Health Consultation

Sparta Aquifer Vulnerability Study

HEALTH IMPLICATIONS OF HEAVY METALS CONTAMINATION
IN LOCUST BAYOU PRIVATE WELLS

LOCUST BAYOU, CALHOUN COUNTY, ARKANSAS 71701

SEPTEMBER 28, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Arkansas Department of Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia 30333

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Statement of Issues

On May 4, 2007, the Arkansas Department of Environmental Quality (ADEQ) informed the Arkansas Department of Health (ADH) that the U.S. Environmental Protection Agency (EPA) was conducting a long-term Sparta Aquifer Vulnerability Study within the Locust Bayou community near the boundaries of Calhoun and Ouachita counties. The study of the groundwater within the Sparta Aquifer was initiated due to previous industrial activities near the former Shumaker Naval Ammunition Depot that EPA has been monitoring for many years. As a collaborative effort between the EPA Region 6, ADEQ, and ADH, this study consists of general (non-potable) groundwater monitoring in the area, as well as private residential (potable) well water testing in the community.

While the majority of the residences in Locust Bayou use a municipal water system for their drinking water, there are a little more than a dozen homes that still use a private well water source as their potable water supply. Most of these private wells are assumed to draw their source from the Sparta Aquifer (the same aquifer being monitored by the EPA). Therefore, federal and state officials determined it was important to test these residential wells for the presence of contaminants, which might reveal the need for future monitoring and/or potential public health implications.

The first round of groundwater monitoring was performed by the EPA. Well locations, depths, and installation were all designated and/or performed by the EPA Region 6. Possible chemicals of concern from the Sparta Aquifer groundwater monitoring by the EPA included the metals lead and arsenic.

During a public availability session held in the community on June 12, 2007, residents were made aware of the EPA Sparta Aquifer Vulnerability Study test results, and they were also asked to volunteer for private well water testing if they did not have access to a municipal water system on their property. ADEQ conducted the second round of groundwater (private well water) testing on June 20 – 21, 2007. ADH evaluated all test data obtained from EPA and ADEQ in order to assess the potential health impacts for the residents whose water was voluntarily tested. Based on all data received, ADH completed this health consultation under cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). The possible chemicals of concern from the private well water testing included the metals lead and copper.

Background and History

The well locations included in the groundwater monitoring study are in the general area of the former Shumaker Naval Ammunition Depot (Shumaker), comprised of approximately 68,417.82 acres covering both Calhoun and Ouachita counties. The former facility is approximately four miles northeast of Camden, Arkansas and lies to the southeast of Highway 79.

From 1944 through 1957, Shumaker was utilized by the U.S. Navy for the manufacture, testing, storage, distribution, disassembly, and destruction of ammunition, bombs, and explosives. Improvements made to the site included: a railroad track and spur line system, reinforced concrete storage magazines, loading dock facilities, headquarters and administration buildings, and an eight mile long rocket test range. On December 3, 1959, the U.S. Navy announced it would cancel its contract with Shumaker and no longer use or occupy that land.

In 1961, International Paper bought 40,000 acres of forest land at the former naval depot. Some of this land is leased for wild game hunting. Brown Engineering Corporation of Houston, Texas, purchased the remaining 25,000 acres of the former Shumaker property. In 1987, 37 companies operated and 4,200 employees worked on the Brown property, which later changed its name to Highland Industrial Park. Highland Industrial Park began operating as an industrial park, and various defense contractors currently utilize the former facilities and buildings for missile production, including: Lockheed-Martin, Loral Vaught Systems, Aerojet, BEI Defense Systems Company, Tracor Aerospace, Hughes Missiles Systems, National Testing Service, Olin Industries, Camden Ordnance, Hitech Incorporated, and Austin Power.

Site Description

An aquifer is defined as a rock unit that will yield water in usable quantities to wells or springs. The aquifer may contain just the saturated zone, or both the saturated and unsaturated zones. The groundwater being examined is part of the Sparta Aquifer (groundwater systems are typified by both a shallow unconfined water table and a deeper confined aquifer.) The hydrogeology in the vicinity of Locust Bayou, Calhoun County, consists of the Quaternary-aged Terrace deposits consisting of complex sequences of unconsolidated gravels, sandy gravels, sands, silty sands, silts, clayey silts, and clays. The Quaternary-aged Alluvial deposits are located to the north, northwest along Caney Creek and are typically composed of unconsolidated gravel grading upward to sand, silt, and clay at the surface. The Cook Mountain formation is underlain by the Tertiary-aged Sparta Sand typically consisting of fine to medium-grained sand interstratified with silt, clay, and shale, and minor amounts of lignite [1]. It is important to identify the dynamics of groundwater flow and its geology in order to manipulate local groundwater flow when contamination is known to have occurred, so that contaminated groundwater flows away from a drinking water source.

Locust Bayou is located approximately two miles southeast from the Ouachita River and from Highland Industrial Park. Past, current, and future land use includes a mixed use of residential and industrial and/or commercial property. At this point, federal and state agencies believe the potentially responsible parties (PRPs) of this area of contamination to be unknown. Possible sources may stem from naturally occurring materials from the earth, the former Shumaker Naval Ammunition Depot, or past or present companies occupying the Highland Industrial Park.

Demographics

According to the U.S. Census Bureau, the total population of Calhoun County is 5,744 (based on data from the year 2000). The gender distribution is 51.9% female and 48.1% male; ethnicities include White (74.5%), Black (23.4%), Latino (1.5%), and American Indian (0.2%) populations. Within this population, 24.3% of people are 17-years-old or younger, and 75.7% of the population is 18-years-old or older [1, 2].

The Locust Bayou community consists of approximately 40 residential properties, two local churches, and a community center (located on U.S. Highway 278). Approximately fourteen of these residential homes use private wells as their main drinking water source and do not have

access to a municipal drinking water supply. ADH estimates there to be approximately three people per household living in these homes using private well water. The potential health effect of any type of contamination in the private well water could impact approximately 35% of the population within the Locust Bayou community.

Discussion

Exposure to contaminants of concern is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., chemical spill),
2. An environmental medium such as water, soil, or air that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium (e.g., private well),
4. An exposure route, such as drinking water from a well, and
5. A population who could come in contact with the contaminants.

An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur.

The EPA's study of the groundwater within the Sparta Aquifer was initiated due to previous industrial activities near the former Shumaker Naval Ammunition Depot that EPA and other federal and state agencies have been monitoring for many years. On April 17, 2006, ATSDR completed a health consultation on the "Health Implications of Perchlorate Contamination in Locust Bayou Private Wells". From this report it was concluded that there was and continues to be a completed exposure pathway from perchlorate contaminated water in the private wells tested in the Locust Bayou community, but the concentration of perchlorate was detected below human health comparison values and categorized as having *no apparent public health hazard* under the conditions that existed at the time of the sampling events in 2006 [3]. As a collaborative effort between the EPA Region 6, ADEQ, and ADH, this study consists of general (non-potable) groundwater monitoring in the area, as well as private residential (potable) well water testing in the community to detect chemicals such as heavy metals, volatile organic compounds, and perchlorate.

The data obtained from the EPA Sparta Aquifer Vulnerability Study test results [4] was evaluated only as a preliminary health screening because it is considered an incomplete human exposure pathway. Since the groundwater monitoring wells were installed by the EPA and designated for use in a groundwater monitoring program, and since there is no direct human exposure route of drinking water from these wells, the data from this study was not used to determine any public health effects in the Locust Bayou community. This data was used, however, to determine the need for further testing of the residence's private well water because most of these private wells are assumed to draw their source from the Sparta Aquifer (the same aquifer being monitored by the EPA for groundwater contamination). See Table 1 below.

Table 1. Shumaker Validated Data for SW-1 through SW-10
(Sampled 02/26/2007-Received by Arkansas Dept. of Health 05/22/2007)

Well	Contaminant	Concentration (μg/L)	MCL (μg/L)
SW-1	bis(2-ethylhexyl)phthalate*	72	6
SW-2	none exceed	-	-
SW-3	none exceed	-	-
SW-4	none exceed	-	-
SW-5	Lead Perchlorate**	18.6 0.44	15 n/a
SW-6	Arsenic Lead	29.6 48.9	10 15
SW-7	Arsenic Lead	12.1 24.2	10 15
SW-8	none exceed	-	-
SW-9	none exceed	-	-
SW-10	Arsenic Lead	20 22.6	10 15

* Determined by EPA to be a lab error
**Only result over Reporting Limit (0.3 μg/L)
MCL = Maximum Contaminant Level for drinking water; μg/L = microgram per liter
SW = Shallow Well (approximately 19.5 to 47 feet below ground surface)

Because the metals arsenic and lead exceeded the Maximum Contaminant Level (MCL) for drinking water standards (set and regulated by the EPA), it was determined that private well water for homes not using a municipal water supply should be tested since the possibility exist that the private well water draws from the same groundwater in the Sparta Aquifer being monitored by EPA Region 6. The EPA Sparta Aquifer Vulnerability Study and data reported in Table 1 were presented to the Locust Bayou community during a public availability session held at the Locust Bayou Community Center on June 12, 2007. During that session, volunteers who were not using any type of municipal water supply at their residences agreed to have their private well water tested, and signed up through ADEQ.

The residents drinking from the private well water taps that were tested were considered to likely be part of a completed pathway or might be in the future if down gradient from the plume, since all five parts mentioned previously existed and exposure to a contaminant of concern has occurred, is occurring, or will occur. Fourteen private wells were voluntarily tested within the Locust Bayou community and surrounding areas. From the test results obtained from ADEQ [5], nine of the private wells reported a value over the ATSDR Health Comparison screening value for either 1,2-dichlorethane, copper, and/or lead.

Health comparison values are doses or substance concentrations set well below levels that are known or anticipated to result in adverse health effects. These values help health assessors make consistent decisions about what substance concentrations or dose levels require a closer look. The levels detected for either 1,2-dichlorethane, copper, or lead slightly exceeded these comparison values for initial screening, thus requiring further evaluation.

Levels of all other compounds detected in the well water samples were below health screening values and were deemed to not represent a likely public health hazard. These compounds included: aluminum, barium, beryllium, boron, calcium, cobalt, iron, magnesium, manganese, nickel, potassium, silicon dioxide, sodium, zinc, bromide, chloride, fluoride, sulfate, and perchlorate. See Table 2 below for specific values of the three compounds that did exceed health comparison values.

For the 1,2-dichlorethane and copper evaluations, short-term Hazard Quotients (HQs) were calculated for each potentially exposed infant, child, or adult for the drinking water pathway. An HQ is a comparison of the average daily intake with a reference dose level below any likelihood that adverse health effects would occur. If the HQ for a chemical is equal to or less than one, it is believed that there is no significant risk that non-cancer health effects will occur. If the HQ exceeds one, there is some possibility that non-cancer effects may occur, although an HQ above one does not indicate an effect will definitely occur.

1,2-Dichlorethane

Drinking Well (DW)-3 was the only sample identified that showed a detectable level of 1,2-dichlorethane. When evaluating the potential risks for 1,2-dichlorethane, all values fell below safe levels for both the HQ calculation and the Lifetime Cancer Risk (LCR) calculation (which is considered by EPA to be safe if between the ranges of 1×10^{-6} to 1×10^{-4}). In the sample labeled DW-3, the HQ for 1,2-dichlorethane fell below a value of one and the LCR fell within the safe target risk range of 1×10^{-6}, therefore eliminating the compound 1,2-dichlorethane from further evaluation since the calculated levels were shown to cause no harmful affects of potential risks.

Copper

For copper, the HQ for samples labeled DW-4, DW-7, DW-8, DW-11, and DW-13 were well below one, and it is likely that no significant risk of non-cancer health effects will occur. The HQ for samples labeled DW-2, DW-5, and DW-6 and evaluated for copper were greater than one for all exposed individuals (these three samples were identified as having the highest reported concentrations). Refer to Table 2 for a summary of the data values.

The potential exist that short-term risks *may* occur from drinking water out of the wells that were used for samples labeled DW-2, DW-5, and DW-6 based on the well water test results. The potential short-term risks were calculated on a child drinking one liter of water per day and an adult drinking two liters of water per day. The timeframe for this potential risk would be of a relatively short duration. Due to copper's specific characteristics and its affect on the human body, any adverse health affects directly related to copper ingestion would be seen within the first 24 to 96 hours [6]. Because the EPA has not assigned a cancer slope factor to copper, LCR was not calculated. In this case, there is no potential for long-term cancer risk associated with copper.

Copper is an essential element required for normal growth and development for a variety of metabolic functions. Numerous factors may affect copper absorption. These factors include: the amount of copper in the diet, competition with other metals (including zinc, iron, and cadmium), and age. No copper-specific biomarkers of effects have yet been identified. The most notable sign of toxicity in humans ingesting a beverage or water containing copper is gastrointestinal distress. Symptoms, including nausea, vomiting, and abdominal pain, usually occur shortly after ingesting the contaminated beverage [6].

Lead

Because of lead's unique characteristics involving the interaction and metabolic uptake within the body, a specific model is used to estimate internal doses of lead as measured by blood lead levels in children rather than calculating a HQ. To evaluate lead for the private well water samples, the Integrated Exposure Uptake Biokinetic (IEUBK) Model for lead analysis was used [7]. This model can *predict* the level of lead in the blood of children ages 1 month through 7 years based on a specific lead level.

The Center for Disease Control and Prevention (CDC) considers blood lead levels a concern when there is greater than a 5% chance that a child will be exposed to lead contamination based on total exposure (diet intake, drinking water, soil and dust, maternal contribution). Samples labeled DW- 6 and DW-11 were the only two samples identified at a concentration that exceeded the MCL of 15 μg/L (all other samples reported a concentration of lead below the MCL). Using the IEUBK Model, the well water sample DW-6 lead concentration showed a 10.0% chance, and well water sample DW-11 lead concentration showed an 11.7% chance that an individual child *may* have elevated blood lead levels from *total* exposure to that well water as well as all other lead sources (dust or soil particles containing lead, lead-based paint chips, ceramics, etc.).

Because children are more sensitive to the effects of lead than adults, the IEUBK model was used. Lead affects children in different ways depending how much lead a child swallows. Different symptoms may be present in children according to the amount of lead they are exposed to (i.e., large amounts of lead exposure cause a different type of health effect than small amounts.) Lead had been shown to affect a child's mental and physical growth depending on the amount to which the child has been exposed.

Table 2. ADH/ATSDR Health Evaluation Outcome of Locust Bayou Residential Well Water Test Results

Compound	ATSDR Health Guideline Comparison Value (μg/L)	Concentration (μg/L)	Well Number	Hazard Quotient	Lifetime Cancer Risk
1,2-Dichloroethane	0.4	1.25	DW-3	$6.5x10^{-03}$ Infant $3.9x10^{-03}$ Child $1.8x10^{-03}$ Adult	$4.2x10^{-06}$ Infant $2.5x10^{-06}$ Child $1.2x10^{-06}$ Adult
Lead*	N/A	37.5	DW-6	N/A	N/A
		33.5	DW-11	N/A	N/A
Copper	100 (Child) 400 (Adult)	1670	**DW-2**	**4.59 Infant** **2.70 Child** **1.30 Adult**	N/A
		125	DW-4	0.35 Infant 0.21 Child 0.10 Adult	N/A
		809	**DW-5**	**2.19 Infant** **1.38 Child** 0.62 Adult	N/A
		922	**DW-6**	**2.49 Infant** **1.57 Child** 0.70 Adult	N/A
		182	DW-7	0.49 Infant 0.30 Child 0.14 Adult	N/A
		218	DW-8	0.59 Infant 0.38 Child 0.17 Adult	N/A
		205	DW-11	0.54 Infant 0.35 Child 0.12 Adult	N/A
		105	DW-13	0.27 Infant 0.18 Child 0.08 Adult	N/A

Text in bold represents Hazard Quotient (HQ) > 1 (EPA target range for non-cancer exceedance).

*Maximum Contaminant Level (MCL) for lead is 15 μg/L. IEUBK Model will be used for lead analysis.

ADH = Arkansas Department of Health; ATSDR = Agency for Toxic Substances and Disease Registry; N/A = Not Applicable; IEUBK = Integrated Exposure Uptake Biokinetic (Model to evaluate children exposed to lead concentrations); μg/L = microgram per liter; DW = Drinking Well

Community Health Concerns

ADH/ATSDR has not been contacted directly by Locust Bayou community members concerning the most recent sampling events. In response to a request from the ADEQ, ADH has become involved in the Sparta Aquifer Vulnerability study in order to assist the community with public health issues that may arise from the well water sampling results. ADH participated in the public availability session held in the community on June 12, 2007, evaluated data from EPA Region 6 monitoring wells and sample results from the private well water testing performed by ADEQ, and sent out individual letters to all residents who participated in the voluntary testing to inform them of their results. ADH/ATSDR personnel will continue to work with the federal and state agencies to insure that all public health questions are being answered within the Locust Bayou community concerning the Sparta Aquifer Vulnerability study.

Child Health Considerations

In communities faced with water, air, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Although exposure to high levels of copper may result in the same type of effects in children and adults (most notably gastrointestinal upset), children are more vulnerable than adults to lead poisoning if exposed to high levels of lead within the environment [8]. Children between the ages of six months to six years are in the greatest danger for lead poisoning. The most accurate way to determine the amount of lead in a child is to have their blood tested. A test to measure the amount of lead in the blood is called the Blood Lead Level test. The CDC recommends that a child's blood lead level be no higher than 10 μg/dL (micrograms of lead per deciliter of blood). If a child's blood lead level measures higher than 10 μg/dL precautions should be taken in order to reduce that child's exposure to lead.

Conclusions

ADH has reviewed all site information and laboratory data and concludes that there is a complete exposure pathway for the individuals (child or adult) ingesting drinking water from wells DW-2, DW-5, DW-6 and/or DW-11 that represents a ***public health hazard*** from exposure to copper and/or lead. Although the HQ and/or IEUBK lead prediction slightly exceeded set standards for the compounds copper and lead, all other sources of copper and/or lead exposure (past and current) to Locust Bayou community members (child or adult) are unknown at this time.

Because of the varied and numerous factors that affect an individual's exposure to these compounds, it can not be determined from the private well water data alone as to the significance of the compounds' impact on any health affects that may have occurred in the past or may occur in the future.

*This **public health hazard** indicates that the **potential** exists that some people may have adverse health affects from drinking the private well water containing the higher concentrations of copper or lead from wells DW-2, DW-5, DW-6 and/or DW-11, but it does not necessarily indicate that every individual would have the same adverse health affects. The potential short-term risks may be due to multiple factors, such as: the amount of water ingested (over one liter per day for a child or over two liters per day for an adult); the exposure concentration of the chemical of concern; the current health status, genetic predisposition, and/or environmental stressors of the individual; or a compromised immune system of an individual (as seen in a sensitive sub-population).*

ADH concludes that there is ***no apparent public health hazard*** from exposure to 1,2-dichlorethane for an infant, child, or adult from drinking water from well DW-3. There is ***no apparent public health hazard*** from ingestion of drinking water from wells DW-4, DW-7, DW-8, and DW-13, as these well samples did not show elevated level of copper which could cause any adverse public health affects (all HQ values in these samples were under 1, and therefore show no potential risks). There is ***no public health hazard*** from ingestion of drinking water for the five wells that resulted in non-detection of all chemicals tested, including wells DW-1, DW-9, DW-10, DW-12, and DW-14. Drinking from these five wells would have no adverse public health affects.

Recommendations

ADH/ATSDR recommendations for lowering an individual's potential adverse health effects from excess copper and lead in private well water (DW-2, DW-5, DW-6 and/or DW-11) that was tested by ADEQ within the Locust Bayou community include:

- Using an alternate water source, such as bottled water and/or a public water system;
- Using a filter (or filtration system) for well water and/or tap water;
- Replacing or treating older copper and/or lead pipe lines that may be causing corrosion* or a bluish stain on fixtures;
- Regular testing of private well water to ensure levels of copper and lead are decreasing;
- A medical test to detect blood lead levels of any children living in the residence known to have elevated lead levels and drinking the well water as their primary drinking source.

*Corrosion in a system can be reduced by changing the water's characteristics, such as adjusting pH and alkalinity; softening the water with lime; changing the level of dissolved oxygen; or the use of corrosion inhibitors which cause a protective coating to form on pipes. Any corrosion adjustment program should include monitoring. This allows for dosage modification, as water characteristics change over time.

Public Health Action Plan

The Public Health Action Plan implemented by ADH/ATSDR with regards to the Sparta Aquifer Vulnerability Study in the Locust Bayou community, Calhoun County, Arkansas, is as follows:

Completed Actions

- ADH personnel participated in a public availability session on June 12, 2007, within the Locust Bayou community.
- ADH personnel reviewed and evaluated Sparta Aquifer groundwater data obtained from EPA and private well water data obtained from ADEQ in order to determine potential public health risks between the time periods of May 22, 2007, through July 13, 2007.
- ADH issued letters of findings to the fourteen residents that had private well water tested by ADEQ informing them of their individual well water results on July 17, 2007. Included in these mailings were ATSDR fact sheets and health education materials developed for the Locust Bayou community concerning metal contamination and Blood Lead Level testing. For those residents that had elevated contaminants in their private well water, the ADH letters also included guidance on exposure reduction.

Future Activities

- ADH will continue to participate in all community activities involving the evaluation and/or testing of the EPA Sparta Aquifer Vulnerability Study groundwater monitoring program or the voluntary private well water residential program. ADH has had verbal assurance from ADEQ that all future individual well water result data will be shared, and ADH will continue to evaluate this data for public health purposes as it becomes available.
- EPA is planning on additional sampling of the groundwater in the Locust Bayou area and ADEQ plans to do follow-up sampling of the private wells previously sampled.
- ADH and ATSDR will provide information and advice to well owners, as requested.
- This site will be referred to the ATSDR PART Workgroup for recommendation follow-up through the federal agency, since it is listed as a Category 2: Public Health Hazard Site.

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Certification

The Arkansas Department of Health prepared this health consultation for the Sparta Aquifer Vulnerability Study in the Locust Bayou community, Calhoun County, Arkansas, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedure existing at the time the health consultation was initiated. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

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