, to the calculation points and stored within the I-M Health database.

The calculation of biological age for a specific biomarker, involves determining the intersection of the measured value from the biomarker test, with the derived curve, that describes the age-norm mean, and from the intersection reading off the mean age, associated with that measurement value.

18. Fev1/FVC

Some examples.....

The decline in the FEV1/FVC ratio with increasing age was sourced from the work of Quanjer *et al.* (1993), supported by Langhammer *et al.* (2000), Hankinson *et al.* (1999), and Gore *et al.* (1995) to derive the I-M Health™ biomarker data.

- Prediction equations were generated for the European Community for Coal and Steel (ECCS) following a Dutch cohort review (lifelong non-smokers) of results from 458 males and 338 females, aged 18 – 70.
- Langhammer studied a Norwegian cohort of 546 females and 362 males lifetime non-smokers without respiratory problems. After a plateau in younger adults, the lung function variables of FEV1, FVC and FEV1/FVC ratio declined with age, with FEV1/FVC decreasing across both sexes at a rate of 0.12 – 0.14% per year.
- Hankinson developed Spirometric reference values for Caucasians, African-Americans, and Mexican-Americans 8 to 80 yr of age from 7,429 asymptomatic, lifelong non-smoking participants in the third National Health and Nutrition Examination Survey (NHANES III). Reference values and lower limits of normal were derived using a piecewise polynomial model with age and height as predictors.
- Gore determined Spirometric prediction equations from 249 female and 165 male, asymptomatic Australian Caucasian adults. The derived equations did not differ significantly from the majority of previously reported equations, again showing a decline in FEV1/FVC over time.

19. Slide 2

20. Cognitive Function

More.....

Each of these measurements provides a speed of response outcome, which is effectively the average reaction time of the individual for each measurement type. The research determined that there is a clear relationship between age and performance on these five CogHealth outcome measures. For example, the values indicating a very strong linear relationship between age and performance. These results indicate that as age advances, speed of performance on CogHealth also increases (i.e. slows down).

21. Total Cholesterol

The rise in serum total cholesterol with increasing age for females was sourced from the work of Bulpitt

- Bulpitt reviewed indicators of aging in 3402 male and 2152 female London Civil Servants, aged from 35-59 years of age, and demonstrated an increase in female serum cholesterol over the decades.
- Moore and Gordon presented data from the US Health Examination Survey between 1959 and 1962, in which examinations were performed on 6,672 civilian, noninstitutional subjects aged 18 – 79 years.
- Jungner primarily measured Apo B and A-I values in 147,576 Swedish males and females, standardised according to the World Health Organization-International Federation of Clinical Chemistry First International Reference Materials". Serum concentrations of cholesterol were measured from 1985-1996 in a Swedish cohort of 83,112 males and 64,464 females ages <20 to >80 years. The mean cholesterol value rose for females up until the 8th decade of life, and then tailed-off.
- Schaefer measured total cholesterol levels in 1,533 men and 1,597 women participating in the 3rd examination cycle of the Framingham Offspring Study. Increased age was associated with significant rises in total cholesterol from the third to the eight decade in life for females.
- Kinlay measured total cholesterol levels in over 600 men and women aged 30 – 69 years who were selected at random from an Australian community. Total cholesterol increased with age, with this effect being most pronounced in women.
- Willeit employed a population-based survey to address changes in risk factors and insulin levels across an age range of 40-79 years in men and women. Population recruitment was performed as part of the Bruneck Study from July to November 1990 and 820 men and women were assessed for insulin concentration
- As part of the examination used in assessing the nutritional and related health status of the U.S. population, 1971-74, Abraham reviewed serum cholesterol

values of adults 18-74 years of age using a cohort sample of 8411 females and 5,260 males .

- Kuzuya reviewed secular trends in serum lipid levels and their influence on the aging process in a large Japanese cohort. The participants included 80 331 Japanese men and women 20-79 years of age, who had received annual health examinations from 1989 to 1998. In cross-sectional analysis, an increase in total cholesterol was observed in the population.
- Carroll presented basic reference data on serum lipids and lipoproteins for US adults aged 20-74 years of age, as part of NHANES II. A total female population of 6,260 provided data which showed an increase in total cholesterol from the 2nd to the 7th decade, with a slight drop in values above 70 years of age.

In addition, Stevenson et al. (1993) demonstrated that aging was associated with increased concentrations of total cholesterol in a female population of 542 non-obese, healthy women.

22. The I-M Health Software

The I-M Health system was born of a desire to have an objective scientific form of age measurement and health assessment for the establishment of a patient's overall state of health. It is the culmination of extensive work by researchers, Doctors, statisticians and computer programmers.

Much of the initial research was taken from Dr. Ward Dean's book "Biological Aging Measurement", published in 1988, unfortunately, this book is no longer in print. As the book was published in 1988, further research was required to take into account recent studies and advancement in the area of biological age measurement, I-M Health continued the research and development of a Biological Age management system, whilst developing the system we realised that we needed more than just biomarkers, in creating a full health and age assessment system we also needed to include what we call General Health Indicators.

General Health indicators are results from tests that do not qualify as Biomarkers and are general tests that are performed to assess the health of a person, these tests include blood, urine, physical and other tests performed to establish the health of a patient.

We also included an extensive questionnaire for the establishment of a patient's health, this with the biomarkers and general health indicators provided software that could be used in a clinical environment for the complete assessment and management of a patient. The system also takes into account recent technological advances in medical science by being able to incorporate new functionality and tests on demand.

The software contains over 1 million lines of code, or 25,000 pages of a normal book and has been based on years of research and development. We have consulted and researched world authorities on Health and Ageing in developing the system and worked with professionals including statisticians, doctors and software designers

23. What is I-M health

I-M Health software is a “Biological Age and Health Measurement System” it measures Biological age and captures General Health Indicators to assess the health and well being of the patient.

The system enables the user to compare Biological and Chronological age, and record General Health indicators for investigation and future reference.

The I-M Health system illustrates, through visualisations and graphs, parts of the body that are ageing at different rates, taking into consideration the patient’s age. The system provides the Doctor with a choice of advice and guidance when interpreting the patient’s results, including a full overview and explanation of the advice. It also offers comprehensive printed reports of the patient’s results, comprising a colour coded body map, graphs, test explanations, and the advice and guidance provided by the Doctor.

24. General Health Indicators

General Health Indicators are captured and recorded by the I-M Health system providing information about the general health of the patient. The information gathered can be used to view changes over a period of time, hopefully, showing an improvement in the health of the patient. The indicators may also be used in the future to reveal unseen health trends in the patient.

It may also be possible that some of the General Health Indicators become biomarkers once enough additional data has been captured. The advantage of the I-M Health system is that it provides for the global capture and storage of data, thus making the information available in the future.

General Health Indicators may not be accurate to help capture the biological age of a patient. However, General Health Indicators are known markers of some disease and disorder, and therefore should be captured and recorded for future reference.

25. The I-M Health Tests

26. Blood and Urine Tests

27. Physical test

28. Dental tests

29. Cognitive Tests

30. Reports