STUDIES ON THE PHYSICO-CHEMICAL PARAMETERS OF WELL, BORE, POND AND LAKE WATERS IN LALAPET VILLAGEOF VELLORE DISTRICT, TAMIL NADU

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Abstract: The present study is aimed to see the water quality of pond water, lake water, bore well water and well water in Lalapet village of Vellore district. For the present study, the water samples collected from well water, bore well water, lake water and pond waters in Lalapet village of Vellore District were analyzed for physical parameters such as Appearance, Odour, Turbidity, Total dissolved solids (TDS) and Electrical conductivity mic mho/cm and chemical parameters such as pH, alkalinity, Total hardness, Mg, Fe, Na, K, Mn, NH_3, NO_2, NO_3, Cl, F, SO_4, PO_4 and Tidy's test content using standard methods as given by APHA (2000) and their results are depicted in table–1. The acceptable limit mentioned in the text represents the standard for drinking water quality according to WHO (1984). The result of the present study indicated that the levels of physico-chemical parameters were found to be within the permissible limit although some of the mineral constituents like nitrate, chloride, fluoride and sulphate were found to be below the desirable limit in pond water of Lalapet village. It is concluded from this result that the waters were seemed to be suitable for drinking purpose although fluoride content was 0.1. It is concluded from the present study that the pond water, bore water and well water were seemed to be good for drinking purpose compared to the lake water of Lalapet village. It is suggested from this study that the water should be kept sustainable from free of intrusion of tannery effluent discharge into these water bodies. However, the low level of fluoride content in a range of 0.2-0.4 showed a harmful effect for dental caries and its related effects as reported by many investigators.

Introduction: India is a vast country, where a large number of people live in villages. A large number of villages and cities still do not have adequate and safe drinking water. In order to essential needs of the people, water comes at the second position of air. During the last decade, it has been realized that the time has come to pay more and more attention to the ground water resources and their adequate management by utilizing modern technique (Tiwari, 1999).

Numerous anthropogenic activities, like disposal of sewage and industrial water, recreational activities, excessive usage of fertilizers to land and use pesticides have threatened environmental health of both surface and ground water. Water pollution has however, threatened to reduce the quantity available in ponds, lakes, rivers and reservoirs due to other human activities (Trivedy and Chandrasekar, 1999). Rao, *et al*. (1999) reported that due to increasing industrialization, urbanization and other developmental activities most of our water bodies such as ponds, lakes, streams and rivers have become polluted. Environmental effects of chromium (Cr) have been extensively reviewed (NAS, 1974; Steven, *et al.,* 1976; Synder, *et al.,* 1977; Towill, *et al.,* 1978; Taylor and Parr, 1978; Langard and Norselth, 1979; Post and Campbell, 1980; Hatherill, 1981; Ecological Analysts, 1981).

Tamil Nadu is situated at the South Eastern Extremity of the Indian peninsula and it is the southernmost state of mainland India. It is located between 8°05 and 13°34 at North Latitude, 76014' and 8021' at East Longitude, Andhra Pradesh in the north, Karnataka in the North-West, Kerala on the West, Bay of Bengal in the east. Vellore district has become not only the hub of educational institution and also for the tannery industry, chemical industry, sugar mills etc., Vellore water is in an alarming condition as it has been receiving domestic and industrial wastes. Hence, the present study is centered around the water quality assessment in well, bore, pond and lake waters of Arcot town and its surrounded area of Vellore District.

Materials and Methods: Sampling area of Lalapet village is 30 km away from Vellore city and located in 12.928303 latitude and 79.332485 longitude and 5 km away from the tannery industrial area like Sipcot which is surrounded with 240 tannery industries along with ceramic, refractory, boiler and chromium chemicals and etc. Water samples collected for three months during the period from December, 2012 to February, 2013 from well and bore well, pond and lake waters. Among these waters, well and borewell waters are found utilized both for drinking and irrigation purposes and pond and lake waters are used for irrigation purpose only. Total population of this area is about 10,500. Water samples for present study were collected from bore well, well, pond and lake. To know the impact of tannery effluent intrusion into these water bodies by direct and indirect means, the waters were assessed with physico-chemical parameters. The methods followed for the physical parameters such as appearance, odour, turbidity NTU, Total Dissolved Solids and electrical conductivity and chemical parameters such as pH, alkalinity pH, alkalinity total, total hardness CaCo3, calcium, magnesium, sodium, potassium, iron total, manganese, free ammonia,, nitrite, nitrate chloride,

fluoride, sulphate, tidy's test were done according to the procedures given in APHA (2000) and their units are represented as mg/l. The water samples were collected using 1 liter of polyethylene bottle from each month starting from December,2012 to February,2013.

Fig 1. Showing The Collection of Water Samples from the Lake in Lalapet Village

Fig 1. Showing The Collection of Water Samples from the Pond in Lalapet Village

Results and Discussion: For the present study, the water samples collected from well water, bore well water, lake water and pond waters in Lalapet village of Vellore District were analysed for physical parameters such as Appearance, Odour, Turbidity, Total dissolved solids (TDS) and Electrical conductivity mic mho/cm and chemical parameters such as pH, alkalinity, Total hardness, Mg, Fe, Na, K, Mn, NH_3, NO_2, NO_3, Cl, F, SO_4, PO_4 and Tidy's test content using standard methods as given by APHA (2000) and their results are depicted in table–1. The acceptable limit mentioned in the text represents the standard for drinking water quality according to WHO (1984). The present study is aimed to see the water quality of pond water, lake water, bore well water and well water in Lalapet village of Vellore district. Appearance of both bore well water and well water are clear and colourless and pond and lake water are slightly yellowish in colour. Appearance may result from the presence of natural metallic ions like iron and Manganese, human and peat material, plankton, Weeds and Industrial waste. The colour is usually the first contaminant to be recognized in waste water that affects the aesthetics, water transparency and gas solubility of water bodies (Yuxing and Jian 1999). Odour was none in pond water, lake water, bore well water and well water. When odour is objectionable it indicates that the water has become deteriorated. Turbidity was 12 and 16 in pond and lake waters and 1 and 0 in bore well and well waters, respectively. Whereas, the turbidity level was within the acceptable limit (30). Increase of Turbidity indicates that the water is under deteriorative condition and this may be due to the suspicious intrusion of tannery effluent discharge from the tannery industries. This increase of turbidity content in the water may cause lack of productivity, reduction of O_2 and increase of CO_2 and thereby reduction of biomass including fish and other aquatic organisms will occur (Akan, et al., 2009).

Table 1. Result of Physico-Chemical Parameters of the Bore, Pond, Lake and Well Water Samples Collected from Lalapet Village (Mathinika)

S. No.	Parameters	Acceptable Limit WHO (1984)		Lalapet (Pond)	Lalapet (Lake)	Lalapet (Bore well water)	Lalapet (Well)
	PHYSICAL EXAMINATIONS						
1.	Appearance	A	B	Sly Yellowish	Yellowish	C &C	C &C
2.	Odour	Unobjectionable		None	None	None	None
3.	Turbidity NTU	1	10	12±0.50	16±0,50	1±0,0	0±00
4.	Total Dissolved Solids mg/l	500	2000	859±0.10	164±0.20	1259±0.20	682±1.0
5.	Electrical Conductivity (Mic mho/cm)	-	-	1227±2.0	234±1.0	1798±2.0	974±2.0
	CHEMICAL EXAMINATIONS						
6.	pH	6.5-8.5	6.5-9.2	8.13±0.09	7.89±0.05	7.03±0.09	7.08±0.09
7.	Alkalintiy pH as $CaCO_3$ mg/l	-	-	0	0	0	0
8.	Alkalintiy Total as $CaCO_3$ mg/l	200	600	296±2.0	48±1.0	396±3.0	292±3.0
9.	Total Hardness as $CaCO_3$ mg/l	200	600	460±2.0	66±1.0	516±1.5	298±1.0
10.	Calcium as Ca mg/l	75	200	144±2.0	14±1.0	154±1.0	99±2.0
11.	Magnesium as Mg mg/l	30	150	24±1.0	7±0.5	32±1.0	12±1.0
12.	Sodium as Na	-	-	-	-	-	-
13.	Potassium as K	-	-	-	-	-	-
14.	Iron Total as Fe mg/l	0.1	1.0	1.05±0,01	1.15±0,02	0.00±00	0.00±00
15.	Manganesium as Mn	30	150	0.00±00	0.00±00	0.00±00	0.00±00
16.	Free ammonia as NH_3 mg/l	-	-	0.86±0.15	1.10±0.02	0.00±00	0.00±00
17.	Nitrite as NO_2 mg/l	-	-	0.06±0.001	0.10±0.09	0.00±00	0.00±00
18.	Nitrate as NO_3 mg/l	45	100	25±1.0	8±0.09	34±1.0	14±1.0
19.	Chloride as Cl mg/l	200	1000	194±2.0	31±1.0	238±2.0	114±2.0
20.	Fluoride as F mg/l	1.0	1.5	0.4±0.01	0.02±0.01	0.6±0.09	0.6±0.09
21.	Sulphate as SO_4 mg/l	200	400	80±1.00	27±0.09	189±1.0	67±1.0
22.	Phosphate as PO_4 mg/l	-	-	0.12±0.01	0.30±0.09	0.00±00	0.00±00
23.	Tidy's Test	-	-	0.3±00	0.6±00	0.2±00	0.2±00
24.	RC	-	0.2	--	-	-	-
25.	BACTERIOLOGICAL EXAMINATION (M.F Technique)			-	-	-	-
26.	Fecal Coliform (100M)	0		0 --	-	-	-

Note:

1. A CPHEEO Std – Desirable Limit: B.CPHEEO/BIS Std – Permissible limit in the absence of alternative source.
2. Results of Chemical Examination expressed in mg/l except pH
3. C & C – Clear & Colourless

Total dissolved solids (TDS) content was found to be 859 in pond water,164 in lake water, 1259 in bore well water and 682 in well water and these levels were found to be within the acceptable limit. Total dissolved solids are one of the important measures of water quality. Waters with high solid content are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer. The desirable limit of TDS is 500 (WHO, 1984). This hike value of TDS may cause harmful effects for the purpose of the Agriculture and drinking and this may be due to the release into the land area with uncontrolled levels.

For most of the natural waters, the main contributors for total dissolved solids are calcium, Magnesium, Sodium, Potassium, Chloride, Sulphates and bicarbonates. TDS reflect the increasing extent of industrial and domestic discharge in aquatic habitats (Welcomme, 1985). High value of TDS were found to affect survival and growth of fish (Dicketson and

Vingard, 1999). High levels of TDS in the effluent renders it unsuitable for irrigation and drinking purpose. According to Manivasakam (1984) high amount of TDS recorded in tannery effluent could be attributed to processes like soaking, liming, dehairing, defleshing and deliming.

Electrical conductivity content was found to be around 1227 in pond water, 234 in lake water, 1798 in bore well water and 974 in well water of Lalapet village. Among these four waters compared the electrical conductivity content was found to be more only at bore well water of Lalapet village. Electrical conductivity is a useful tool to evaluate the purity of water. It is the property of water caused by the presence of various ionic species. The acceptable limit of Electrical Conductivity is 600 (WHO,1984). It is significantly noticed that the Electrical Conductivity content was likely to be increased only in the bore well water carrying the sludge of tannery effluent discharge. The high level of conductivity may be due to the presence of inorganic substances and salts which show good conductivity (Robinson and Stokes, 1959). The electrical conductivity is a useful parameter of water quality for indicating salinity hazards.

Among the physical parameters of the waters compared in four different water bodies like bore well water, well water, lake water and pond water of Lalapet village, their levels assumed to be within the desirable limit as prescribed by WHO (1984) and these by it is clearly indicated that there is no harmful effects due to the presence of these parameter and it is so healthy for drinking and irrigation purposes. It is suggested after analyzing the parameter that the water bodies should be kept in a sustainable manner from free of intrusion of industrial water into the water bodies by direct or indirect means. The pH value of the water is an important indication of its quality and it is dependent on the carbon dioxide, carbonate and bicarbonate equilibrium. The pH of the present study was ranged between 7.03-8.13 in pond water, lake water, bore well water and well water. The result of pH showed that there is no harmful effect due to its presence varied between 7.02-8.13.

The discharge of waste water into water bodies may cause a drop or increase their pH affecting size and activities of microbial populations therein. Other workers also reported acidic (Pathe, et al., 1995; Dikshit and Shukla, 1989; Mbuthia, et al., 1989; Saravanan, et al., 1999) and alkaline tannery waste waters (Shukla and Shukla, 1994; Kadam, 1990; Sastry, 1986; Sakthivel and Sampath, 1990). The factors like photosynthesis, exposure to air, disposal of industrial wastes and domestic sewage affect pH (Saxena, 1987). Alkalinity is a total measure of the substances in water that have acid neutralizing ability. Total alkalinity was found to be 296 in pond water, 48 in lake water, 396 in bore well water and 292 in well waters of Lalapet village of Walaja taluk. Among the four water bodies in Lalapet village compared the level of total alkalinity was seemed to be within the permissible limit except its low content present in Lalapet lake water (48). It is predicted from this result that the water is found to be suitable for drinking purposes.

Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes (keep the pH fairly constant) and makes water less vulnerable to acid rain. High alkalinity values are indicative of the eutrophic nature of the water body. Total alkalinity values of water are important in calculating the dose of alum and biocides in water (Trivedy and Goel, 1986).

The value of total hardness was optimum in pond water (460), in bore well water (516) and well water (298) and these levels were found to be within the permissible limit. It is predicted that this water is seemed to be suitable for drinking purposes. Whereas, low content of total hardness was noticed only in Lalapet lake water. Hardness is advantageous in certain conditions. It prevents the corrosion in the pipes by forming a thin layer of scales and reduces the entry of heavy metals from the pipes to the water (Praharaj, et al., 2002). The hardness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hard water will precipitate soap and lathering does not take place satisfactorily. Hujare (2008) reported total hardness was high during summer than rainy season and winter season.

Calcium content was noticed to be 144 in pond water, 14 in lake water, 154 in bore well water and 99 in well waters and these levels were seemed to be within the permissible limit except the lake water wherein low content was noticed (14). The presence of bicarbonates of calcium and magnesium indicate temporary hardness, which can be removed by boiling. Hard water is generally believed to have no harmful effect on human being. Cardiovascular diseases were reported to continue more to the areas of soft waters than to those having hard water (Crawford, 1972). Maximum value of hardness is observed in winter and minimum in summer (Pandhe, et al., 1995).

Vijayaram, et al. (1989) found that the concentrations of total hardness, chlorides, calcium, magnesium and sulphates were 2 to 20 times higher in the ground water of Thiruchirapalli city, Tamil Nadu due to the presence of tanneries. Calcium is most important cation in the study of water quality. Hardness of water as calcium carbonate is an important measure of pollution. Calcium is one of the nutrients required by the organism and at low concentration calcium

has no hazardous effect on human health. The calcium is an essential constituent of human being. The low content of calcium in drinking water may cause rickets and defective teeth; it is essential for nervous system, cardiac function and in coagulation of blood. Being an important contributor to hardness in water it reduces the utility of water for domestic use (Purohit and Saxena, 1990). Geologically Magnesium rich minerals are associated with basic and ultra basic rocks and ultramafic rocks of igneous and metamorphic percentage. Magnesium content was seemed to be low in pond water (24), lake water (7) and well water (12) and this level was maintained in optimum condition only in Lalapet bore well water.

When Magnesium is present above 200mg/l, it may produce gastrointestinal irritation. Magnesium is moderately toxic element if its concentration in drinking water is high. Calcium and Magnesium are of great neurochemical importance. Symptoms of cathartic and diuretic action are observed if excess of these ions are consumed (Brian and Berry, 1977). They are also the source of the hardness. The same trend could be noticed from the tannery effluent in Nagpur by Srinivas, et al. (1984) and reported that the presence of calcium, magnesium and bicarbonates in excess makes water unfit for irrigation since its application increase problems of soil salinity and its permeability detrimental to crop plants.

Iron content was 1.05 in pond water, 1.15 in lake water and nil values in both the bore well and well waters. Generally, surface water contains < 1mg/l of Fe. Some ground water contains much higher level of Fe. The iron value > 2mg/l imparts bitter astringent taste to the water (Maiti, 2002). Concentration of Fe above the safe limit could lead to liver, lung, kidney, brain, heart, muscle and respiratory disorders (Lark, et al., 2002). Free ammonia content was found to be 0.86 in pond water and 1.10 in lake water and there was no value noticed in both the bore well and well waters. Wetzel (1983) stated that ammonia is generated by heterotrophic microbes as a primary end product of decomposition of organic matter either directly from proteins or from the organic compounds.

Similarly Nitrite content was noticed to be 0.06 in pond water and 0.10 in lake waters and there is no values recorded in the bore and well waters. Nitrite poisoning causes fish mortality resulting in converting haemoglobin to form methaemoglobin as indicated by Boyd (1990). Nitrite content was seemed to be low in pond water (25) and bore well water (34) and very low content was noticed in lake water (8) and well water (14). The acceptable limit of NO_3 is 45-100. In excessive amounts it contributes to the illness of infant methaemoglobinemia and to prevent this disorder, a limit of 10mg dm^3 of nitrate nitrogen is imposed on drinking water (Agarwal, 2005). Nitrate represents the end product of oxidation of nitrogenous matter and its concentration is a presence of nitrification activities under progress in water (Singh, 2002).

Nitrate is a prime plant nutrient and rising in its concentration might be expected to increase the eutrophication of water (Goher, 2002). Nitrate is one of the several inorganic pollutants contributed by nitrogenous fertilizers, human waste and industrial effluents through the biochemical activities of micro organisms (Agarwal, 2005). Chloride level in water is a useful measure in water sample. High level is not known to be injurious to fresh water organism. The acceptable limit of Cl is 200-1000. Chloride content was found to be within permissible limit in pond water (194) and bore well water (238). Moderately low value was noticed in well water (14) and very low value was noticed in lake water (31) and chloride values were found optimum only in pond and bore waters.

Chloride becomes more toxic when they combined with other toxic substances such as cyanides, phenols and ammonia (Anonymous, 1976). The pollution from the industrial effluent will be a source of chloride concentration in the industrial area. High chlorides indicate organic pollution, particularly from domestic sewage. Discharge of industrial effluents in surface water bodies, presence of sodium and calcium, chloride in natural water and higher salinity are responsible for higher concentration of chloride in the area. Fluoride content was noticed to be very low in lake water (0.2), pond water (0.4), bore well water (0.6) and well water (0.6). This result indicated that the low level of fluoride content in the water may cause dental fluorosis.

Fluoride is also an important chemical constituent of the water. It is generally present in small quantities. Its occurrences in higher amount in the order of 1 mg/l is safe and effective in reducing the dental decays. The low concentration of fluoride below 0.5 mg/l causes dental caries and when present in higher concentration it causes dental and skeletal fluorosis, mottling of teeth etc. (Agarwal, 2005; Prajapati and Raol, 2006).

Gujarat is one of the most worst affected state amongst the 15 states of India reported as endemic for fluorosis (Jain, et al., 2000). Fluoride is often referred to as two-edged sword fluoride is very much essential for healthy growth of teeth. However, levels higher than 1.5 mg/l causes dental and skeletal fluorosis, decalcification, mineralization of tendencies, digestive and nervous disorders (Udhaya kumar, et al., 2006). Sulphate content was noticed to be 80 in pond water, 27 in lake water, 189 in bore water and 67 in well water and these values were seemed to be below the desirable limit. It is noticed that an appreciable quantity of sulphate content was noticed

in bore water of Lalapet village. The acceptable limit of So4 is 200-400. The presence of sulphate content in high salt water, sewage effluent, ceramic industry, etc. has been discussed in detail by many investigators (Saxena, 1987; Kaur, et al., 1996; Srinivas, et al., 2002). High concentration of sulphate in the tanneries is also as a result of many chemicals containing sodium sulphate as a by-product of the manufacturer or chrome tanning powders containing high levels of sodium sulphate (Bosmic, et al., 2000).

Phosphate content was noticed to be 0.12 in pond water, 0.3 in lake water and nil values in both the bore well and well waters. Generally, high content of PO_4 in the water may be attributed to the inlet of sewage and the detergents are the contribute factors for phosphates. The excessive phosphate concentration evokes an algal bloom in the water. Since, nitrate, nitrite and phosphate are nutrients for plankton growth, the water is rich in algal contents. The Tidy's content was recorded to be 0.3, 0.6,0.2 and 0.2 in pond, lake, bore well and well waters of Lalapet village. Tidy's test is useful for testing organic pollution. The pollution may be due to sewage or industrial waste. When the organic load is high, the dissolved oxygen level in water is high, the dissolved oxygen level in water decreased and affects the aquatic life.

Sinha and Gaurav kumar Rastogi (2007) studied the physico-chemical characteristics of underground drinking water at Moradabad industrial area in India and T indicated that the drinking water was found to be highly contaminated with reference to most of the parameters. Their study suggested that people dependent on this water are prone to health hazards of contaminated drinking water and some effective measures are urgently needed for water quality management. In a report of Government of Tamil Nadu it is stated that a water system head-work has to be virtually abandoned due to the high pollution level by tannery effluents. The water quality in and around Vaniyambadi, Ambur, Walajapet and Dindugal leave much to be desired. The need for tackling the tannery effluents on a serious footing has been raised from time to time (Tamil Nadu Leather Corporation, 1986).

According to Dhulasi Birundha and Saradha (1993), the sewage of a tannery discharged after treatment of one ton hide is equivalent to public sewage of little town inhabited with 5000 people. The effect that leather tanning industry has on the open water bodies is very greater often quite detrimental. The presence of sodium sulphate, chromium and some tanning agents remove oxygen from water, give it an unpleasant odour and completely stop the self purification process in water bodies by killing the biota. The tanning industry is a potential polluting industry of considerable importance. It is realized that the untreated waste waters when allowed to stagnate as is being done in most cases now, give rise to odour nuisance unsightly appearance besides creating ground water and surface water pollution.

Ramaswamy and Sridharan (1998) studied the groundwater quality of Tamil Nadu in the premises of tanneries and observed that the total hardness, chlorides, calcium and magnesium were 3 to 28 times higher than the drinking water permissible limit prescribed by WHO (1993). The tannery effluent contains high concentration of metallic ions like chromium, potassium, sodium and magnesium and organic pollutants like oil, grease, tannin and lignin (Manonmani, et al., 1991). Khwaja,et al. (2001) discussed about the influence of wasted on the physico-chemical characteristics of the Ganga water and sediments tannery at Kanpur (India) and revealed that increase values of parameters such as BOD, COD, chlorine and total solids could be due to the domestic wastes just as much as to the tannery wastes. However, chromium is one parameter which can primarily be identified to originate from the tanneries.

Sponza (2003) stated that the waste water (industrial effluents) causes soil and ground water pollution besides causing a number of adverse effect on agricultural produce, animals and health of people living in the neighbouring areas, since it contains waste chemicals and toxic heavy metals. An enormous increase in pollution due to discharge of effluents from industrial units into rivers and lakes is a matter of great concern in developing and developed countries which have water pollution problem due to industrial proliferation and modernization agricultural technologies, are now on the ways of combating the problems through improved waste water treatment technique. But, developing countries with lack of technical known how weak implementation of environmental policies and with limited financial resources are still facing problems. The result of the present study indicated that the levels of physico-chemical parameters were found to be within the permissible limit although some of the mineral contstituents like nitrate, chloride, fluoride and sulphate were found to be below the desirable limit in pond water of Lalapet village. It is concluded from this result that the waters were seemed to be suitable for drinking purpose although fluoride content was 0.1.

In lake water of Lalapet village the levels of physic-chemical parameters were not exceeded than the permissible limit, but, they were below the desirable limit. In bore well water of Lalapet village, the levels of most of these parameters were found to be below the desirable limit. In bore well water of Lalapet village, the levels of most of the physic-chemical parameters were found to be within the permissible

limit except some of the low values of nitrate and fluoride content found in their waters. In well water of Lalapet village, TDS, EC, pH, alkalinity, total hardness and calcium carbonate were found to be within the permissible limit and nitrate, chloride, fluoride and sulphate contents were found to be below the desirable limit. This result indicated that the bore well water was seemed to be more suitable for drinking purpose compared to well water.

It is concluded from the present study that the pond water, bore water and well water were seemed to be good for drinking purpose compared to the lake water of Lalapet village. It is suggested from this study that the water should be kept sustainable from free of intrusion of tannery effluent discharge into these water bodies. However, the low level of fluoride content in a range of 0.2-0.4 showed a harmful effect for dental caries and its related effects as reported by many investigators.

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