

Appropriate Technology for Health Care



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Introduction

Technology is necessary in health care at all levels, in prevention, diagnosis, in treatment and rehabilitation. In as much health care is an important tool in attainment of better health, the availability of appropriate health related technology is necessary for better health.

Health related technology has developed at a rapid pace in the last few years. But their impact on indices of public health has been minimal. While in urban areas technology has influenced health care significantly, its role and relevance into the processes of disease diagnosis, disease treatment, and disease prevention in the rural areas in both the public and the private sector has been poor. The situation is worse at the level of the health workers at the village level, where these public health problems are most often seen, as they have even poorer or no access to technology. We are now faced with a situation where we have technology that is very advanced but cannot be used by the majority of population, because of its expense, inaccessibility and inappropriateness to the problem being encountered.

At *Jan Swasthya Sahyog*, a voluntary organization composed of professionals working towards better health care for the poor, based in Bilaspur in Chhattisgarh, we have been working over the last 5 years on developing health related technologies for health care needs of the people with limited resources identified at the field level. We strive to ensure that these technologies be as accurate, if not more, as the prevailing ones and yet be simple, acceptable, and yet cheap and which can be used in the low-resource settings in the rural and community levels. We hope that they can be used by the all levels of health workers especially the most peripheral health workers and would make diagnosis more rational and decrease misuse of drugs. The scope of such appropriate technologies includes aids, skills, and techniques, technologies that could be applied towards the above aims.

How have these technologies been developed?

Development of these technologies follows a path of identification of the problem, development of the technology, its validation, and then its application after training of the end-users.

First, the *need for a certain technology for disease diagnosis, treatment or prevention is identified*. Public health problems for which the existing technology is either expensive or not accessible

or too mystified or complicated are identified at the community health program or at the referral centre or in the laboratories of Jan Swasthya Sahyog or by interaction with similar groups. Thereafter, the *development* of appropriate technology is done using the principles of science. Kits are *fabricated* for initial *laboratory validation* under controlled conditions against the gold standard. Once validated, these kits are made available to limited organizations for *field validation* after training them. If validated, these kits are available for *general use*.

Given below are the details of some of the instruments, tools and diagnostics kits developed by us. These details are a rather brief, and we would be happy to provide more detailed information, in case you need it. In this list some of the items have successfully completed a few rounds of field trials and some are at the field evaluation stage. In case you have a need for any of the listed technologies/ kits, you can place your orders with us. The costs indicated in the brochure are an estimate and the exact cost and the delivery time will be communicated after receiving confirmed orders. However, we can assure you that as JSS works with a non-profit ethos, the rates reflect primarily the production costs. Also, we conduct training programmes for interested individuals/groups for use of these equipment and tests.

Health related technology kits already developed

Diagnostic kits

I. Urinary tract infection

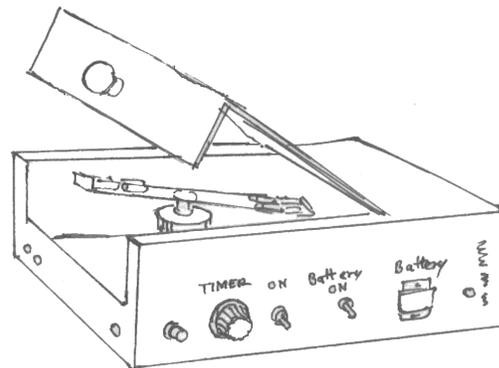
The currently available techniques used for the diagnosis of this infection involve either microbial cultures, which are not available at most places, or microscopy performed by a well trained technician using a good microscope. For these reasons the diagnosis of this rather important infection, is in most settings far from satisfactory, and often presumptive. Especially in pregnancy, UTI is an important condition where one particularly wants an accurate diagnosis. This kit is based on detecting nitrite (as a surrogate for bacteria, which produce nitrite from nitrates present in urine) and the activity of the enzyme leukocyte esterase, which is produced by the pus cells in urine(as a surrogate for pus cells). Besides,



this kit gives the report in less than 10 minutes. This test kit has been extensively tested. The sensitivity and specificity of this test in certain situations is over 95%.

II. Measurement of anemia status

While diagnosing severe anemia may be simple by clinical examination in adults, lesser grades of anemia that are also a cause of significant morbidity are not diagnosed by health professionals reliably. In children this problem is even bigger, where the clinical diagnosis is liable to be more inaccurate. The present tests available are either inaccurate (e.g. the sahli's test), or require an expensive colorimeter (for the ferricyanide test). The estimation of anemia status in this kit is done by measuring the packed cell volume of centrifuged blood. 'Semi skilled' health workers can perform it, as it does not involve a venous puncture to collect blood samples. It requires only a finger prick sample. Thus it is more suitable for use in the field situation for this major public health problem. This kit utilizes a portable capillary centrifuge (*capifuge*) and has been used extensively and found to be working reliably. The *capifuge* can run on AC mains or battery. The spin off advantage of this technique is the availability of the separated plasma which can be subjected to tests such as biochemical tests like that of glucose estimation!



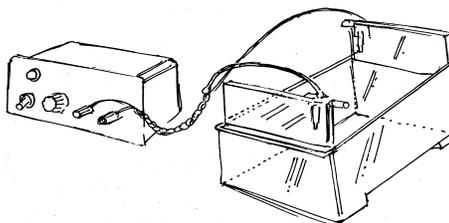
III. Measurement of anemia status using copper sulphate solutions

While the above testing apparatus gives you an accurate report, it requires a certain amount of training of the health worker. Another test that can be performed at the community level to diagnose anemia is by measuring the density of blood using different concentrations of copper sulphate solutions. The density of blood is primarily determined by hemoglobin. If we take different concentrations of copper sulphate in a solution form and allow drops of blood to fall on it, the ability of blood drops to sink or float will depend on its density. We have standardized 3 different concentrations of copper sulphate that correlate with hemoglobins of 11, 9 and 6 grams percent. Thus, it allows rapid, very visible (and thus convincing) and cheap way to classify hemoglobins in the categories of over 11, 8 to11, 6 to 8 and below 6 grams per cent. The other advantage is that it can

be performed very easily by village level health workers and also that it can be done in a group setting. Pre weighed satchets of copper sulphate granules and refill packs that need to be dissolved in water are available.

IV. *Diagnosis of sickle cell anemia*

Sickle cell disease is an important problem in several parts of India, in particular central India and Southern India. This disease is common not only in several tribal groups and several other caste groups, where it caused lifelong morbidity, and often death. An accurate diagnosis is a must to make a correct therapeutic plan. Much as the screening test is often available in several health care set ups, the confirmatory test of hemoglobin electrophoresis is not available easily, and if available is rather expensive because of the initial expense of the equipment and the running costs. Our kit is also based on conventional electrophoresis, but is available at a fraction of the cost of the one available in the market. It uses the agarose gel/nitrocellulose paper as the medium. The kit has been evaluated.



IV. *Sputum concentration system for increasing the sensitivity of microscopic diagnosis of tuberculosis*

For all practical purposes, tuberculosis is transmitted only by patients with pulmonary disease who shed *M. tuberculosis* in their sputum (also known as ‘open cases’). Therefore, in order to control disease transmission, it is important to detect ‘open’ cases as early as possible by microscopy or culture of the sputum. Since culture for *M. tuberculosis* is expensive and time-consuming, most laboratories in endemic areas rely on microscopy for diagnosis for reasons of economy, convenience and time. Direct smears are made from the sample without preliminary processing. They at their best can pick up less than half as many cases as can be done by culture for *M. tuberculosis*. In reality, even this potential is not achieved in most situations for reasons of high sample loads that lead to less than optimal time being devoted to individual smears.

The technique suggested by us is the Ammonium sulphate – Sodium hydroxide technique pioneered by Dr Vasanthakumari that has the unique advantage of providing reliable concentration of tuberculosis bacteria without the need for centrifugation. Moreover, it is a single step technique requiring very little hands on time is very easy to learn and

perform and uses chemicals that are inexpensive. We have seen that it increases the detection rate of tuberculosis bacteria in sputum and other by 33%. The great advantages this allows in the Classification of a larger number of patients as Sputum-Positive and avoids the expense / logistic difficulties of a Chest X-ray, which at best allows only a presumptive diagnosis. This technique also facilitates the follow-up of sputum-positive patients during treatment when culture facilities are not available.

A kit useful at the community level for disease prevention:

Microbiological testing of water and disinfection system

The H₂S paper strip test was developed by the DRDO in Gwalior as a simple test for the detection of fecal contamination of water. It was used during an outbreak of waterborne illnesses to identify safe sources of drinking water. The technique involved incubation of the water sample in the H₂S paper strip bottle in the laboratory for 48 hours. Jan Swasthya Sahyog has adapted this test to use at the village level. This paper strip test to detect fecal contamination of drinking water can be used *by the community themselves*. Instead of laboratory based incubation it was found that if the water sample is incubated by contact with the body, comparable results are obtained. If there is fecal contamination, the water turns black.

Once the water is detected to be fecally contaminated, the water can be treated using an ultraviolet light based treatment apparatus. Unlike the commercial UV based technology it can be used for water that is not running (as is the case for most rural and urban households) can be used where there is no electricity and can be shared by many households.

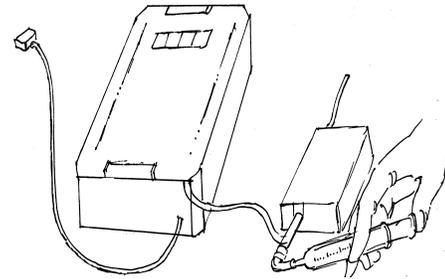
This disinfecting system uses a 254 nm light from a 9W tube light. In ten minutes 50 litres of clear water can be disinfected. It can run using either AC mains or 12V battery or a cycle dynamo. The progress and completion of the disinfection process is also displayed.

Diagnostic kits under field evaluation

I. Glucose

Blood glucose is an important test in as much as it allows us to diagnose and monitor diabetes mellitus, an increasingly important public health problem. Its estimation is also important in monitoring sick patients, say with malaria.

In the kit for glucose estimation, a dedicated colorimeter is used to read the developed colour by glucose present in the plasma and O-toluidine reaction. The plasma that is separated while checking for anemia using the capillary centrifuge can be used for this. This test can run on AC mains or battery. Beta version of this kit is being evaluated presently. This chemical test does not require refrigeration for its reagents.



II. Vaginal tract infections

Vaginal infections are an important cause of morbidity in women. Its diagnosis is either not available (due to lack of suitable lab set up, lack of woman health workers, or even due to reluctance of several women to allow even women health workers to perform an internal examination to collect a fluid specimen from the vagina), or is not even attempted! Several recommendations from important national and supranational bodies thus recommend empirical therapy for anyone woman who presents with vaginal discharge.

In order to rationalize the diagnosis of this set of infections, this kit has been developed which uses a self administered adsorbent testing pad which the woman can use to collect a vaginal fluid sample on her own. Three tests, namely pH, KOH amine and leukocyte esterase are performed. An algorithm to effectively use these three tests for the diagnosis of vaginal infection is also included in the kit. The results allow one to distinguish excessive normal discharge from vaginal infections. Besides, it allows one to rationalize the therapy of infections by reducing the number of drugs that one may have to do if one

was to use the otherwise prescribed *syndromic approach*. This test is presently being evaluated further.

III. Reproductive health test kit

This kit incorporates the above mentioned tests to diagnose urinary tract infection that does not need a microscope, and to diagnose reliably diagnose the presence (or the absence) of vaginitis or cervicitis among women presenting with vaginal discharge. Besides, it includes urine pregnancy test strips that can enable a village health worker to diagnose early pregnancy so that subsequent decisions be taken. It also includes reagents that enable the detection of proteinuria as a secondary marker of pregnancy induced hypertension- another common problem that causes significant mortality and morbidity both in the mother and the baby. This assembly of these 4 diagnostic tests in addition to the anemia diagnosis tests allows has the potential of strengthening reproductive health programme by adding a laboratory component to public health.

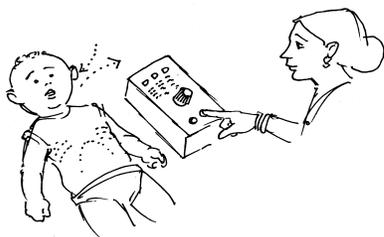
Equipment useful in diagnosis and evaluation in health care

I. Stadiometer

Height is arguably the best way to measure the nutritional status of the entire community, but is sparingly used for the want of a simple technology that is portable. Use of height is also necessary to identify high risk pregnancy who should be advised institutional deliveries It can be used to assess the body mass index (weight/ height squared) which is a robust marker of nutritional status. Using a flexible tape stuck to a wall is liable to be inaccurate. Our portable and inexpensive device can measure heights in the field, or even in the clinics.



II. Breath counter

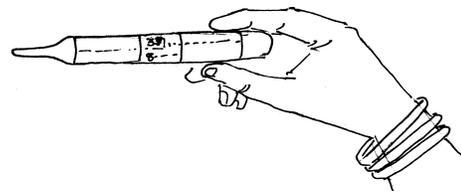


Measurement of respiratory rates is essential for the early diagnosis of lower respiratory tract infections in children that accounts for a large number of deaths. We believe that accurate measurement of respiratory rates and remembering different rate cutoffs for different age groups is not easy. Since most health personnel whom most mothers access for health problems and are available in the community have limited

literacy and clinical skills, early diagnosis of pneumonia is a public health problem. Semiliterate and neoliterate health workers find it difficult to measure rates in young children, where rates are high, to maintain coordination between counting the breaths and the watch and to remember various age specific cutoffs for abnormal respiratory rates, is difficult. In fact it is difficult even for more literate and higher levels of health workers including nurses and doctors. Our breath counter is a microcontroller based counter, runs on a 9V battery, and records the rate of breathing by just pressing on a button and gives the output in form of red or green signal for abnormally high rate or otherwise.

III. *Easy to read thermometers*

Measurement of temperature is a useful clinical tool. It distinguishes those illnesses that are associated with fever (and require a different work up) from those that are not associated with fever e.g. iron deficiency anemia). Thermometry also allows one to assess the effect of medicines or non-drug therapy given to bring the fever down. However usual thermometers are difficult to read for those health workers who have limited literacy levels. Our thermometers are essentially for these groups of health workers in which the abnormal temperature range on it are coloured red for easy use.



IV. *Teaching stethoscope*

This training aid allows a trainer to teach and evaluate the use of a stethoscope in clinical care. A stethoscope is required in the measurement of blood pressure, finding and counting fetal heart sounds in a pregnant woman and hearing the breath sounds to diagnose chest problems and in several other situations.

Essentially it has one chest piece and 2 sets of earpieces, one each for the trainer and the trainee.

V. *Easy to read blood pressure apparatus*

Measurement of blood pressure is a useful skill in picking up hypertension, an important public health problem. In pregnancy its measurement has the very important function of picking up Pregnancy induced hypertension/ preeclampsia, which if untreated can lead to morbidity and mortality for both the baby and the mother. This skill is traditionally

performed by senior health professionals like the nurse and the doctor' the more peripheral health workers, say at the village level usually do not measure this important parameter because of the lack of availability of a simple, easy to understand apparatus.

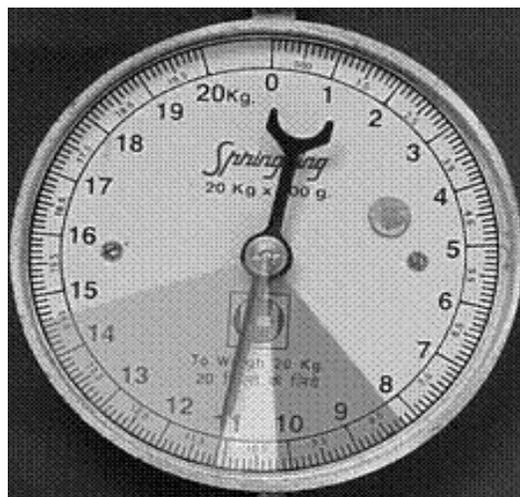
Our easy to read blood pressure apparatus has the abnormal blood pressure ranges for both the systolic and the diastolic values coloured red. This enables health workers with limited literacy skills to be able to measure blood pressure.

Training Material

I. Growth booklets for growth monitoring

We believe that growth monitoring is an important tool in nutrition improvement strategies. But understanding the concept of the graph is not easy for health workers with limited literacy skills. This growth booklet is an attempt to overcome this problem.

Our growth monitoring is with the help of a booklet, and not a card or graph, is based on the two assumptions namely that each child should follow his/ her own trajectory of growth, which depends on the birth weight. If the child grows normally, the child should not slip below the designated trajectory. Also, given additional inputs an undernourished child should catch up the trajectory of a normal child, but at least retain his / her previously designated trajectory. Thus there is in fact a series of booklets to cater to a range of birth weights that depict different trajectories for different weight and sex categories.



The second assumption is that each point on the growth trajectory is designated a separate page where the visual depiction and interpretation of growth is done on an actual picture of the weighing scale aided by a long established norm of ***red means danger and green means normal*** colour scheme on the dial of the scale. The viewer can simply plot the weight on the picture and

immediately read the nutrition status depending on where the plotting pencil stands- red or green.

Seeing their child's weight pictorially by long established norm of **red means danger and green means normal** is likely to impress them about the need for action. In this way, growth monitoring is likely to increase the acceptability of health education, acceptability of food supplementation and impress the need to treat infections/ illnesses in their child early. At a community level this is more likely to lead to demand for implementation of food programmes or for changes in agricultural practices.

We see some other advantages of the growth booklet. In an environment of poverty, the growth booklet is a record for the family; it may be the only record of the child. The family members and the community are likely to see the relation between food and growth better, which unfortunately is not well appreciated by several people. The medical community, has medicalized hunger as "malnutrition" and is inclined to suggest non-food ways of managing it. With the help of the growth booklet the parents can see the consequences of illnesses on the nutritional status, and conversely see the benefit on the weight of the child due to additional food during recovery from illnesses.

II. Pictorial drug formulary for semiliterate health workers

For the use of village health workers who have limited literacy skills, we have developed a drug formulary that is pictorial and has information on about 15 drugs that a health worker would be using in her usual service. There is also scope to add information on new drugs that a health worker may learn subsequently.

दवा का नाम : नसोरोबिन

कम देते हैं:
 1 यदि बुखार की स्थिति में स्टाइड में मतेरिया निकलता है।
 2 यदि बुखार का कारण मतेरिया समता है।

कितनी मात्रा में:

कितने बड़े को	1	2	3	4	5
पेच देने से जे	गण्ड चमक	बाएँ चमक	बाएँ चमक से बाएँ बाएँ चमक	बाएँ चमक से बाएँ बाएँ चमक	बाएँ चमक से बाएँ बाएँ चमक
पहला दिन	डेढ़ चमक	बाएँ चमक	डेढ़ चमक	बाएँ चमक	बाएँ चमक
दूसरा दिन	डेढ़ चमक	बाएँ चमक	डेढ़ चमक	बाएँ चमक	बाएँ चमक
तीसरा दिन	पस चमक	डेढ़ चमक	पस चमक	डेढ़ चमक	डेढ़ चमक

Items useful at the community level for disease prevention and/or treatment

I. Mosquito repellent oil based on Neem, DMPA and citronella

In tribal areas where falciparum malaria is a major public health problem mosquito nets alone are not enough for prevention of mosquito bites as people get bitten in the evening hours, often at night while guarding the harvest, and in the early hours of the morning

when people go out to the forest for work. Therefore there is a need for a mosquito repellent which should be effective and yet cheap.

Effective mosquito repellent creams and oils with a good odour at a fraction of commercial cost using 5% neem oil, 10% Dimethyl phthalate and 5% citronella oil made in Mahua oil have been developed here. They have been evaluated and found to be effective and acceptable with one time application protects against mosquito bites for at least 4 hours.

II. *ORS packets*

Oral rehydration solution (ORS) is universally accepted as one of the most important lifesaving drug during a diarrheal episode. The Oral rehydration solution packs available commercially are expensive. Homemade ORS has the limitations of not containing potassium salts and in not being accurately weighed. The other problem that is often seen in the field is that often poor families do not have sugar at home to make the ORS solution and have to buy afresh. To circumvent this problem Jan Swasthya Sahyog trained village health workers to make their own ORS in a packet form. Plastic spoons of such a volume that they contain the required amount of salts and table sugar have been prepared. The packs are sealed by a packet-sealing machine by the village health workers themselves. The ORS pack contains the following:

- Sodium chloride : 3.5 g.
- Trisodium citrate: 2.9 g.
- Potassium chloride: 1.5 g.
- Sucrose : 40 g.

III. *Appliance for breaking tablets into 3-4 pieces for childhood medication*

When one dispenses tablet formulations to children, breaking a tablet accurately in two pieces is not difficult, but breaking into accurate fractions of one third is not easy. This tablet breaker helps in rather accurate breaking of a tablet into three pieces.

IV. *Safe delivery kits for the mother, baby and the birth attendants*

At the time of birth of the child, there is clearly a requirement of an assortment of items that should be clean, appropriate and readily available. Thus it has been a common practice in public health care to make available delivery kits to pregnant women. However, most of the delivery kits that we have seen do not have all the things that are required at the time of delivery, both for the baby and the mother for at least one post partum day,

and which is convenient to use. The delivery kits that have been developed here have looked at these issues and have evolved over time on basis of feedbacks from the users. The kits are ethylene oxide sterilized. They also contain a pictorial booklet suggesting its use and a list of advice for the mother and child.

V. *First aid kit for villages*

Primary care for acute health problems illnesses is a major lacuna in our health care systems, which results in considerable hardships and impoverishment, besides causing avoidable mortality and morbidity. Injuries and animal bites are common in the rural areas and appropriate first aid for them is very often found wanting. Similarly, care for common illnesses like fever, vomitings and diarrhea is necessary. There are several problems such as drowning, cardiopulmonary arrest, choking on a foreign body and epistaxis whose outcomes will improve dramatically if appropriate skills for immediate care are available in the community at large. We have fabricated a kit that looks at the needs of the rural people, and offers information, replenishable materials, and certain essential equipment that allows first aid to be administered by someone who will need a day long training programme in its use. This kit has 29 items and also includes things like bamboo splints for fractures of lower limb and upper limbs, a cloth to make a triangular sling for clavicular fracture, a peripheral blood smear making slide kit box, an easy to read thermometer and a few disposable syringes for safe injections. Of course, the other advantage of the use of this kit is fostering of this belief that self help is possible without getting help from specialists, and even primary care for illnesses and injuries is possible to be made available even through the lay people.

VI. *Soap*

Soaps are made by our village health workers using locally available cheap oils (in our area- from mahua (called *Saral mahua soap*), from mustard or kusum oil) for use as a public health measure. These soaps that are rather economical, and yet retain all the attractive properties like foam, good smell and the softness and lack of dryness after soap use. It has been shown that use of soap reduces the incidence of diarrrheal illnesses by 30%. Our objective for making these soaps is that village people should get good quality soaps at a cheap rate and should preferably have there own individual soaps.

Nutritional formulary

While it is true that under nutrition is primarily due to poor food availability, knowledge about feeding practices and the choice of foods has a role. Once a child (or an adult slips into severe under nutrition, besides availability of appropriate foods, there is a role for certain micronutrients, that should be available in a cheap and convenient formulation. We have identified some important roadblocks in managing severe undernutrition where technology has a role and have the following solutions:

Type of intervention	Target	Objective	Formulation
oil	calorie undernut	increase calorie density	200 ml bottles
amylase rich flour	under 5 children	ready to eat semisolid food in areas where milk is not available	200 g packs
amla pachak	iron deficiency anemia, pregnant women	vitamin C provision	35 g packs, to finish in 1 week, enough to provide the desired Vit C to ensure iron absorption per day
choona namak	calcium deficiency	Provision of calcium	500 mg elemental calcium sachets
mineral mix	severe calorie undernutrition	pottasium, zinc and magnesium supplements	As sweet "bataashas" containing the appropriate amounts

I. Amylase rich flour

Semisolid and liquid preparations of food which are calorie dense is an important requirement of complementary feeding of children in the post weaning period i.e. from the age of 6 months to 2 years of age. This is a critical time when children who have previously been well nourished slip into under nutrition. Where available, use of animal milk is used as an additive for softening feeds. However in many communities animal milk is not available. Amylase rich flour prepared by germinating cereals such as wheat,

Ragi and jowar is useful in softening cereal based foods, making it sweeter, more digestible and adding to the nutritive value.

II. *Edible oil supplementation*

Adding oil to the food is a simple way to increase the calorie density and the calories delivered without increasing the volume of food. Such advice can be made more effective by making available such exclusive bottles that contain adequate oil for a week's need of a child.

III. *Amla paachak*

A ready source of Vitamin C, that is food based, and is dry and thus can be dispensed is necessary, given the fact that the bulk of food that we consume is cereal- pulse based. Amla (Indian Gooseberry) is perhaps the richest source of dietary Vitamin C, and significant amounts remain even after it is dried.

IV. *Choona namak*

A dietary source of calcium is necessary. Drug based calcium is either expensive, or most formulations contain very little calcium. Our preparation- presently in satchet form is called choona namak- literally calcium salt- and is actually 1.25 grams of calcium carbonate, which provides 500 mg of elemental calcium, is supposed to be added to food, like salt. 2 satchets of this should provide 1 gram of elemental calcium enough as a therapeutic measure for pregnant and lactating women, for osteomalacia and osteoporosis and for rickets.

V. *Mineral mix*

Due to chronic food deficiency, besides calorie deficiency, we also observe deficiency of several minerals- which if not supplied specifically will retard the recovery from the state of severe under nutrition. Among the prominent ones are potassium, zinc and magnesium. Several studies have shown that failure to supplement potassium and zinc have resulted in higher deaths and morbidity in the setting of severe under nutrition. We have formulated the necessary amount of these minerals in the form of "Bataashas"- a sweet candy- to be consumed daily. These bataashas are also available to provide potassium supplements alone too.

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