WHO Sanitary Inspection based Assessment of Contamination Risk in Drinking Water from Community Tubewells with Handpump in Rural India

Mukul Kulshrestha, Nagendra Parasad Singh

Abstract: ***This paper evaluates contamination risks associated with community based rural tubewells with handpump in rural areas of nine districts of the State of Uttar Pradesh in Northern India. A total of 324 such sources of drinking water were field surveyed to assess the prevalence of contamination risk based on the World Health Organization sanitary inspection guidelines.***

In the field survey conducted, a total of 37.7% of all community based tubewells with handpump in rural areas were found unsafe. Significantly, the prevalence of medium to very high risk was widespread: as many as 28.7% of all the 324 sampled community tubewells with handpump were found infested with medium, high or very high Risk levels, clearly portraying a rather alarming situation that needs immediate attention of field engineers, planners and policy makers, who need to coordinate work in order to minimize total risk of contamination in drinking water.

Index Terms: Community based rural tubewells with handpumps, contamination risk, World Health Organization sanitary inspection guidelines

I. INTRODUCTION

As per the United Nations prescribed Sustainable Development Goals (SDGs), Clean water and sanitation take priority in ensuring availability and sustainable management of water and sanitation [1]. While in the past few decades, the research has widely focused on water supply policies in urban areas [2], [3] including ensuring efficiencies of urban water supplies [4], [5] the recent focus on making available "Water to All by 2024" [6], has ensured that rural water supply schemes, and particularly the community based schemes, get a renewed attention of policy-makers, planners and engineers [7].

Unfortunately, most developing countries including India have not been completely successful in providing clean potable waters to a majority of the rural population, resulting in severe health ailments that often translate into fatal mortality. It is estimated that nearly 3.1% deaths are related to contaminated water consumption [8]. The adverse health impacts are far more prevalent, and some of these are immediate, while others become noticeable over time. The water related health diseases often related to stomach, intestines, vomiting, diarrhea, and a host of other diseases like Hepatitis and Typhoid [9]-[11].

The World Health Organization (WHO) indicates that nearly 80% diseases are related to water contamination, and several researchers have pointed out that many countries are not able to fulfill the water quality guidelines set by WHO for drinking water [10], [12]. The rural areas remain the worst sufferers, particularly where the water supplied are not through tap..

In India, the National Sample Survey [13] of the government of India has showed that 55% of rural households in India were served by a tube well, 12% by a well, and 3% per cent by a tap. It is therefore evident that a very large proportion of rural area is actually dependent on tube-wells for sustainable access to safe drinking water. Many of these tubewells installed with handpump act as the source of community based water supplies in rural India.

To ensure contamination risk free water supplies from tubewells with handpump, a sanitary onsite inspection is recommended by WHO [14]. This is a fact finding activity that identifies system deficiencies based on simple indicators that may be easily recognised and diagnosed on the field. The advantage of such surveillance lies in prevention of occurrence of disease by cutting the risk of occurrence. While a microbiological analysis often happens post the spread of disease, such analysis is also costly and time-consuming, often requiring technical personnel for test and data interpretation, a survey based sanitary inspection is often easy, consumes less time, and does not require expertise and specialisation to carry out. WHO has therefore prescribed sanitary inspection formats [14] for carrying out the field surveys in rural background.

The two principal activities regarding surveillance and control of water qualities are sanitary inspection and water-quality analysis. In general for the reasons spelled above, the sanitary inspection should take priority over quality analysis, as the sanitary inspection often easily identifies potential hazards to safety.

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WHO prescribes that analytical, bacteriological, or chemical survey, no matter how carefully these are carried out, cannot be substitutes for comprehensive information on field conditions at the water-source. Further, the water quality samples represent conditions at a single point in time and with the prevalence of infrequent sampling, possibilities of contamination and spread of diseases loom large. It is also noteworthy that the microbiological contaminations are often sporadic, and occasional sampling may not be good enough to pinpoint their occurrence with reasonable certainty in time and space.

It is for above reasons that the World Health Organization has prescribed internationally applicable guidelines [14], by using a sanitary inspection format for tubewell with hand-pump. The WHO seeks diagnostic information under 10 risk categories [14] and the use of these risk categories enables a hazard score (or a risk level) to be assigned to the particular water supply based on the total number of risk hazards found. The contamination risk is based on minimizing what may be called a Minimum Safe Distance (MSD), determined locally as illustrated in Fig.1. When groundwater abstraction from a tubewell with hand-pump is used for human consumption, , the MSD for all potentially polluting activities should be fixed during the planning stage for enabling possible control of sources of contamination of groundwater. The MSD should be determined from the time taken by contaminants to travel from their source to the source of drinking-water [14]. This would necessarily depend on local conditions, the most important of which are the geological and hydro-geological conditions of the area, the quantity of faecal matter likely to be discharged, and the number of existing and planned sources of contamination in near vicinity of the handpump. To circumvent the determination of MSD, the WHO has prescribed a 10-point sanitary inspection format, where each of the 10-point diagnostic information relates to MSD, and is a physical proxy for MSD [14].

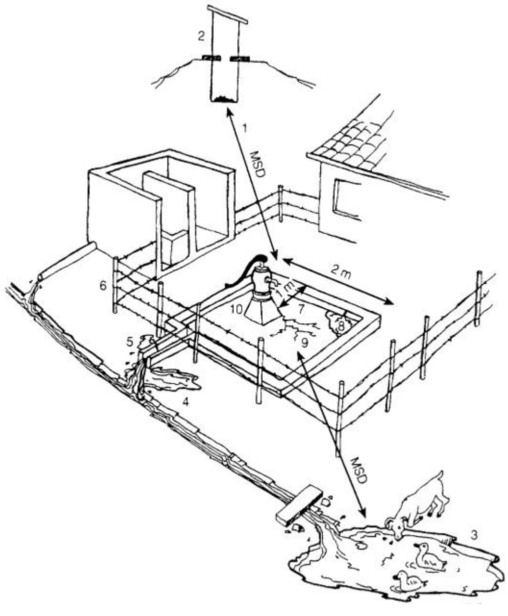

Fig 1. Minimum safe distance for sanitary inspection form for tubewell with hand-pump [14]

II. OBJECTIVES OF THE RESEARCH WORK

The work was undertaken with an objective to assess the prevalence of risk of contamination in drinking water from the rural community based tubewells with handpump in Indian scenario for the work area identified. It was further contemplated to quantify and categorise the contamination risk levels in order to prioritise corrective measures at places that are at higher risk.

Thus the work objectives were two-fold:

A. Determination of whether the sample community supplies (tubewells with handpump) suffered from associated risk of contamination and comprised unsafe drinking water source.

B. Determination of the extent of risk, ie., quantification of contamination risk posed in case the tubewell with handpump community drinking water schemes returned with potentially unsafe category.

III. WORK AREA AND METHODOLOGY

This study was carried out in rural parts of 9 Districts in the State of Uttar Pradesh, India. A total of 324 community based tubewells with handpump were surveyed and analyzed for sanitary inspection as per the WHO format [14]. Table 1 shows the distribution of these handpumps in the respective districts.

Table 1. Distribution of rural community tubewell with hand-pump across various study districts

District	Numbers of Tubewells with Hand-pump
Moradabad	115
Allahabad	108
Gorakhpur	15
Maharajganj	15
Kusinagar	15
Deoria	15
Basti	15
Sidharth Nagar	15
Sant Kabir Nagar	11
Total	**324**

The sanitary surveys were undertaken by inspecting each of the 324 community Tubewells with handpump, in WHO format [14] that assigned various contamination risk scores across the sample. The rather massive survey work was undertaken during the period 2014-2017. Data was collected on each of the 10 contamination risk categories for every community tubewell with handpump and was compiled as per WHO format [14].

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Subsequently, the contamination risk posed by the unsafe sources in the sample was quantified into 4 categories as recommended by WHO [14].

IV. RESULTS AND DISCUSSIONS

The survey work on 324 rural community based tubewells with handpump was carried out with the help of a sanitary inspection format as outlined in Table 2. Specific diagnostic information was sought for each of the sample drinking water scheme, and the consequential risk was ascertained as per Table 2.

Table 2. Sanitary inspection form for tubewell with hand-pump:10 Risk categories

S. No.	Specific diagnostic information for assessment	Risk
1	Is there a latrine within 10m of the hand-pump ?	Y/N
2	Is the nearest latrine on higher ground than the hand-pump?	Y/N
3	Is there any other source of pollution (e.g. animal excreta, rubbish, surface water) within 10m of the hand-pump?	Y/N
4	Is the drainage poor, causing stagnant water within 2 m of the hand-pump?	Y/N
5	Is the hand-pump drainage channel faulty? Is it broken, permitting ponding? Does it need cleaning?	Y/N
6	Is the fencing around the hand-pump inadequate, allowing animals in?	Y/N
7	Is the concrete floor less than 1m wide all around the hand-pump?	Y/N
8	Is there any ponding on the concrete floor around the hand-pump?	Y/N
9	Are there any cracks in the concrete floor around the hand-pump which could permit water to enter the well?	Y/N
10	Is the hand-pump loose at the point of attachment to the base so that water could enter the casing?	Y/N

Y-Yes, N-No. Source- [14]

After sanitary inspection of tubewell with the hand-pump, the total/cumulative contamination risk scores were calculated out of 10 assuming an equal weighing of 1 each[14], for each of the risk categories listed in Table 1 (Y=1, N=0). The total risks associated with that tubewell were subsequently determined by summing individual risk category scores.

A total of 202 samples returned a cumulative score of zero, implying completely safe status. However, as many as 122 sample tubewells with handpump returned with a score that was non-zero, thereby implying unsafe status. The results are illustrated in Fig 3, indicating that a large number of tubewells with handpump (37.7%) in Northern India actually pose contamination risk to rural community users. This indicates that across the rural areas significant risk exists wherever community based water supply through tubewells with handpump is practiced.

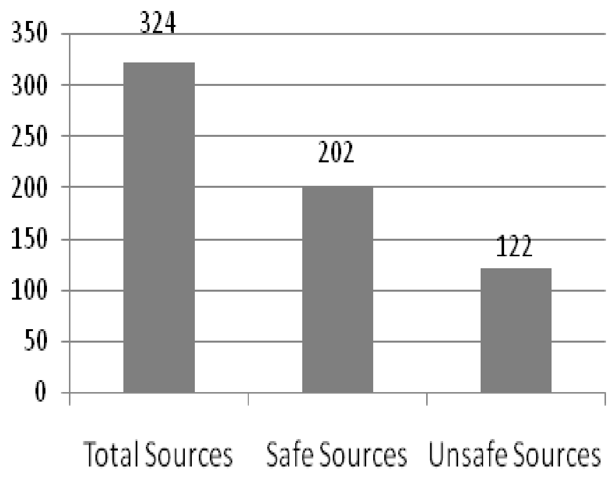

Fig. 3. Numbers of Safe and Unsafe Sources in the Sample

To categorize and quantify the level of risk of contamination that the unsafe sources posed to public, the total risk score on a scale of 0 to 10 was subsequently classified in 4 discreet Risk categories as illustrated in Table 3 for each tubewell with the hand-pump.

Subsequently, it became imperative that the risk of contamination associated with large numbers (122) rural community tubewells with handpump, out of a total sample size of 324, be quantified. The break-up of the risk level was determined as per Table 3, and the results are summed up in Fig 4. It is evident from Fig 4 that high and medium risk levels are most common and occur in more than 70% cases where the community tubewell with handpump is unsafe. This is an alarming situation because whenever the source is unsafe, there is likelihood that contamination Risk is Medium to Very high in as many as 76.2% cases, thereby exposing the consumers to significant health risk.

Table 3. Contaminated Risk Levels [14]

Total score out of 10	Risk level
9-10	Very High
6-8	High
3-5	Intermediate
0-2	Low

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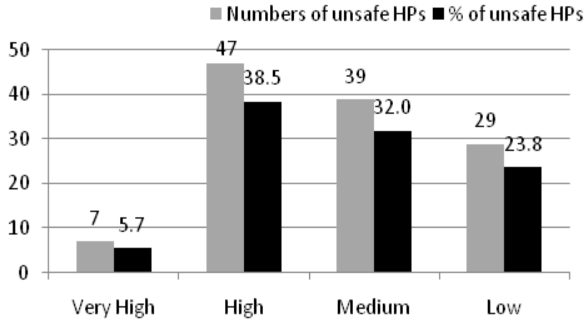

Fig.4. Contamination Risk level categories associated with unsafe tubewells with handpump

V. CONCLUSIONS

In the field survey conducted, 37.7% of all community based tubewells with handpump in rural areas of 9 districts were found unsafe. Of these 122 unsafe cases as many as 93 cases recorded total contamination risk level varying from medium to very high. Thus, 28.7% of all sampled community tubewells with handpump were found infested with medium, high or very high contamination Risk levels, a rather alarming situation implying more than 1 in every 4 tubewell with handpump poses significant risk to community. The field engineers, planners and policy makers need to coordinate activities in order to ensure that water is safe.

The contaminated Risk Scores/ levels based on above template as illustrated in Tables 2 and 3 in the form of a checklist for use in inspections can be of immense help to sanitary inspectors particularly in rural areas, where regular testing and monitoring of water quality is often either non-existent or is irregular, or insufficient on a regular periodic basis as is the case in countries of Africa and other developing countries including India. Sanitary inspections thus constitute a useful monitoring tool and are an affordable means of identifying water sources at risk of contamination, and for evaluating the extent of such risk.

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