Epidemiological investigation of an outbreak of Acute Viral Hepatitis A and E in a semi-urban locality in Chandigarh, North Indian Union Territory, 2016–17

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Abstract

Context: During ongoing passive surveillance in Burail, Chandigarh an unexpected rise in number of acute viral hepatitis (AVH) was reported during December 2016. **Aims:** An outbreak of AVH was investigated in an urbanized village, Burail, in Chandigarh, India with an objective of describing its epidemiological features. **Settings and Design:** A house-to-house survey was conducted in Burail (population 51,958). **Subjects and Methods:** WHO's standard case definition for AVH was used to identify cases. Suspected cases were tested for hepatitis A virus (HAV) and E virus (HEV) using enzyme-linked immunosorbent assay. Drinking water samples were tested for fecal contamination. Control measures were implemented to contain the outbreak. **Statistical Analysis Used:** Descriptive analysis was done as per time, person, and place. **Results:** Out of 141 confirmed cases of AVH, 85.1% were positive for HEV, 12.8% for HAV, and 2.1% for both HAV and HEV. The attack rate was 27.1 per 10,000 in a population. Males were affected more than females ($P < 0.05$). One of the areas reported a leakage in drinking water pipeline and had highest attack rate (36.8/10000 population). Drinking water samples were found negative for contamination. Around 27% of confirmed cases reported history of taking food from local vendors in Burail 2–6 weeks prior to the onset of symptoms. **Conclusion:** This study described the epidemiological features of dual hepatitis outbreak due to HAV and HEV from Chandigarh, Union Territory, north India.

Keywords: Attack rate, jaundice, hepatitis A, hepatitis E, outbreak investigation

Access this article online

Quick Response Code:

Website:
www.jfmpc.com

DOI:
10.4103/jfmpc.jfmpc_1244_19

Introduction

Globally, acute viral hepatitis (AVH) endures a major public health problem and it is now considered as comparable to big three communicable disease, that is, HIV/AIDS, malaria, and tuberculosis.[1] It is responsible for around 1.4 million deaths, where 47% deaths are caused due to hepatitis B virus (HBV), 48% due to

How to cite this article: Kankaria A, Gupta M, Bashar MD, Aggarwal S, Murugan S, Bhag C, *et al.* Epidemiological investigation of an outbreak of Acute Viral Hepatitis A and E in a semi-urban locality in Chandigarh, North Indian Union Territory, 2016–17. J Family Med Prim Care 2020;9:1856-67.

hepatitis C virus (HCV), and the rest are caused by both hepatitis A (HAV) and E (HEV) viruses.[2] HAV mainly attacks pediatric age group (1–3 years) and HEV mainly affects older children and young adults and is responsible for frequent epidemics.[3,4] Occasionally, HEV epidemic is associated with HAV epidemics in the form of dual infection in developing countries.[5] These viruses are mainly transmitted through ingestion of contaminated food and water. Inadequate sanitary conditions, inadequate safe drinking water, and sewage disposal problems leads to these outbreaks.[6,7] Hepatitis cases due HEV and HAV are routinely reported from different regions from India.[8]

These infections take a decent time for recovery from illness which affects daily life and have significant economic and social impact in the community.[3,4] The impact of these viral disease in respect of public health dimensions is poorly understood in many countries. The key challenges include poor public health approach, lack of access to affordable treatment, ignorance in the community, inadequate data, and lack of commitment. To address these challenges, the world health assembly adopted the first Global Health Sector Strategy on Viral Hepatitis, 2016–2021, with a vision of eliminating viral hepatitis as a public health problem with global targets of reducing new viral hepatitis infections by 90% and reducing deaths due to viral hepatitis by 65% by 2030.[2] In achieving sustainable development goals (SDGs), recently the National Viral Hepatitis Control Program is launched in India aiming to end viral hepatitis by 2030.[9]

During December 2016 to March 2017, 32 cases of jaundice with features of acute hepatitis were reported in the catchment area of Civil Hospital, sector 45 (CH-45), Chandigarh, India. This number was significantly higher than the numbers (3–5 cases) reported in the last 3 years' reports of integrated disease surveillance project (IDSP) in the same period (2014–16).[10] With the team of epidemiologist, virologist, and program officers an AVH outbreak was detected, and an epidemiological investigation was carried out. The objective was to describe its epidemiological features, identify the source of contamination and implement the containment measures in Chandigarh, a North Indian Union Territory.

Subjects and Methods

A descriptive outbreak investigation of AVH was done from December 2016 to November 2017, in the catchment area of CH-45, Chandigarh, mainly involving Burail (an urbanized village), where 51,958 were affected. Inhabitants of this area were mostly poor migrants who lived in overcrowded buildings with poor sanitary conditions and interrupted water supply. It is also a field practice area of medical college and tertiary care institute, in northern India. A verbal consent was taken from the study participants.

Outbreak Verification

Case definition

We used standard WHO case definition to investigate the outbreak.[11] Acute illness was defined as symptoms of acute

jaundice, dark urine, anorexia, malaise, extreme fatigue, and right upper quadrant tenderness. Biological signs included increased urine urobilinogen and >2.5 times the upper limit of serum alanine aminotransferase. A case positive for IgM anti-HAV was labeled as hepatitis A, and positive for IgM anti-HEV labeled as hepatitis E. The suspected case was defined as a case if compatible with the clinical description. The confirmed case was defined as a suspected case that is laboratory-confirmed for hepatitis A and E.

Active surveillance

The house to house survey was carried out by the trained team of field investigators with standard case record form from April 2017 to November 2017. [Supplementary File 1].

Laboratory and environmental investigations

Hepatitis A and E antibodies were detected by ELISA in the designated laboratory under Integrated Diseases Surveillance Project (IDSP) in Civil Hospital (CH), Manimajra, Chandigarh, for all the suspected cases. The diagnosis was also verified in randomly selected 19 cases in designated reference laboratory in the department of virology, tertiary care institute, and medical college.

A total of 18 drinking water samples from five tube wells and nearby households were tested during February 2017 and April 2017 for most probable number at IDSP designated laboratory at CH Manimajra. Additionally, six drinking water samples from the suspected contaminated area were tested in bacteriology laboratory in tertiary care institute and medical college for cross-verification.

Data analysis

A line list of confirmed and probable cases was maintained in an Excel sheet. Descriptive analysis of all the confirmed cases was done as per time, person, and place. Attack rates of acute hepatitis by age and gender was calculated. Hypothesis was generated and tested by conducting an age and gender matched case control study, where 125 pairs were identified and water sources, food, and travel history 2–6 weeks prior to the onset of any symptoms was obtained to identify the source of infection.

The mean serum levels of bilirubin, serum glutamate oxaloacetic transaminase (SGOT), and serum glutamic pyruvate transaminase (SGPT) were calculated. The cutoff for hepatitis was taken as total bilirubin >1.2 mg/dL, SGOT and SGPT >35 U/L calculated.[12]

Ethical clearance

The ethical approval was obtained by the Institute Ethics Committee, Chandigarh. (NK/5003/report/097).

Results

A total of 31,527 individuals and 10,509 households in Burail were contacted, and a total of 246 suspected cases were

identified. Out of these, 141 cases were confirmed serologically for hepatitis A and E. Hence, a mixed outbreak of hepatitis A and E was declared in Burail. Line list of all confirmed cases was maintained [Supplementary Table 1].

Time trend analysis

The time trend analysis of the outbreak indicated that the cases were continuously rising and falling throughout the year. Weekly attack rate (per 10,000) ranged from 0 to 1.35 case per week per 10,000. Active surveillance was carried out till November 8, 2017 (45th week), thereafter, passive surveillance continued. [Figure 1].

Person analysis

The age of the cases varied from 2 years to 74 years (mean 21.6 ± 1.03). The adolescents and young adults (10–29 years) were most commonly affected. Overall, attack rate was 27.1/10000 and age specific attack rate was the highest between 10 and 14 years age group (86.7/10000), males were affected more than females (64% versus 36%, Chi-square: 6.80, $P < 0.05$). The gender-specific attack rate was higher among males (32.8/10000 male population) as compared to females (20.8/10,000 females) Table 1.

Four pregnant women aged 20–34 years reported to be positive for AVH (three cases were HEV positive and one was HAV positive), out of 18 pregnant women during the outbreak. One of them had a miscarriage at 23 weeks of gestation due to severity of HEV, and others had delivered live and healthy babies by normal vaginal delivery. No maternal death reported.

Of the 141 confirmed cases, majority (85.1%) were due to mono infection with HEV followed by mono infection with HAV (12.8%), and rest (2.1%) were coinfected with both HAV and HEV. The attack rate was higher for HEV (23.10/10,000) than HAV (3.46/10,000) and coinfection (0.58/10,000). HAV mainly affected population <14 years of age (88%), where majority of the cases were between 5 and 9 years age group. HEV mainly affected population >10 years (95%), where majority of the cases were between 20 and 24 years age group.
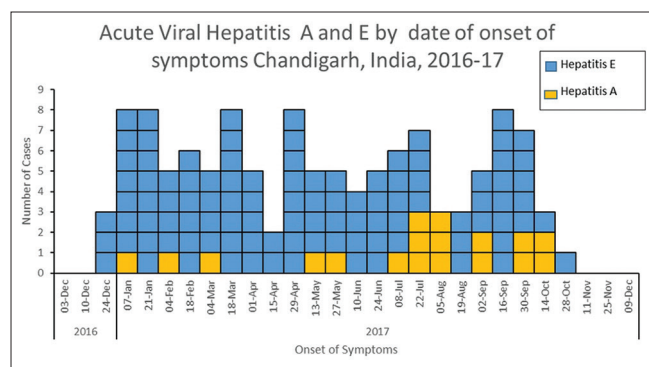
The three coinfected cases were present in 20–24 years age group ($n = 2$) and 30–34 age group ($n = 1$). HAV was prevalent more among females (56%) than males (44%), whereas HEV was prevalent more among males (68%) as compared to females (32%).

Around 27% of confirmed cases reported history of taking food from local vendors in Burail 2–6 weeks prior to the onset of symptoms. Around 35% of cases aged 25–29 years reported history of eating food from outside and across gender highest attack rate among males of age 15–19 years.

Clinically, the jaundice was the most commonly reported symptom (78%) and diarrhea was the least (27%) reported symptom. The average duration between the onsets of symptoms to the presentation at any health facility was 6.18 days, and it varied from 0 days to 49 days. Biochemical investigations of the patient have shown deranged liver functions in majority of the patients with mean total bilirubin levels of 6.67 ± 0.41 mg/dL ($n = 104$), SGOT 1132.9 ± 72.56 U/I ($n = 133$), SGPT 1291.6 ± 77.89 U/I ($n = 133$).

None of the population surveyed was immunized against hepatitis A vaccine.

Place analysis

The spot map was drawn with important landmarks, locations of cases, and source of drinking water like municipality tube wells. There were five tube wells in Burail as shown in the spot map of the area. The cases were mainly clustered around tube wells located near the wheat mill (*Atta Chakki*) [marked as area under blue rectangle on the right side in Figure 2]. There were also seven dried wells in the area, as it was an urbanized village. However, no one gave the history of using these wells. Since Burail area is divided in five blocks (marked as number 1 to 5) as per the population covered by an ANM, we estimated attack rate per ANM's area and plotted the incidence map as shown in Supplementary Figure 1. The highest attack rate was observed in area five (36.8 per 10,000) and lowest (15.2 per 10000) in area one. [Supplementary Figure 1].

Some residents (household no 1330, 218, and 818) complained of foul smell coming from the water supplied from the tube wells. There was also a history of leakage in drinking water pipelines and overflowing drains in the area (household no 750 to 760 and 810 to 825).

Case control study

Out of 125 pairs, 82 (65.6%) were males and 43 (36.4%) were females. All case and control had same source of drinking water and sewage drainage. None of the controls had the history of eating food outside or contaminated food or water, history of travel outside, history of attending large gatherings and history of contact with confirmed case or suspect as compared to the cases. Among 125 cases, 11% ate outside food, 18% ate

Figure 1: Epidemic curve of acute viral hepatitis (A and E) cases during December 2016 to November 2017 (45 weeks), in Burail, sector 45, Chandigarh

Age Category	Males			Females			Total		
	Cases	Population	Attack rate	Cases	Population	Attack rate	Cases	Population	Attack rate
0-1	0	375	0	0	351	0	0	726	0
1-4	6	1132	53.0	1	1179	8.5	7	2311	30.3
5-9	4	1354	29.5	7	1264	55.4	11	2618	42.0
10-14	17	1436	118.4	8	1447	55.3	25	2883	86.7
15-19	19	1445	131.5	4	1486	26.9	23	2931	78.5
20-24	19	2420	78.5	10	2013	49.7	29	4433	65.4
25-29	6	3088	19.4	11	2252	48.85	17	5340	31.8
30-34	6	2568	23.4	4	1932	20.7	10	4500	22.2
35-39	8	2233	35.8	2	1881	10.6	10	4114	24.3
40-44	0	1971	0	2	2054	9.7	2	4025	5.0
45-49	0	2331	0	0	2011	0	0	4342	0
50-54	3	1894	15.8	0	1610	0	3	3504	8.6
55-59	1	1738	5.75	2	1710	11.7	3	3448	8.7
60-64	0	1656	0	0	1505	0	0	3161	0
65 and above	1	1833	5.5	0	1789	0	1	3622	2.8
Total	90	27474	32.8	51	24484	20.8	141	51958	27.1

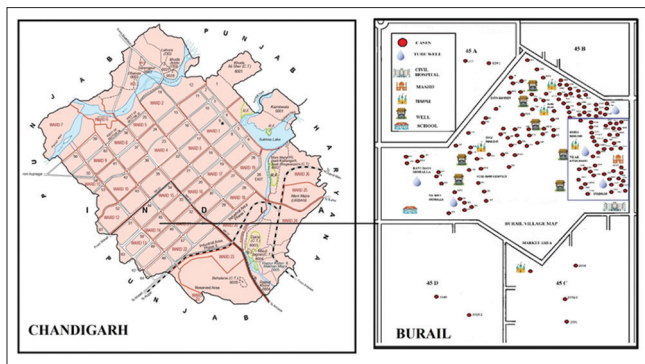Table 1: Age- and gender-specific attack rate per 10,000

Figure 2: Spot map showing distribution of cases and nearby drinking water source in Burail, Chandigarh, India

contaminated food or water, 18% had traveled outside, 8% attended large gatherings, and 20% had a contact either with confirmed case or suspect. One of the cases was employed as food handler in the schools of the Burail area. She was advised to take all the mandatory precaution required to contain the spread of the disease.

Water supply chain

The main source of drinking water in Burail was tap water supplied by Municipal Corporation, Chandigarh Administration. However, it was supplied intermittently for 1–2 h in the morning and evening through the tube wells. Chlorination is done daily as a routine at water works and tube well by the staff from Municipal Corporation.

Environmental findings

Drinking water samples were found to be satisfactory in bacteriology lab in tertiary care institute and medical college. The water samples tested by hydrogen sulfide test by the local CH-45 staff or by most probable number at IDSP lab in CH Manimajra were tested negative for contamination.

Probable source of infection

Based upon the results of the case control study, the probable source of infection seems to be contaminated food or water (as reported by 18% cases).

Control measures and management of cases

During the active surveillance period (1 April 2017 to November 8, 2017), regular health talks were organized by the doctors and the public health specialists in the community, schools, *anganwadis*, and health facilities. A meeting was held with area councilor to take initiatives to control the outbreak. He confirmed that pipes were laid 70 years back and there was a possibility of mixing of sewage with drinking water. An interim report was submitted to him. Based on the interim report, regular cleaning of gutters/manholes started in area five in Supplementary Figure 1, and separation of pipeline with sewerage line and new pipeline work started in Burail in April, 2017.

Discussion

The time trend analysis of the outbreak indicated that the cases were continuously rising and falling throughout the year. The shape of the epidemic curve suggested a persisting continuous transmission pattern. The attack rate of cases was similar irrespective of age group and gender.

The study findings confirm the HEV as the prime etiological agent of this outbreak of acute hepatitis. HEV is documented to be major cause of outbreaks of acute hepatitis in developing countries like India.[13,14] These outbreaks are reported from various parts of the country viz., Chattisgarh,[6] West Bengal,[15] Ahmedabad,[16] and Punjab.[17,18]

During the outbreak, 18 (12.8%) cases of HAV were detected along with three cases of coinfection of HAV with HEV. Similarly, a lower prevalence of HAV (20%) in hospitalized cases

was documented by from Madhya Pradesh,[19] Punjab,[17,18] and Chhattisgarh.[6] The decreasing trend of HAV in these studies supports the shift in seroprevalence of HAV reflecting improved living standard and environmental hygiene.[20]

The age of the cases varied from 2 years to 74 years and maximum number of cases ranged below 29 years. The younger age groups (10–29 years) were most commonly affected. More adults in comparison to children were affected due to HEV and more children in comparison to adults were affected due to HAV. Similar findings were reported from Chhattisgarh,[6] Kerala,[21] Andhra Pradesh[22] Gujarat,[16,23] Punjab,[17,18] and north western India.[24]

However, HAV was also identified in later ages, that is, >14 years age group as mono and dual infection which supports the gradual transition in age of acquiring HAV from childhood to adulthood.[20,25]

In this outbreak, more males (64%) were affected than females (36%) which was analogous to other studies from Chhattisgarh,[6] Punjab,[18] Gujarat,[16,23] and south India.[21] This suggests that males are more exposed to contaminated food and water as they go out for work.

Infection with HEV in pregnant women is found to be associated with adverse obstetric outcome and increased perinatal mortality.[18,26] During this outbreak, pregnant women were infected with HEV and one of the pregnancies had an adverse outcome. It was in contrast to the studies from Gujarat[23] and south India[22] where no HEV cases were found among pregnant women in the survey population.

The different symptoms reported were almost similar to presentation in other studies and presenting symptoms mainly included jaundice, dark urine, abdominal pain, fever, vomiting, loss of appetite, and fatigue.[6,16,17] On biochemical investigations majority of the patients had deranged liver function test similar to the other studies.[6,16]

Similar to our study, no deaths were reported in Gujarat outbreak.[16] However, studies from south India[21] and Chhattisgarh[6] had reported mortality due to hepatitis.

2–6 weeks prior to the onset of symptoms 27% of the cases had taken food from local vendors which points toward food being source of infection. However, we could not test food samples as there no local labs in Chandigarh which test for presence of HAV or HEV in food. The results of the case control study are also pointing at the contaminated food and water as source of infection in this outbreak.

The tested water samples were satisfactory for chlorination. However, in Burail, the drinking water pipeline and sewerage line were closely laid over and there is a possibility that due to leakage in the sewerage line, the wastewater contaminated with fecal matter was sucked into intermittently supplied drinking water system. However, we hypothesized that contamination of water in the old and corroded water pipes, after release from the tube wells, with the sewage due to negative pressure generated in the water pipes because of intermittent water supply, might be responsible for contamination and causation of this outbreak. Similarly studies done in Gujarat[16,23] Punjab[17] Chhattisgarh[6] and South India[21] have reported contaminated water as the primary reason for these outbreaks. However, all the water samples were tested negative for probable fecal contamination. The results of the case control study hinted at the possible contamination of outside food as source of infection.

The study findings confirm dual infection with HAV and HEV. HEV was the prime etiological agent of this outbreak. However, HAV was identified at a later age (>14 years) as both mono and dual infection which supports the gradual transition in age of acquiring HAV. The attack rate was 27.1 per 10,000. The shape of the epidemic curve suggested a persisting continuous transmission pattern. The gender specific attack rate was higher among males (32.8/10,000 male) as compared to females (20.8/10,000). The age-specific attack rates were higher between 10 and 29 years age group across both males and females. Pregnant women were infected with HEV and one of them had adverse outcome. The present outbreak was probably due to contamination of drinking water supplied to the affected areas with sewage water, which occurred due to old and corroded leaking pipelines of drinking water passing close to old leaking sewage lines.

This study provided an opportunity to strengthen the existing health system by training of health care staff in outbreak investigation, timely referral and follow-up, documentation of cases, health promotion activities, and importance of engaging stakeholders. Further, awareness is increased in the community regarding symptoms and preventive measure of the disease. This study increased overall preparedness of the health system in preventing and managing future outbreaks.

Conclusion and Recommendation

This study described the detailed methodology for epidemiological investigation of an outbreak and described the epidemiological features of dual hepatitis outbreak from northern India. The quality of the water both at the source of distribution and consumer end should be periodically checked for sewage contamination. There is a need of better engineering of sewage pipelines and drinking water distribution system with proper disposal systems for human feces and surveillance of status of water pipelines for any leakages especially in the old and closed communities. Authorities may consider vaccinating the susceptible population, local food vendors with licensed hepatitis A vaccine. The residents have to be informed about the possible contamination of outside food with hepatitis virus so that they avoid eating out especially in these settings, which are quite prevalent in low- and middle-income group countries.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Locarnini S, Chen DS, Shibuya K. No more excuses: Viral hepatitis can be eliminated. Lancet 2016;387:1703-4.

2. World Health Organization. Global Health Sector Strategy on Viral Hepatitis 2016-2021. Towards Ending Viral Hepatitis. World Health Organization; 2016.

3. Hepatitis A [Internet]. Available from: https://www.who.int/news-room/fact-sheets/detail/hepatitis-a. [Last cited on 2019 Jan 29].

4. Hepatitis E [Internet]. Available from: https://www.who.int/news-room/fact-sheets/detail/hepatitis-e. [Last cited on 2019 Jan 29].

5. Mirazo S, Ramos N, Mainardi V, Gerona S, Arbiza J. Transmission, diagnosis, and management of hepatitis E: An update. Hepat Med 2014;6:45-59.

6. Negi SS, Barde PV, Pathak R, Gaikwad U, Das P, Bhargav A. An outbreak of hepatitis E virus in Raipur, Chhattisgarh, India in 2014: A conventional and genetic analysis. J Med Microb Diagn 2015;4:2161-703.

7. Acharya SK. This is hepatitis: Know it, confront it. Indian J Med Res 2013;138:8-10.

8. Kumar T, Shrivastava A, Kumar A, Laserson KF, Narain JP, Venkatesh S, *et al.* Viral hepatitis surveillance--India, 2011-2013. MMWR Morb Mortal Wkly Rep 2015;64:758-62.

9. National Viral Hepatitis Control Program (NVHCP). National Health Portal of India [Internet]. Available from: https://www.nhp.gov.in/national-viral-hepatitis-control-program-(nvhcp)_pg. [Last cited on 2019 Jan 29].

10. Director General of Health Services [Internet]. National Centre for Disease Control. Ministry of Health and Family Welfare. Integrated Disease Control Programme. Available from: https://idsp.nic.in/. [Last cited on 2019 May 20].

11. WHO-Recommended Surveillance Standard of Acute Viral Hepatitis [Internet]. World Health Organization. 2014. Available from: https://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/passive/hepatitis_standards/en/. [Last cited on 2019 Jan 29].

12. Lu CM. Appendix: Therapeutic drug monitoring and laboratory reference intervals, and ; pharmacogenetic testing. In: Papadakis MA, McPhee SJ, Rabow MW, editors. Current Medical Diagnosis and Treatment 2019. New York, NY: McGraw-Hill Education; 2019. Available from: http://accessmedicine.mhmedical.com/content.aspx?aid=1155690725. [Last accessed on 2019 Jan 29].

13. Hakim MS, Wang W, Bramer WM, Geng J, Huang F, de Man RA, *et al.* The global burden of hepatitis E outbreaks: A systematic review. Liver Int 2017;37:19-31.

14. Gupta E, Agarwala P. Hepatitis E virus infection: An old virus with a new story! Indian J Med Microbiol 2018;36:317-23.

15. Das P, Adhikary KK, Gupta PK. An outbreak investigation of viral hepatitis E in south Dumdum municipality of Kolkata. Indian J Community Med 2007;32:84-5.

16. Chauhan NT, Prajapati P, Trivedi A V, Bhagyalaxmi A. Epidemic investigation of the jaundice outbreak in Girdharnagar, Ahmedabad, Gujarat, India, 2008. Indian J Community Med 2010;35:294-97.

17. Arora D, Jindal N, Shukla RK, Bansal R. Water borne hepatitis A and hepatitis E in Malwa Region of Punjab, India. J Clin Diagnostic Res 2013;7:2163-66.

18. Kaur M, Sidhu S, Singh K, Devi P, Kaur M, Singh N. Hepatitis E virus: A leading cause of waterborne viral hepatitis in Northwest Districts of Punjab, India. J Lab Physicians 2017;9:121-24.

19. Barde PV, Shukla MK, Pathak R, Kori BK, Bharti PK. Circulation of hepatitis A genotype IIIA virus in paediatric patients in central India. Indian J Med Res 2014;139:940-4.

20. Mathur P, Arora NK. Epidemiological transition of hepatitis A in India: Issues for vaccination in developing countries. Indian J Med Res 2008;128:699-704.

21. Rakesh PS, Mainu TTCR, Raj A, Babu D, Rajiv M, Mohandas KS, *et al.* Investigating a community wide outbreak of hepatitis A in Kerala, India. J Family Med Prim Care 2018;7:1537-41.

22. Vivek R, Nihal L, Illiayaraja J, Reddy PK, Sarkar R, Eapen CE, *et al.* Investigation of an epidemic of Hepatitis E in Nellore in south India. Trop Med Int Heal 2010;15:1333-9.

23. Verma PB, Thakor N, Goswami M. An epidemic investigation of hepatitis E in Juna Sachivalay area of Gandhinagar city, Gujarat, India. Int J Community Med Public Health 2016;3:2601-4.

24. Chandra NS, Sharma A, Rai RR, Malhotra B. Contribution of hepatitis E virus in acute sporadic hepatitis in north western India. Indian J Med Res 2012;136:477-82.

25. Kadri SM, Rehman SU, Rehana K, Benetou DR, Ahmad DF, Abdullah A, *et al.* Hepatitis A and E outbreak surveillance during 2015-2017 in Kashmir, India: Is the water to blame? J Epidemiol Glob Health 2018;8:203-7.

26. Gautam N, Ganju S, Ganju SA, Walia S, Kumar AK. Foetomaternal outcomes of hepatitis E infection outbreak in North India. Indian J Med Microbiol 2018;36:121-3.

Age	Sex	Address	Onset of Symptoms	Date of Visit to Hospital	Clinical Symptoms* (1=Symptom present, 0=Symptom absent)									Date of Lab Result	Test Result
					F	J	DU	AP	LOA	Fa	V	N	D		
12	M	#89, Burail,	28-Dec-16	30-Dec-16	1	0	1	1	0	1	0	0	1	06.01.2017	E
23	F	#1660, Burail,	24-Dec-16	31-Dec-16	1	1	1	0	0	1	0	0	0	13.01.2017	A&E
15	M	#332, Burail,	26-Dec-16	4-Jan-17	0	1	0	0	1	1	1	1	1	13.01.2017	E
9	M	#1247 A Burail,	6-Jan-17	6-Jan-17	1	1	0	0	0	0	0	0	0	13.01.2017	A
38	M	#330, Burail,	28Dec. 16	6-Jan-17	0	0	1	1	0	0	0	1	0	13.01.2017	E
20	M	#1909, Burail,	7-Jan-17	6-Jan-17	1	1	0	0	1	0	1	0	0	13.01.2017	E
19	M	#966, Burail,	11-Jan-17	6-Jan-17	0	1	1	1	1	1	1	1	1	13.01.2017	E
28	M	#627, Burail,	28-Dec-16	6-Jan-17	1	1	1	1	1	0	1	1	1	13.01.2017	E
23	F	#543, Burail,	5-Jan-17	14-Jan-17	1	0	0	1	0	1	1	0	0	21-Jan-17	E
29	M	#1711/1 Burail,	15-Jan-17	17-Jan-17	0	0	0	1	0	0	0	0	0	21-Jan-17	E
23	F	#1247, Burail,	12-Jan-17	19-Jan-17	1	1	0	0	1	0	0	1	0	21-Jan-17	E
28	F	#393, Burail,	12-Jan-17	21-Jan-17	1	0	1	0	0	0	0	1	0	27-Jan-17	E
9	F	#1529, Burail,	14-Jan-17	21-Jan-17	1	0	1	0	1	1	0	1	0	27-Jan-17	E
35	F	#1651, Burail,	16-Jan-17	23-Jan-17	1	0	1	1	1	1	1	1	0	27-Jan-17	E
35	M	#1284, Burail,	10-Jan-17	25-Jan-17	1	0	0	0	1	1	0	1	0	27-Jan-17	E
14	M	#1684, Burail,	22-Jan-17	28-Jan-17	1	0	1	1	1	1	1	1	1	4-Feb-17	E
38	F	#1668, Burail,	28-Jan-17	30-Jan-17	1	1	1	1	1	1	1	1	1	4-Feb-17	E
10	F	#1679, Burail,	22-Jan-17	1-Feb-17	0	1	1	1	1	1	1	1	0	4-Feb-17	E
24	M	#1520, Burail,	20-Jan-17	2-Feb-17	0	0	0	1	0	1	0	0	1	4-Feb-17	E
24	M	#971, Burail,	18-Jan-17	2-Feb-17	1	0	0	0	1	1	0	0	0	4-Feb-17	E
20	M	1055, Burail	28-Jan-17	7-Feb-17	1	1	0	0	1	0	0	1	0	11-Feb-17	E
12	F	#359, Burail	10-Feb-17	16-Feb-17	1	1	1	0	1	1	0	1	0	16-Feb-17	E
32	F	#428, Burail	28-Jan-17	16-Feb-17	1	1	1	1	1	1	1	1	0	16-Feb-17	A& E
14	M	#1628, Burail	10-Feb-17	17-Feb-17	1	1	1	0	1	0	0	1	0	25-Feb-17	E
24	M	#79, Burail	14-Feb-17	23-Feb-17	1	1	1	0	1	0	0	0	0	25-Feb-17	E
32	F	#787 Burail	2-Feb-17	16-Feb-17	1	1	0	1	1	0	0	1	0	16-Feb-17	A
11	F	#1651, Burail	20-Feb-17	23-Feb-17	1	1	1	0	1	0	1	0	0	25-Feb-17	E
12	M	#1529, Burail,	9-Feb-17	15-Feb-17	Asymptomatic but house hold contact of case									20-Feb-17	E
26	F	#1661, Burail	1-Feb-17	15-Feb-17	0	1	1	1	1	0	0	0	0	20-Feb-17	E
30	M	#565, Burail	26-Feb-17	28-Feb-17	1	1	1	0	1	1	1	0	1	3-Mar-17	E
17	M	#596, Burail	28-Feb-17	28-Feb-17	1	1	1	1	0	1	0	0	0	3-Mar-17	E
3	F	#1598, Burail	24-Feb-17	1-Mar-17	1	1	1	0	1	1	1	0	0	3-Mar-17	A
18	M	#1421, Burail	17-Jan-17	3-Mar-18	1	1	1	0	0	1	0	1	0	10-Mar-17	E
20	F	#1190, Burail	5-Mar-17	3-Mar-17	0	1	0	1	0	0	1	0	0	10-Mar-17	E
34	F	#605, Burail	8Mar. 17	11-Mar-17	1	1	1	0	1	1	0	0	0	17-Mar-17	E
28	M	#492, Burail	7 Mar. 17	15-Mar-17	1	1	1	0	0	0	0	0	0	17-Mar-17	E
25	F	#901, Burail	16Mar. 17	17March. 17	1	1	1	1	1	1	1	0	0	23-Mar-17	Test
25	M	#40, Burail	18Feb, 17	23-Mar-17	1	1	DU	1	1	Fa	0	N	0	31-Mar-17	Result
28	M	#1283, Burail	11Mar, 17	23March. 17	1	1	1	1	0	0	1	1	0	31-Mar-17	E
51	M	#1591 Burail	15Feb, 17	15March. 17	0	1	1	1	1	1	0	0	1	17-Mar-17	E
33	M	#728, Burail	20Mar. 17	23-Mar-17	1	1	1	1	0	1	1	0	0	31-Mar-17	E
10	M	#534, Burail	17Mar. 17	23March. 17	0	1	1	1	1	1	1	1	0	31-Mar-17	E
20	F	#2009.Burail	23Mar. 17	25 March. 17	1	1	1	1	0	1	1	0	0	31-Mar-17	E
13	F	#1172, Burail	22Mar. 17	27 March. 17	1	0	1	1	0	1	1	1	0	31-Mar-17	E
20	M	#1680, Burail	3Apr. 17	29 March. 17	1	1	1	1	1	1	0	0	0	31-Mar-17	E
25	F	#378 Burail	27Mar. 17	3April. 17	1	1	1	0	1	0	1	0	0	7-Apr-17	E
29	F	#534 Burail	16Mar. 17	3April. 17	1	1	1	1	0	1	1	0	1	7-Apr-17	E
16	M	#530 Burail	2Apr. 17	3April. 17	1	1	1	1	1	1	1	1	1	7-Apr-17	E
9	M	# 1130 burail	4Apr. 17	12April. 17	1	1	1	1	1	1	1	1	0	12-Apr-17	E
24	M	#1667 Burail	12Apr. 17	21April. 17	1	1	1	0	0	0	1	0	0	15-Apr-17	E
14	M	#1197, Burail	8Apr. 17	21April. 17	1	1	1	1	1	1	1	1	0	15-Apr-17	E
18	M	# 135, Burail	30Mar. 17	28April. 17	0	1	1	1	1	0	1	0	0	28-Apr-17	E
18	M	#552, burail	23Apr. 17	27Apr. 17	1	1	1	1	0	0	1	1	0	25April. 17	E
16	M	#1642, Burail	25Apr. 17	01May. 17	1	0	1	1	1	0	0	0	1	3-May-17	E

Contd...

|					Supplementary Table 1: Contd...										
Age	Sex	Address	Onset of Symptoms	Date of Visit to Hospital	Clinical Symptoms* (1=Symptom present, 0=Symptom absent)									Date of Lab Result	Test Result
					F	J	DU	AP	LOA	Fa	V	N	D		
40	F	#1008, Burail	12Apr. 17	03May. 17	1	1	1	1	0	0	1	0	0	03May. 17	E
16	M	#1109, Burail	22Apr. 17	01May. 17	1	1	1	0	0	0	0	0	0	3-May-17	E
17	F	#236, Burail	16Apr. 17	03May 0.17	1	1	1	1	0	0	1	0	0	5-May-17	E
23	F	#1936, Burai	24Apr. 17	27April. 17	0	1	1	0	0	1	1	1	1	6-May-17	E
13	F	#641, Burail	05May. 17	01May. 17	0	1	0	0	0	1	0	0	0	5-May-17	E
44	F	#1493, Burail	2May. 17	09May. 17	1	1	1	1	0	1	0	0	1	12-May-17	E
25	M	#1493, Burail	26Apr. 17	27Apr. 17	1	1	1	1	0	0	1	0	0	7May. 17	E
20	M	#863, Burail	26Apr. 17	08May. 17	1	1	1	1	1	1	1	1	1	12-May-17	E
13	M	#1517, Burail	13May. 17	13May. 17	1	1	1	1	0	0	0	0	0	19-May-17	E
9	M	#423, Burail	25Mar. 17	13May. 17	0	1	1	1	0	0	0	0	0	19-May-17	E
55	F	#331, Burail	8May. 17	13May. 17	1	1	1	1	0	0	0	1	0	19-May-17	E
19	F	#1729, Burail	8May. 17	15May. 17	0	1	0	1	1	0	1	0	0	19-May-17	E
22	M	#538, Burail	10May. 17	17May. 17	0	1	1	1	1	1	1	1	1	19-May-17	A&E
14	M	#1216, Burail	15May. 17	19May. 17	1	1	1	0	0	0	1	0	0	26May. 17	E
19	M	#1493, Burail	20May. 17	24May. 17	1	1	1	1	0	1	1	1	0	26May. 17	E
17	M	#940, burail	17May. 17	22May. 17	0	1	1	0	0	1	1	0	1	26May. 17	A
32	M	#431, Burail	27May. 17	30May. 17	0	1	1	1	0	0	0	0	1	02June. 17	E
20	M	#70, Burail	28May. 17	31June 17	0	1	1	1	0	0	1	0	1	02June. 17	E
22	M	#698, Burail	22May. 17	1June. 17	1	1	1	1	1	1	1	0	0	02June. 17	E
12	F	#1427, Burail	22May. 17	01June. 17	1	1	1	1	1	1	1	0	1	12June. 17	E
39	M	#887, Burail	26May. 17	09 June 0.17	1	1	1	0	1	1	1	0	1	12 June. 2017	E
5	F	#1489, Burail	02June. 17	12 June. 17	1	1	1	1	1	1	1	0	0	16 June. 2017	A
22	M	#57, Burail	10June. 17	12 June 0.17	1	1	1	1	0	0	1	0	1	16 June. 2017	E
28	F	#774, Burail	12June. 17	19 June. 17	0	0	0	1	1	1	0	0	0	23 June. 2017	E
25	F	#1493, Burail	16June. 17	20 June. 17	1	1	1	1	0	0	1	0	0	23 June. 2017	E
26	F	#600/A, Burail	15May. 17	20 June. 17	0	1	0	0	0	0	0	0	0	23-Jun-17	E
14	M	#487, Burail	25July. 17	26 June. 17	1	1	1	0	0	1	0	0	0	30 June. 2017	E
26	F	#1176, Burail	05July. 17	05July. 17	0	1	0	0	0	0	1	0	0	0 June 0.2017	E
23	M	# 605, Burail	20June. 17	30 June. 17	0	1	1	1	1	1	0	0	0	07July. 2017	E
5	F	#197, Burail	29June. 17	04 July. 17	0	1	1	1	1	0	0	0	0	07 July. 2017	E
55	M	#1386.Burail	09July. 17	12 July. 17	0	0	1	0	1	0	1	0	0	14 July. 2017	E
35	M	# 585 , Burail	06July. 17	14.07.2017	1	1	1	1	1	0	0	0	0	21 July. 2017	E
15	M	# 345/1 , Burail	12July. 17	15 July. 17	1	1	1	1	1	1	1	0	0	21 July. 2017	E
7	M	# 1060, Burail	08Aug. 17	15 July. 17	1	1	1	1	1	1	0	0	0	21 July. 2017	E
19	F	#728 , Burail	12July. 17	15 July. 17	1	1	1	1	1	1	1	1	1	21 July. 2017	E
29	F	# 990, Burail	13 July. 17	14 July. 17	0	0	0	1	1	1	0	0	1	21 July. 2017	E
21	M	# 1574 , Burail	23 July. 17	27July. 17	0	1	0	1	0	1	0	0	0	28July. 2017	Test
37	M	# 1253 , Burail	27 July. 17	27July. 17	1	0	DU	AP	0	1	0	0	0	28July. 2017	E
11	M	# 487 , Burail	16July. 17	21July. 17	0	1	1	1	0	0	1	0	0	28July. 2017	A
3	M	# 822 , Burail	19July. 17	22July. 17	1	1	1	1	0	0	1	0	1	28July. 2017	A
20	M	# 541 , Burail	22July. 17	24July. 17	1	1	0	1	0	0	0	0	0	28July. 2017	E
32	M	# 1517, Burail	23July. 17	24July. 17	0	1	1	0	0	0	0	0	0	28July. 2017	E
5	F	# 1321, Burail	19July. 17	21July. 17	1	1	1	1	0	0	1	0	0	28July. 2017	A
52	M	# 1768 , Burail	20May. 17	21July. 17	0	1	1	0	0	0	0	1	0	28July. 2017	E
20	F	# 1298 , Burail	18July. 17	20July. 17	1	1	0	0	0	0	0	0	0	28July. 2017	E
10	F	# 171, Burail	30July. 17	31July. 17	1	1	0	1	0	0	0	0	1	04.08.2017	A
30	M	# 1131, Burail	26July. 17	01Aug. 17	0	0	1	1	1	1	0	0	0	04.08.2017	E
19	M	# 270, Burail	28July. 17	2Aug. 17	0	1	1	1	1	0	0	0	0	04.August. 2017	E
12	M	# 1282, Burail	01Aug. 17	03Aug. 17	1	1	1	0	0	1	0	0	0	11. August. 2017	E
4	M	# 1471, Burail	15July. 17	07.08.2017	1	1	1	1	0	0	1	0	1	11.2 August 017	A
6	F	# 570, Burail	05Aug. 17	10Aug. 17	1	1	0	0	1	0	1	0	0	11. August 2017	A
2	M	# 1419, Burail	05Aug. 17	10Aug. 17	0	1	1	1	0	0	1	0	0	11 Aust. 2017	E
25	F	#160, Burail	10Aug. 17	13.8.2017	0	0	1	1	1	0	0	0	0	19.Aug. 2017	E
7	F	# 1519, Burail	12Aug. 17	18Aug. 17	1	0	0	1	1	0	0	1	1	19 Aug. 2017	A
33	M	#89, Burail	19Aug. 17	21.8.2017	1	1	0	1	0	0	0	0	1	21. Aug. 2017	E

Contd...

Age	Sex	Address	Onset of Symptoms	Date of Visit to Hospital	Clinical Symptoms* (1=Symptom present, 0=Symptom absent)									Date of Lab Result	Test Result
					F	J	DU	AP	LOA	Fa	V	N	D		
18	M	#1519, Burail	25Aug. 17	26Aug. 17	1	1	1	1	0	0	1	0	0	31-Aug-17	E
16	M	#2011, Burail	26Aug. 17	01Sept. 17	1	1	0	1	0	0	1	0	0	8.Sept. 2017	E
22	M	#334, Burail	29Aug. 17	04sept. 17	0	0	0	1	1	1	0	0	0	8.Sept. 2017	E
3	M	#1628, Burail	05Sept. 17	04sept. 17	1	1	1	1	0	0	1	1	1	8.Sept. 2017	A
12	M	#93, Burail	07Sept. 17	07Sept. 17	0	1	1	1	0	0	0	0	1	8.Sept. 2017	E
3	M	#1063, Burail	08Sept. 17	08sept. 17	0	1	0	1	0	0	0	0	1	1Sept. 2017	E
22	M	#1285, Burail	08Sept. 17	12sept. 17	0	0	1	1	0	0	0	0	1	15.Sept. 2017	E
56	F	#1519, Burail	06Sept. 17	13sept. 17	0	1	1	0	1	0	1	0	0	15.Sept. 2017	E
5	F	#57, Burail	08Sept. 17	13.9.2017	1	1	1	0	0	0	0	0	0	15.Sept. 2017	A
18	M	#1668, Burail	11Sept. 17	16sept. 17	0	1	1	0	1	0	0	0	0	22.Sept. 2017	E
50	M	#1668, Burail	21Sept. 17	22sept. 17	1	0	1	1	0	0	0	0	1	29.Sept. 2017	E
20	M	#864, Burail	21Sept. 17	23Sept. 17	1	1	0	1	0	0	0	0	0	29.Sept. 2017	E
11	M	#622, Burail	20Sept. 17	22Sept. 17	0	1	1	0	0	0	1	1	0	29.Sept. 2017	E
16	M	#160, Burail	25Sept. 17	25Sept. 2017	0	1	0	0	0	0	1	0	0	29.Sept. 2017	E
23	M	#1410, Burail	21Sept. 17	25Sept. 17	0	0	1	1	1	0	0	0	0	29.Sept. 2017	E
17	M	#1533, Burail	23Sept. 17	26Sept. 17	1	1	1	0	0	0	1	0	0	29.Sept. 2017	E
19	M	#1481, Burail	23Sept. 17	27Sept. 17	0	1	0	0	0	0	0	0	0	29.Sept. 2017	E
11	F	#940, Burail	25Sept. 17	27Sept. 17	0	1	0	0	0	0	1	0	1	29.Sept. 2017	A
24	F	#106, Burail	26Sept. 17	06Oct. 17	0	0	0	1	1	0	1	1	0	07Oct. 2017	E
32	F	#1407, Burail	27Sept. 17	06Oct. 17	1	1	0	0	1	1	0	0	1	07.10.2017	E
11	M	#1218, Burail	29Sept. 17	06Oct. 17	0	0	1	0	1	0	1	1	0	07.10.2017	A
12	M	#831, Burail	2Aug. 17	06Oct. 17	0	1	0	1	0	1	0	0	0	13.10.2017	E
17	F	#755, Burail	30Sept. 17	07Oct. 17	1	1	0	1	0	0	0	0	0	13.10.2017	E
10	M	#345, Burail	29Sept. 17	07Oct. 17	1	0	1	1	0	0	0	1	0	13.10.2017	E
33	M	#550, Burail	3Oct. 17	08Oct. 17	1	1	0	1	0	0	0	0	0	13.10.2017	E
7	F	#105, Burail	04Oct. 17	12.Oct. 17	1	0	1	0	0	0	0	1	0	13.10.2017	A
4	M	#1247, Burail	10Oct. 17	13.10.2017	1	1	0	1	0	0	1	1	1	21Oct. 2017	A
14	M	#755, Burail	12Oct. 17	16Oct. 17	1	1	0	1	0	0	0	0	0	21Oct. 2017	E
35	M	#557, Burail	08 Oct. 17	16Oct. 17	0	0	1	0	1	0	0	0	1	21Oct. 2017	E
23	F	#238, Burail	14 Oct. 17	21Oct. 17	1	1	0	0	1	0	1	1	0	27 Oct. 2017	E
20	F	#749, Burail	22Oct. 17	24Oct. 17	0	0	0	1	1	0	0	1	0	27 Oct. 2017	E
37	M	#901, Burail	30Oct. 17	06Nov. 17	0	1	1	1	0	0	0	1	0	11 Nov. 2017	E
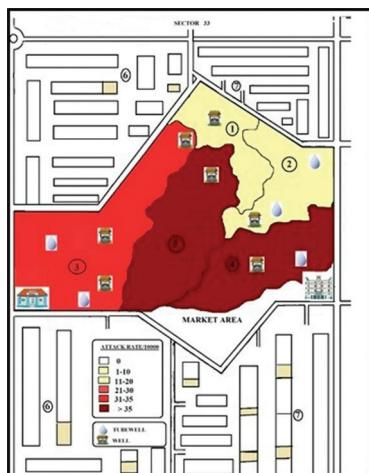
Supplementary Figure 1: Area wise attack rate of Acute Viral Hepatitis in Burail and sector 45 (*n*=141)

Supplementary File 1: Case Investigation Form

Case Investigation Form (CIF) for House to House Survey in Burail

1. Unique ID:
2. Date of Investigation:
3. Name of the Investigator with Designation:

DEMOGRAPHIC INFORMATION

4. Name:
5. Age:
6. Date of Birth
7. Gender:
8. Address:
9. Contact no:
10. Source of drinking water: (Ask Tube well with landmark)

11. Drainage system

CLINICAL & DIAGNOSTIC DATA:

12. Are you having following symptoms:

Symptom	No	Unknown	Yes	If yes date of onset

If any of the symptoms are present then ask following question:

13. Whether you took any treatment for such symptoms?
    a) **If yes from** where

14. What was the diagnosis?

15. What was the date of diagnosis?
16. What all investigations were done?

17. Was the patient hospitalized?   yes ….no   …**If yes**
    a) what was   diagnosis?
    b) Admission Date: ………………..c) Discharge Date:

18. Was the patient pregnant? _ No _ Unknown _ Yes
    If Yes then Due Date: __ __   Diagnosis Date: __ __ / __ __ /__ __ __ __

19. Did the patient die from this illness? _ No _ Unknown _ Yes
    If Yes then Date of Death: __ __

20. Laboratory diagnosis:

Test	Date of Sample	Date of Result	Status(Result values for SGOT/SGPT B and Positive/Neg/Unknown for IgM A and E)
Total Serum Billirubin (TSB)			
ALT (SGPT)			
AST (SGOT			
IgM ant HAV			
IgM anti HEV:			

   *If SGPT/SGOT done multiple times write results with date below:

21. Diagnosis: Case Status: _ Confirmed _ Not a Case
        i. Hepatitis A, acute………ii) Hepatitis E, acute

EXPOSURE HISTORY:

During the 2-6 weeks prior to prior to onset of symptoms:

22. Did the patient travel outside the Chandigarh? _ No _ Unknown _ Yes
    If yes, where : _____

23. Was the patient a contact of confirmed case or suspected case of Hepatits A and E ?
    No _ Unknown _ Yes
    If yes, type of contact:
    a. Household Member…..
    b. Sex Partner
    c. Child Cared by this patient
    d. Babysitter of this patient
    e. Playmate
    f. Others………

24. Was the **patient a child or employee in a daycare center, nursery, or preschool**? _ No _ Unknown _ Yes If yes, where: _____

25. Was the patient **a household contact of (Q 24)** a child or employee in a daycare center, nursery, or preschool? _ No _ Unknown _ Yes If yes, where: _____
    a. If ans were to either 3 or 4 is yes then was there a identified case of Hepatitis A and E in the child care facility?

26. Was the patient a household contact of a pregnant woman? _ No _ Unknown _ Yes If yes, who with address: _____

27. Was the patient employed as a food handler while symptomatic with diarrhea? _ No _ Unknown _ Yes If yes, where: _____

28. Was the patient exposed to contaminated food and water ? _ No _ Unknown _ Yes If yes, where: _____

29. Was the patient exposed to important events before the onset of illness/public gatherings (marriage/fest)? _ No _ Unknown _ Yes If yes, where: _____

30. Was the patient exposed to outside food and local food vendors? _ No _ Unknown _ Yes If yes, where: _____

31. Ask following question irrespective of gender:
    a) How many male sex partners did the patient have..0..1….2-5…>5…unknown
    b) How many female sex partners did the patient have..0..1….2-5…>5…unknown

32. **In the 3 months prior to symptoms onset**
    Did anyone in patient house travel outside Chandigarh ……and if yes where

33. **Outbreak Related:** Is the patient **aware of others** in this area **with similar illness**? _ No _ Unknown _ Yes If yes, who:

34. **VACCINATION HISTORY:**
    Has the patient ever received any vaccination/immunoglobulins for Hepatitis A: Yes…..NO
    If yes
    a) Hepatitis A vaccine: No. of Doses…. ……. Year when last dose received
    b) Immunoglobulin: Year when last dose received….

Remarks: