8.11 PROVISION OF SAFE DRINKING WATER AS A STRATEGY FOR MITIGATION OF CHRONIC KIDNEY DISEASE IN SRI LANKA

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Abstract:

Chronic Kidney Disease (CKD) which is prevalent in the North Central Province and certain other areas in Sri Lanka is considered a major health hazard. In these areas a considerable percentage of the population including young adults and children are affected. CKD has considerable socio economic impacts on the communities and it is even considered as a social stigma. Extensive research to find the root cause of the disease has been conducted by several local as well as foreign agencies. Several hypotheses attributing the disease to cadmium, pesticides, fluoride, arsenic, algal toxins etc. have been presented. Yet the real cause is not established.

The areas affected are largely paddy cultivation areas. These communities mainly use groundwater from dug wells and hand pumps for their consumption. In the entire affected area groundwater is found to be hard and contain fluoride exceeding the WHO standards. Areas in NCP where the water supply is surface water based, are free from CKD. Though the possible effect of hardness is not well established, it is medically accepted that water containing fluoride is extremely detrimental to kidney patients.

Considering the water source limitations and the quantum of investments needed, it is not practicable to supply all affected village areas with surface water based pipe borne water. An alternative approach which combines advanced water treatment technology with a simple transport mechanism using water tankers to supply community tanks, is proposed as an alternative viable solution. Implementation of such a strategy is considered effective in mitigating CKD in Sri Lanka.

BACKGROUND

Chronic Kidney Disease (CKD) has been prevalent in the North Central Province (NCP) of Sri Lanka over the past two decades or so. In certain areas 5 to 10 % of the population are affected and the disease is on the increase and includes children. In Anuradhapura District alone 18,000 cases of CKD are reported with over 200 deaths recorded annually. It is reported to be spreading to parts of North Western, Uva and Eastern Provinces too. The disease occurs without pre-existing conditions such as hypertension and diabetes. Thus it has to be attributed to external environmental factors.

About 50% of the population of 1,175,000 in NCP are farmers having a very low income level and have little means to expend on medications. Thus they mainly depend on state run hospitals for their medical treatment.

The cost of dialysis of CKD patients has become a severe burden on the government health authorities, the annual expenditure being Rs. 350 Mn which is 4.6% of the health budget[1]. It could well be that patients are not receiving the required medical treatment due to these constraints.

Several agencies and individuals have carried out research on CKD and have come up with varied presumptions. The disease has been attributed to the heavy metal cadmium, pesticides, chemical fertilizer etc. connected with agriculture. Some have attributed it to fluoride/fluoride in combination with aluminium (from cooking utensils). Since of late, arsenic, algal toxins have also been cited as probable causes. It is unlikely that in spite of the research carried out, the exact cause of this chronic disease will be established in the near future.

Considering the seriousness of the epidemic that has affected people of all age groups including children it would be prudent to take whatever possible remedial measures to control further spreading of this disease.

MEDICAL ASSERTIONS OF CKD

It is common knowledge that the medium of transmission of any disease would be food, water or air. In this instance air could be excluded. Various environmental factors are attributed to CKD in terms of medical research.

Ingestion of heavy metals particularly cadmium is one possible factor. Cadmium could be present in chemical fertilisers in varied concentrations.

There is no evidence that arsenic by itself causes kidney disease. Arsenic commonly causes skin sores and cancers as experienced in Bangladesh. However, certain arsenic compounds such as calcium arsenate could cause kidney disease. Arsenic could be present in pesticides and herbicides. It has also been established that due to microbial activity arsenic could leach off soils and sediments[(2)].

Recent research though not very comprehensive suggests that fluoride in drinking water could cause kidney disease. 'Fluoride Action Network' reports[(3)] "Because the kidney accumulates more fluoride than all other soft tissues (with the exception of the pineal gland), there is concern that excess fluoride exposure may contribute to kidney disease - thus initiating a "vicious cycle" where the damaged kidneys increase the accumulation of fluoride, causing in turn further damage to the kidney, bone, and other organs."

There is extensive medical documentation to demonstrate that drinking water containing fluoride is very harmful to kidney patients. An article on 'Fluoride Dangers'[(4)] states that a patient who underwent frequent hospitalisations due to kidney disease for years started a remarkable recovery which baffled doctors, the only change being that the water was no longer fluoridated. This indicates that even the normal recommended fluoridation levels of 0.7 to 1.2 mg/l could be harmful to kidney patients.

An article titled 'Fluoride & Renal Osteodystrophy'[(5)] states that "in healthy adults, the kidneys are able to excrete approximately 50% of an ingested dose of fluoride. However, in adults with kidney disease the kidneys may excrete as little as 10 to 20% of an ingested dose - thus increasing the body burden of fluoride and increasing an individual's susceptibility to fluoride poisoning (e.g. renal osteodystrophy)"

Further according to 'Environmental Health Risk for the Chronic Renal Failure in Sri Lanka'[6] and other literature, aluminium fluoride complexes have been found to be detrimental to the kidneys.

It may not be possible to pin point the cause of CKD in Sri Lanka. Considering the fact that CKD is prevalent in predominantly paddy cultivation areas, it is likely that the disease condition has some link with agriculture chemicals. It is very likely that water also plays a significant role. It could even be a combination of several factors.

DRINKING WATER SOURCES

At present, only a few areas in NCP have access to pipe borne water from surface water sources. The rest of the population depends on ground water from tube wells, hand pumps, dug wells etc. It has been observed that in the affected areas, groundwater is hard (calcium hardness) and contains high fluoride levels ranging from 2 to 6 mg/l. This is way over the WHO limit. It has also been generally observed that CKD is almost non-existent in NCP areas supplied with pipe borne water from surface water sources. It may also be worth recognising the fact that CKD is non-prevalent in several other similar agricultural areas in the South where the groundwater has high fluoride with low calcium hardness. This indicates a correlation between CKD and the quality of drinking water.

Ideally in this situation it would be beneficial to provide all affected areas with surface water based treated water. However, considering the limitation of surface water sources and the magnitude of the capital investments necessary, it would not be possible to increase the coverage of pipe borne water substantially even in the medium term. Thus it would be necessary to consider viable alternatives for provision of safe drinking water.

AVAILABLE OPTIONS

The sources of water presently used by the residents such as dug wells, hand pumps, tube wells, small tanks etc. are satisfactory for general purposes such as bathing, toilet flushing, washing of clothes and utensils etc. Thus it would be appropriate to provide the CKD affected areas with good quality water for their drinking and cooking purposes. A per capita supply of 5 lpd is considered adequate.

Household treatment

One option could be a domestic level filter. Some filters capable of fluoride removal have been developed locally using broken bricks as the media. The cost per unit is approx Rs. 4500.00. There are other designs developed in some African countries using charcoal and Moringa seed. There are certain doubts regarding their effectiveness and the capability of the users to maintain them and hence their long term sustainability is questionable. Though use of these types of filters should be encouraged, they would have limitations in providing a complete solution for controlling CKD.

Rainwater harvesting

Rain water harvesting could be an option. These areas have an average annual rainfall of 1100 mm. With this level of rainfall, it would be possible to harvest rainwater sufficient for their drinking and cooking purposes. Considering a roof area of approx. 50 m^2 and a per capita consumption of 5 lpd, a storage tank of 2000 litres will be sufficient. The storage tank and the necessary gutter system would cost approx. Rs.40,000 per household. For this to be successful, the houses should have a min. 50 m^2 roof area and the roof should be of a reasonable quality in order to fix gutters satisfactorily. Such a system consisting of 150 rainwater tanks has been established in Polpithigama, Kurunegala District as a pilot project. The project is successful. However, considering the cost and roof requirements, it is more suited for lower middle income households. It would not be possible to extend such a system to the typical rural village populations.

Supply of treated water to community tanks

Another option could be provision of treated water to community tanks. Under this system, groundwater could be treated using the appropriate advanced treatment technologies such as reverse osmosis, ultra-filtration or adsorption techniques considering the quality of source water. These technologies are expensive. However, as the quantity of treated water necessary for drinking and cooking is just 5% of the requirement for conventional water supplies, it is feasible and affordable to adopt such advanced technologies. It may be noted that small advanced treatment units suitable even for community operation are available.

Water tankers could be deployed to supply community tanks within a radius of approx. 10 km from the water treatment centre. In the country's typical rural setting, one could expect approx. 12 villages having a total population of approx. 7750 within such proximity. The water requirement for drinking and cooking would be 40 m^3/d. Thus considering 20 hours operation, a 50 m^3/d treatment plant would suffice. The capacities of storage tanks are designed based on filling being carried out twice a month. The number and capacities of community storage tanks would be decided depending on the spread of housing units. It could be one tank for 3 to 4 houses. In a situation where the houses are far apart it may be one tank for two houses. The capital cost for such a system would be approx. Rs.11,000 per beneficiary household. The comparable figure for conventional major water supplies is approx. Rs. 300,000 per beneficiary household. The monthly recurrent cost will be within Rs. 250 per household. This system can work very effectively.

The same concept could be operated from an existing water treatment facility. The treatment costs and overheads would be even lower in such a situation.

This concept was tested in a CKD affected village named Billewa in the Anuradhapura District in March 2011 as a World Water Day event. The village was provided with 50 nos. 1000 litres storage tanks, one tank to be shared by 3 houses. Each house was given a 10 litre container. They are expected to fill the containers twice a day and use the water exclusively for drinking and cooking.

Due to time constraints it was not possible to establish a groundwater treatment facility at this location. Instead, for the time being water is transported from one of NWSDB's treatment plants 30 km away. The system has been in operation for one year and is a great success. It is reported that some houses outside the village are also using this water. The Anuradhapura Hospital has a programme to screen the beneficiaries for CKD. There is a general feeling among the people that there is an improvement in their health status. According to them, the so called 'stomach irritations and burning sensations' they suffered when they consumed well water are not there at present. People here are willing to pay Rs. 200 to 250 per month for the water use. Thus, it is possible to cover full operational cost.

A complete system with a 50 m^3/d treatment facility covering a population of 7500 people is being planned in Girandurukotte another CKD affected area. Yet another system of 100 m^3/d capacity is being planned for a population of 15,500 in Nikawewa. Further, water from the Oyamaduwa 'Deyata Kirula' water treatment facility is to be utilised to supply water for drinking and cooking to villages in Maha Wilachchiya.

Operation of the treatment facility and the water transport system could be undertaken by NWSDB or in some instances the local authority may be in a position to take over the complete operation or at least the water transport system. Revenue collection could be undertaken by the community based organisation (CBO). Thus it is considered operationally sustainable.

CONCLUSIONS

1. Chronic kidney disease (CKD) in NCP and other parts of the country appear to be complex. It may not be possible to pin point the root cause(s). However, it is a fair presumption that quality of drinking water has a direct or indirect impact on CKD.

2. Provision of good quality water free of hardness and fluoride will be an important mitigation measure.

3. Household water treatment for removal of hardness and fluoride may be adopted but considering their limitations, will not be a preferred option.

4. Rainwater harvesting for 'drinking and cooking' could be an option for lower middle income groups.

5. The system proposed to 'supply treated water to community tanks' has a low capital cost which would easily set off against the potential health benefits. Full recovery of the operational costs is possible. The system is effective, reliable and acceptable to rural communities. It is operationally sustainable. Thus it is considered as a viable strategy to mitigate CKD.

6. Water Supply and Health Authorities should pursue to implement such systems as a matter of urgency and national priority.

References

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