

Surveillance and outbreak reports

A CLUSTER OF HEPATITIS B INFECTIONS ASSOCIATED WITH INCORRECT USE OF A CAPILLARY BLOOD SAMPLING DEVICE IN A NURSING HOME IN THE NETHERLANDS, 2007

H M Götz (gotzh@ggd.rotterdam.nl)^{1,2}, M Schutten³, G J Borsboom², B Hendriks⁴, G van Doornum³, O de Zwart^{1,2}

1. Division of Infectious Disease Control, Municipal Public Health Service Rotterdam Rijnmond, The Netherlands

2. Department of Public Health, Erasmus Medical Center, University Medical Center Rotterdam, The Netherlands

3. Department of Virology, Erasmus Medical Center, University Medical Center Rotterdam, The Netherlands

4. Division of Hygiene and Environment, Municipal Public Health Service Rotterdam Rijnmond, The Netherlands

In July 2007, two residents of a nursing home were diagnosed with acute Hepatitis B virus infection. To identify risk factors for HBV infection a retrospective cohort study among residents was performed. Case finding included discharged diabetes patients and those receiving home care. Among 32 residents one case of chronic hepatitis B was found that could be identified by genotyping as the source patient for the acute cases. Diabetes and finger sticks were risk factors for HBV infection. Most likely the cause of transmission was a multiclix finger stick device developed for use in individual patients but used in multiple patients. Education and training in the use of new equipment and hygiene audits remain the cornerstones in infection control practices.

Introduction

Hepatitis B virus (HBV) is transmitted by percutaneous and permucosal exposure to infected blood or body fluids, either directly or indirectly through contact with contaminated surfaces. Nosocomial transmission of HBV has previously been associated with unsafe injection practices, including contamination of multidose-multipatient vials and finger stick blood sampling devices with reusable components [1-7].

In mid-July 2007, the Municipal Public Health Service Rotterdam-Rijnmond (MPHS) received two notifications of acute hepatitis B in Dutch diabetic women in their late eighties and early nineties, hereafter called patient A and B. The onset of illness had been early July 2007. During the incubation period the two patients had lived in the same nursing home. An outbreak investigation was initiated in order to find the source of infection and to prevent further transmission. Our hypothesis was that HBV transmission had occurred through unhygienic capillary blood sampling. We considered this event a multiple needle stick injury with possible transmission of HBV, hepatitis C virus (HCV) and human immunodeficiency virus (HIV). To identify exposures associated with HBV infection, a retrospective cohort study was conducted among nursing home residents who lived in the home between 1 January and 31 July, 2007.

Methods

Inventory, environmental and other investigations

The nursing home, a separate unit of a larger institution, has 32 beds in four wards. The unit staff work exclusively in this unit, but some have additional tasks in a mobile team for home care. In

August 2007, the nursing home had 32 residents. Since January 2007, 42 residents had been discharged and 14 residents had died. One of the deceased residents was known to be HBV-positive (patient C).

Infection control procedures were assessed through direct observation of activities of the pedicure and by interviews with nursing staff about protocols of nursing procedures. In a self-administered questionnaire the activities at work of health care workers applying finger sticks, as well as their HBV serostatus were assessed. Because finger sticks were suspected to be the cause of transmission, we additionally investigated six out of 42 discharged residents with diabetes mellitus and another eight patients on whom the mobile team had performed finger sticks at home, supposedly with devices from the nursing home.

Retrospective cohort study

The cohort consisted of 32 residents in August 2007 (including the two notified patients A and B) and the third patient C, for whom the medical history and serum were available for investigation. Informed consent was obtained from 31 residents and a relative of patient C. Risk factors were evaluated by reviewing the medical records for percutaneous and other possible exposures e.g. frequency and date of capillary blood sampling, insulin use, pedicure therapy and wound dressing.

Virological investigation

Serum specimens were tested for anti-hepatitis-B-core antibodies (anti-HBc; total and IgM) using standard assays (chemoluminescence assay; Siemens, Los Angeles, USA). In patients with a history of finger sticks, anti-HCV and anti-HIV testing was performed as well (both by enzyme-linked immunosorbent assay; Bio Rad, Paris, France). In anti-HBc-positive patients, hepatitis B surface antigen (HBsAg) and hepatitis B surface antibodies (anti-HBs) (chemoluminescence assay; Siemens, Los Angeles, USA) as well as hepatitis B envelope antigen (HBeAg) and hepatitis B envelope antibodies (anti-HBe) (enzyme-linked immunosorbent assay; Bio Merieux, Lyon, France) were measured. In anti-HBc-negative patients who were known to have undergone finger sticks, HBsAg was tested in order to detect a possible early infection. The HBV viral load was determined with a previously described *in house* developed real-time PCR assay that targets a 752 bp fragment of the HBV genome [8]. The PCR products obtained from the nursing

home patients were sequenced and compared with all HBV non-African genotype A fragments obtained from another contact tracing project of the MPHS [9]. The nucleotide sequences of the complete HBV genome obtained from a selected number of individuals were determined by methods described earlier [10,11].

Definitions

HBV infection was defined as infection in any resident who tested positive for HBsAg and total anti-HBc, and were either anti-HBc-IgM-negative (chronic) or -positive (acute). Individuals testing positive for total anti-HBc, negative for HBsAg and positive for anti-HBs were considered immune to HBV infection, and those testing negative for total anti-HBc and HBsAg were defined susceptible.

Statistical analysis

Univariate exact conditional logistic regression analysis was performed for various risk factors with dependent variable Hepatitis B infection, and the attack rates and percentage of cases exposed to the risk factor were calculated [12]. Proc logistic in SAS 9.1 was used (SAS Institute Inc., 2004, SAS/STAT 9.1 User's Guide, Cary, NC: SAS Institute Inc.)

Results

Inventory

Patient A had an acute hepatitis B infection in July 2007. In early 2007, she had had normal transaminase levels suggesting that she had not been infected at that time. Patient B also had an acute hepatitis B infection in July 2007 and normal transaminase levels in December 2006.

Patient C had been admitted to the nursing home on mid-January 2007 and died in early March 2007. This Dutch women in her mid-eighties had stayed in hospital after a hip fracture in November 2006, and was tested for hepatitis because of ascites – with a positive result. The diagnosis of hepatitis B had been reported to the MPHS and the serological pattern was interpreted as chronic infection with a flare-up including anti-HBc IgM. Patient C was not treated with antiviral therapy. All three hepatitis B patients had a viral load above 9×10^8 genome equivalents/ml at the time

of diagnosis (see Table 1 and Figure for details). All three patients had diabetes mellitus and underwent regular glucose monitoring. We found one blood sampling in the records for patients A and C that had been performed on the same day. One patient (B) had pedicure during the incubation period. No other risk factors were found in these patients. The three patients had no social contacts with each other during their stay in the nursing home.

The additional investigation showed that none of the discharged and home-based patients were recently infected with hepatitis B. None of the health workers was infected with HBV.

Environmental investigation

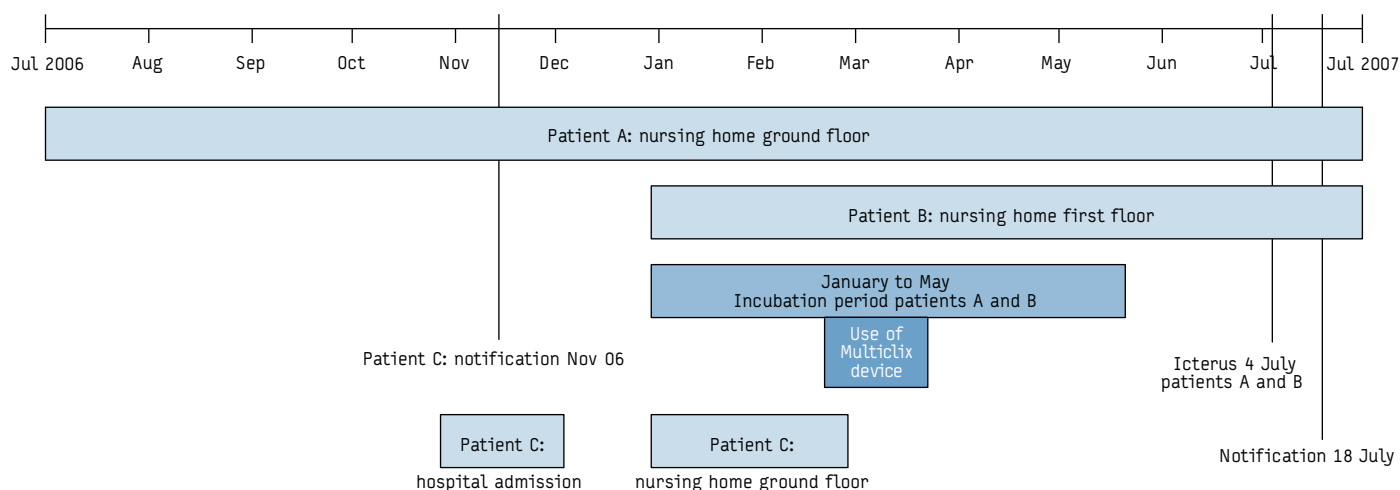
The hygiene audit informed us that HBV transmission was not likely to occur during pedicure. According to nursing procedures, gloves were used when disinfecting the skin and while taking capillary blood samples and discarded after use for one patient. However, some personnel admitted to wearing gloves irregularly during capillary blood sampling.

Until 12 February 2007, spring-loaded devices with a disposable platform had been used. After pressure on the device the lancet punctures the skin. It is technically impossible to use one lancet for more than one needle-stick. After use, both lancet and platform were disposed into a sharps-container. The devices themselves were re-used and occasionally shared between wards. They were not disinfected unless visibly contaminated with blood.

In the period from 13 February to 12 March 2007, a Multiclix device for capillary sampling was used in the nursing home (multiclix device "Accu-Chek® Multiclix"; F. Hoffmann-La Roche Ltd, Basel, Switzerland). This device has a drum with six lancets for rotating use. However, when rotating is forgotten, a lancet can be used twice. Even without re-using lancets, it cannot be excluded that one of the unused lancets comes into contact with blood remaining in the end cap of the drum. Staff at the nursing home applied this pen for multiple patients, but when they discovered that accidental re-use of lancets can occur, they stopped using it and re-introduced the spring-loaded device suitable for professional use in several patients [13].

FIGURE

Timeline for HBV patients A, B and C, July 2006-July 2007



It is obvious from the manufacturers guidelines that the “Accu-Chek® Multiclix” device is only meant for use in individual patients and not for use in institutions for several patients [14]. Sixteen of the 38 staff members performing capillary blood sampling had used the Multiclix device, eight of them worked on all four wards of the nursing home. None of the health workers was infected with HBV.

Cohort Study

The mean age of the cohort population was 80 years (range 53-96 years); 26 women and six men. The median admission time during the study period was 102 days (19-224 days). Except for the known patients (A, B and C) we found no other HBV-infected or immune people. Apart from one resident known to have a chronic hepatitis C infection (no finger sticks), no other HCV or HIV infections were found.

In the cohort, three of the eight diabetic patients were infected with hepatitis B compared to none of the 24 non-diabetics (Odds ratio 14.82 [95% confidence interval (CI) 1.448- infinity]; see Table 2). The attack rate for five residents receiving finger sticks during admission was 60% compared with none for the 27 residents not receiving finger sticks (Odds ratio 32.65 [95% CI 3.013 – infinity]). Undergoing blood sampling in the period of use of the multiclix device was associated with risk for HBV infection – although not statistically significant – compared to outside this period (Odds ratio 9.667 [95% CI 0.24-infinity]). Eleven of 32 residents were admitted from January to mid-March, i.e. they stayed in the home in the same period as patient C, as well as during the critical period of the use of the multiclix device. In this subgroup three of 11 residents were HBV-infected, while none of the patients admitted later got infected (Odds ratio 8.713 [95% CI 0.868-infinity]). Pedicure treatment was not a risk for Hepatitis B.

TABLE 1

Medical history of HBV patients A, B and C related to nursing home

	A	B	C
Sex	F	F	F
Age	89	91	85
Admission nursing home	Early July ground floor	Early January 1st floor	Mid-January 2007 ground floor
Onset of illness	Early July 2007	Early July 2007	NA
Date diagnosis HBV	Mid-July 2007	Mid-July 2007	Mid-November 2006
Anti-HBc	pos	pos	pos
Anti-HBc-IgM	pos	border line	pos
HBsAg	pos	pos	pos
HBeAg	pos	pos	pos
History transaminases	January/February 2007 normal	December 2006 normal	
Transaminases at diagnosis (N < 41 IU/L)	ASAT 151 IU/L, ALAT 126 IU/L	ALAT 1500 IU/L	ASAT 53 IU/L, ALAT 63 IU/L
Viral load at diagnosis (geq/L)	4,18x10 ⁹	9,9x10 ⁸	2,1*10 ¹⁰ #
Geno-typing	Identical type A	Identical type A	Identical type A
Sero-conversion (HBsAg-neg)	Unknown (deceased October 2007)	Sep-07	Unknown
Diabetes mellitus	Insulin-dependent	Oral medication	Insulin-dependent

assessed August 2007; NA: not applicable; geq: genome equivalents

TABLE 2

Risk factors for Hepatitis B infection in the nursing home, 1 January – 31 July 2007

Risk factor	Exposed			Non-exposed			% cases exposed to risk factor	Exact conditional logistic regression	
	HBV infection	Total	Attack rate	HBV infection	Total	Attack rate		Odds ratio	95% CI
Diabetes mellitus	3	8	38%	0	24	0%	100%	14.82	1.448 - infinity
Finger sticks	3	5	60%	0	27	0%	100%	32.65	3.013 - infinity
Pedicure	1	14	7%	2	18	11%	33%	0.624	0.01 - 13.28
Capillary blood sampling in critical period*	1	1	100%	2	31	7%	33%	9.667	0.248 - infinity
Admission nursing home in critical period	3	11	27%	0	21	0%	100%	8.713	0.868 - infinity
Finger sticks in diabetes mellitus patients	3	5	60%	0	3	0%	100%	3.444	0.262 - infinity
Insulin use in diabetes mellitus patients	2	3	67%	1	5	20%	67%	5.784	0.158 - 587

HBV: hepatitis B virus; CI: confidence interval

* critical period is the period of use of the multiclix device

Relatedness of HBV isolates

Since the three nursing home patients were infected with genotype A, the 752 bp HBV-PCR fragment from these patients was compared with all HBV non-African genotype A fragments available in our MPHS contact tracing project [9]. In a total population size of 115 genotype A sequences and 298 non genotype A sequences, the HBV sequence of the three nursing home patients (A, B, and C) was part of a phylogenetic cluster of five completely identical sequences (A, B, C, G and H) and one completely identical sequence (F) with seven nucleotide ambiguity positions (not shown). The complete HBV genome (3,221 nucleotides) of the HBV strains from the five individuals in the cluster were determined and proved to be 100% identical over the complete length of the genome. We could not find an epidemiological link between the nursing home patients and patients F, G and H.

Discussion

Two concurrent acute hepatitis B infections in people that had lived in the same nursing for more than six months was suggestive of nosocomial transmission. Accounting for an incubation period of between six weeks and six months, the infection must have happened between early January and mid-May 2007. In our cohort study we did not find hepatitis B infections other than the acute cases (A, B) and case C. Patient C was highly infectious for hepatitis B when admitted to the nursing home in January 2007 for terminal care. Genotyping of the isolated Hepatitis B viruses of patients A, B and C showed that the viruses were completely identical, which confirmed that the three nursing home patients formed a transmission cluster. In view of the course of events, patient C was most likely the source patient for A and B. Since only patient B had pedicure treatment in mid-April it would be highly unlikely that this was the cause for transmission. Moreover, we did not observe any hygiene deficits in pedicure practice that could have led to a possible transmission of HBV.

Having diabetes and undergoing capillary blood sampling were clear risk factors for Hepatitis B infection; in fact, only diabetics were exposed to finger sticks. Outbreaks of hepatitis B through unhygienic use of finger stick devices have been reported before [1-6,15-17]. Most suspect in our case was the use of a multiclix device from mid-February to mid-March for multiple patients, for whom re-use of lancets could not be excluded. We could not establish a clear association between being sampled in the period of the use of the multiclix device and hepatitis B infection as according to the registration, only patient B had undergone finger sticks in this period. Since patient A had undergone a high number of finger sticks several times a week but not during this critical period this raises doubts about whether the registration of finger sticks was complete. The staff confirmed technical problems in their registration system and that missing registrations could not be excluded. We found staying in the nursing home during the critical period a risk for HBV infection, however, this coincides with the admission of the source case and is therefore not proof for a causal relation.

Could the HBV have been transmitted by the spring-loaded device? This device is developed for professional use in multiple patients and the lancet is disposed after use together with the platform which has been in contact with the skin of the patient [13]. The use of this spring-loaded device did not form a risk for transmission in our cluster. Despite our finding that gloves were not used every time when performing capillary sampling it seems unlikely that transmission via the hands of nursing staff can explain this cluster.

Patient A who frequently underwent capillary sampling stayed on the same ward as source patient C. Case B stayed on a different ward, but we have found a once-only registration of a glucose day curve carried out on the same day in cases B and C. Patient B could have been infected by rotating staff who used the multiclix device on several wards.

As patient C was highly infectious we would have expected even more HBV infections in the nursing home. By searching for early infections (HBsAg testing in exposed anti-HBc-negative residents) in mid-August, five months after the critical period, we excluded additional HBV infections. The death of patient C in early March 2007 and the discontinued use of the multiclix device may have contributed to the limited number of acute HBV infections. Had another procedure than the use of the multiclix device been the cause of transmission, new cases arising from the acute cases with high viral load should have occurred. Awareness of the HBV infection of patient C in nursing home staff may have led to increased vigilance regarding infection prevention. But even without that knowledge transmission of blood-borne pathogens in health care settings is entirely preventable by adherence to standards of care including infection control [1,18].

Recommendations and public health implications

As far as we know this is the first report of incorrect use for multiple patients of a device designed for individual use, which has most likely led to two acute HBV infections. It is striking that this device was used on multiple patients in the institution, although the instructions of the manufacturer clearly indicate "only individual use". When introducing new equipment, studying the instruction manuals, training the health care workers and evaluating the use of the new tools should be a routine. In yearly hygiene audits special attention should be paid to capillary blood sampling procedures. We consider it advisable to use personal finger stick devices in institutions for long term care as has been reported before [1].

These recommendations were discussed with the nursing home and reported to the health care inspectorate. The public health concern of our case is illustrated by the fact that a general practitioner group-practice in the Netherlands reported in December 2007 to have started an investigation among their exposed patients after having used the same multiclix device for multiple patients for several months. This was followed by another similar report from a clinic in the Netherlands. The inspectorate requested the manufacturer to issue a letter to all users of the multiclix device in the Netherlands in order to increase awareness of possible wrong use of the device [19].

Acknowledgements

This investigation could not have been performed without the support of nursing and medical staff of the nursing home. The logistics and processing of serological investigations were greatly facilitated by A. Donkers, manager at the STAR laboratory. Several people at the MPHS Rotterdam - Rijnmond have assisted in the investigation (A. Blom, B. Diederiks, MC Trompenaars, M. Stevens) and Dr. J.H. Richardus gave valuable comments.

At the Erasmus Medical Center, Ing S. Diepstraten-Pas, and Dr. T. Mes are acknowledged for generating the sequences and phylogenetic tree.

References

1. Centers for Disease Control and Prevention (CDC). Transmission of hepatitis B virus among persons undergoing blood glucose monitoring in long-term-care facilities--Mississippi, North Carolina, and Los Angeles County, California, 2003-2004. *MMWR Morb Mortal Wkly Rep.* 2005;54(9):220-3.
2. Centers for Disease Control and Prevention (CDC). Nosocomial hepatitis B virus infection associated with reusable fingerstick blood sampling devices--Ohio and New York City, 1996. *MMWR Morb Mortal Wkly Rep.* 1997;46(10):217-21.
3. Centers for Disease Control and Prevention (CDC). Nosocomial transmission of hepatitis B virus associated with a spring-loaded fingerstick device--California. *MMWR Morb Mortal Wkly Rep.* 1990;39(35):610-3.
4. Polish LB, Shapiro CN, Bauer F, Klotz P, Ginier P, Roberto RR, et al. Nosocomial transmission of hepatitis B virus associated with the use of a spring-loaded finger-stick device. *N Engl J Med.* 1992;326(11):721-5.
5. Quale JM, Landman D, Wallace B, Atwood E, Ditore V, Fruchter G. Deja vu: nosocomial hepatitis B virus transmission and fingerstick monitoring. *Am J Med.* 1998;105(4):296-301.
6. De Schrijver K, Maes I, Van Damme P, Tersago J, Moes E, Van Ranst M. An outbreak of nosocomial hepatitis B virus infection in a nursing home for the elderly in Antwerp (Belgium). *Acta Clin Belg.* 2005;60(2):63-9.
7. Kidd-Ljunggren K, Broman E, Ekvall H, Gustavsson O. Nosocomial transmission of hepatitis B virus infection through multiple-dose vials. *J Hosp Infect.* 1999;43(1):57-62.
8. Pas SD, Niesters HG. Detection of HBV DNA using real time analysis. *J Clin Virol.* 2002;25(1):93-4.
9. Mostert MC, de Man RA, Gotz HM, van Doornum GJ, Niesters HG, Richardus JH. Additional value of genetic fingerprinting in source and contact tracing of hepatitis B virus infection in the community. *Eur J Gastroenterol Hepatol.* 2006;18(1):A58-A59.
10. Niesters HG, Pas S, de Man RA. Detection of hepatitis B virus genotypes and mutants: current status. *J Clin Virol.* 2005;34 Suppl 1:S4-8.
11. Stuyver L, De Gendt S, Van Geyt C, Zoulim F, Fried M, Schinazi RF, et al. A new genotype of hepatitis B virus: complete genome and phylogenetic relatedness. *J Gen Virol.* 2000;81(Pt 1):67-74.
12. Cox DR, Snell EJ. *Analysis of binary data.* New York: Chapman and Hall; 1970.
13. Roche. Accu-Chek® Softclix® Pro. 2007. Available from: http://www.accu-chek.nl/nl/rewrite/generalContent/nl_NL/article/ACCM_general_article_367.htm
14. Roche. Accu-Chek Multiclix. 2007. Available from: http://www.accu-chek.nl/nl/rewrite/content/nl_NL/3.1.1.1:10/article/ACCM_general_article_1205.htm
15. De Schrijver K, Editorial team. Hepatitis B transmission in care homes linked to blood glucose monitoring, Belgium and United States. *Euro Surveill.* 2005;10(11):pii=2663. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=2663>
16. Douvin C, Simon D, Zinelabidine H, Wirquin V, Perlemuter L, Dhumeaux D. An outbreak of hepatitis B in an endocrinology unit traced to a capillary-blood-sampling device. *N Engl J Med.* 1990;322(1):57-8.
17. Dreesman JM, Baillet A, Hamschmidt L, Monazahian M, Wend UC, Gerlich WH. Outbreak of hepatitis B in a nursing home associated with capillary blood sampling. *Epidemiol Infect.* 2006;134(5):1102-13.
18. Perz JF, Fiore AE. Hepatitis B virus infection risks among diabetic patients residing in long-term care facilities. *Clin Infect Dis.* 2005;41(5):760-1.
19. The Netherlands Health Care Inspectorate. Waarschuwing: prikpenen voor zelfcontrole uitsluitend bedoeld voor gebruik één persoon. 2007. Available from: <http://www.igz.nl/actueel/nieuwsberichten/prikpenen>.

This article was published on 3 July 2008.

Citation style for this article: Götz HM, Schutten M, Borsboom GJ, Hendriks B, van Doornum G, de Zwart O. A cluster of hepatitis B infections associated with incorrect use of a capillary blood sampling device in a nursing home in the Netherlands, 2007. *Euro Surveill.* 2008;13(27):pii=18918. Available online: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=18918>