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A Health Monitor in your Pocket ?

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(This article is a sequelae to the Invited Talk presented in the Computer Science Section of the 83rd Indian Science Congress held in Patiala in Jan 1996. The ideas presented may encourage our IT professionals, particularly those interested in medicine, to do some innovative work to alleviate the human suffering.)

Homeostastis is the automotive process in the body to continually adjust itself to the variations in the environment. It thus helps to keep the internal equilibrium. Perhaps human efficiency is optimum in this state. Sometimes infections, injury, nutritional imbalances, stress, etc., become too much for this process to handle and we need external help. Medicine can be understood as the intervention to put the system back on the track when aberrations occur. Activities to put the system back on the track when aberrations occur. Activities such as immunizations, advice for change in attitudes and life styles, and nutritional supplementations are also interventions but they are preventive and promotive in nature, and generally categorized under the generic of health rather than medicine.

The nature and extent of medical interventions depend on proper assessment of the existing condition. The mankind is becoming increasingly concerned about health, and the investments in health are perceived to pay back multifold. Thus, newer more versatile, more accurate, and less costly instruments and procedures are being increasingly discovered and used. The wonder silicon chip is becoming an intergral part of most medical instrumentation. Due to very fast and innovative developments in the chip technology, the size is quickly shrinking and the capacity exponentially increasing. A room size computer has taken a shape of a notebook in just about 30 years. All these developments could lead to a pocket size instrument in another 25 years which would comprehensively monitor health of our next generation.

Computerized medical instrumentation may be just about the most exciting use of IT in medical and health care. This is not to under-estimate the applications such as access to latest world wide literature through MADLARS, local area networking in the hospitals for instant transmission of investigation reports and of treatment responses, facilities of consultation and learning on internet, 'virtual body' for learning through animated 3-D pictures of body organs, their functions and to rehearse surgery, and expert systems to assist in diagnosis and treatment. These developments are no less important. But computerized instruments can make 'on-line' transmission of anatomical images (x-rays, scenography, computerized tomography scans, magnetic resonance images and electro-cardiograms), of data on physiological and biochemical parameters (blood pressure, serum glucose level, leukocyte count), of text (history of the disease, complaints, signs) and of sounds (cardiac murmers, ronchi, speech stammers). An important by-product of 'on-line' availability of images is computer-assisted surgery (CAS) such as sterotatic and image-guided surgeries. These make separate x-rays, scans, etc., redundant. The surgeon sees the organ in 3-D in the computer screen and performs surgery at the same time at the exact location of deformity. The view thus available to the surgeon is better because it is instant and in 3-D while the scanned images are photographs in 2-D. Computer-assisted surgery is quick, more precise, less painful, with fewer complications, and ultimately less expensive. This also provides an opportunity to perform new or previously impossible, minimally invasive procedures.

Many heart patients are aware of the Holter instrument which records the electro-cardiogram (ECG) of the patient round the clock. It is a small instrument of the size of a walkman which can be tucked on to the belt of the user. Electronic leads from this are clamped on different parts of the chest. A bigger machine is required to read the recorded tape. Nevertheless, we can now imagine a pocket size instrument which would comprehensively monitor structure and functions of various organs of the body. This would have capacity to store the normal variations of features of each part of the body in memory which can even be individualized for the condition of the user. This means that this own age, gender, height, weight, blood group, etc., can be recorded which may be needed to interpret the medical measurements. The instrument thus would be able to analyze the measurements at a given point of time against the normal variations and can set the alarm when departures more than accepted are detected. It can be programmed to even dial a pre-set telephone number through remote control and call the attention of such assistance as doctor and ambulance if required. Perhaps the day is not too far when people, particularly those at risk, would carry such an instrument in their pocket, and feel safe.

Holter is an example of an already existing equipment. The other is the pocket-size ECG transmitter popularly known as Heartline promoted by Apollo Hospitals. Beside heart, brain

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produces large number of electrical signals currently recorded as elecroencephelogram (EEG). In addition, stimulus such as visuals, sounds touch and movements evoke electrical responses which are used to diagnose a variety of neurological disorders such as optic atrophy, myopathy and demyelinating disease. Investigation of brain activity for epilepsy and tumour is common. Being electrical in origin, all these can be easily monitored on a computer.

A watch-type instrument is available which measures blood pressure and pulse rate and can immediately detect hypertension. The body temperature can now be measured with the help of small thermal strip. Urine profile can be obtained with the help of a paper stick which is chemically coated to produce shades of colour indicating levels of sugar, albumin, acetone, etc. Sticks are available for estimating sugar in blood also as well as for hemoglobin level. The reliability of all these is suspect at this stage but can be substantially improved with the assistance of a computer processor. The stick technology can be extended to a variety of investigations such as cholesterol, triglycerides, bilirubin and creatinine, perhaps TLC, DLC also. These can help early detection of a variety of diseased such as diabetes, hepatitis, leukemia, even HIV.

A computerized machine of the size of a brief case now measures lung functions such as vital capacity and forced expiratory volume. One just have to breathe into it to get a display of the values. Earlier it used to be bigger than the size of a fridge. These functions are important indicators of positive health of the person in the sense of his capability to handle extra physical load on the body when required and to diagnose lung diseases including bronchitis, asthma, emphysema and pneumoconiosis. Lung functions show change much before the clinical onset of disease. Developments now occurring in computer technology are bound to further reduce the size of this machine.

Imaging in 3-dimensions is becoming so advanced by dat that our next generation could see a small instrument which would provide instant picture of any internal part of your choice and store it if required for retrieval later on. Depending on the organ imaged, this can help detect malignancy, tuberculosis, pericardiitis, fracture, pneumonia, etc.

When all these are accomplished, their integration into one 'walkman' could be anybody's game. One side of this instrument could be scanner and the other side, say a 2-line screen and a keypad. Besides the chip to process all the data, it may have a small size disk of say 80 MB capacity for storage, a small disk drive and possibly a cellular modem. It may also have interfaces for connecting to another computer when needed and to transmit the images, text, data and sounds to the experts if required. It's shape may look like the one shown in the Figure. A dial for blood pressure and pulse, a sensor for laboratory sticks, a recorder of electrical signals with electrodes, a small stethoscope diaphragm piece for capturing sounds, a mouth piece for breathing into, are all that is required. This instrument should be able to alert us about most of our health problems. It can at least guide us about seriousness of the problem and prompt us to consult a doctor when needed. The instrument can be extremely useful as a diagnostic aid but not for treatment. Qualified doctors would remain the sole manager of therapeutics and to decide about requirement of further detailed examination. Any takers!

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Can a future Health Monitor of pocket size look something like this?