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Original Article

Identification, investigation and management of patient-to-patient hepatitis B transmission within an inpatient renal ward in North West England

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Abstract

Background. Transmission of hepatitis B virus (HBV) is rare within healthcare settings in developed countries. The aim of the article is to outline the process of identification and management of transmission of acute hepatitis B in a renal inpatient ward.

Methods. The case was identified through routine reporting to public health specialists, and epidemiological, virological and environmental assessment was undertaken to investigate the source of infection. An audit of HBV vaccination in patients with chronic kidney disease was undertaken.

Results. Investigations identified inpatient admission to a renal ward as the only risk factor and confirmed a source patient with clear epidemiological, virological and environmental links to the case. Multiple failures in infection control leading to a contaminated environment and blood glucose testing equipment, failure to isolate a non-compliant, high-risk patient and incomplete vaccination for patients with chronic kidney disease may have contributed to the transmission.

Conclusions. Patient-to-patient transmission of hepatitis B was shown to have occurred in a renal ward in the UK, due to multiple failures in infection control. A number of policy changes led to improvements in infection control, including reducing multi-function use of wards, developing policies for non-compliant patients, improving cleaning policies and implementing competency assessment for glucometer use and decontamination. HBV vaccination of renal patients may prevent patient-to-patient transmission of HBV. Consistent national guidance should be available, and clear pathways should be in place between primary and secondary care to ensure appropriate hepatitis B vaccination and follow-up testing.

Keywords: chronic kidney disease; cross infection; hepatitis B; nosocomial infections

Introduction

Hepatitis B virus (HBV) is blood borne and can lead to an acute illness characterized by nausea, abdominal pain, malaise and jaundice if symptomatic. It may lead to chronic infection, associated with the risk of chronic liver disease and hepatocellular carcinoma. The most common routes of transmission are sexual contact, contact with infected blood and perinatal transmission from mother to child. In 2011, 589 cases of acute HBV were reported for England, an annual incidence of 1.13 per 100 000 population [1]. The mode of transmission was unknown to public health specialists in 50% of cases, and 7.7% of acute hepatitis B cases were known to have had healthcare-related exposures in 2011 [1].

Transmission of HBV within healthcare settings continues to occur. Although instances are rare, the implications for patients and the healthcare setting can be considerable, and therefore, attempts to further reduce these instances are important. One systematic review considered outbreaks involving patient-to-patient transmission of hepatitis B between 1992 and 2007 in Europe and the USA [2]. The review identified 33 incidents involving 471 affected patients, with 4 outbreaks affecting 37 patients in the UK. The majority of outbreaks originated from immunocompromised patients such as those suffering from end-stage renal disease, diabetes or cancer. The most common clinical setting for transmission was dialysis units (30%), followed by medical wards (21%) and nursing homes (21%). Common transmission pathways were multi-vial drugs (30%), multi-patient capillary blood sampling devices (27%) and multiple deficiencies in applying standard infection control precautions (9%).

HBV transmission has been acknowledged as a risk in patients with chronic kidney disease (CKD) since the commencement of haemodialysis in the 1960s. There are

multiple risk factors for patients with CKD including immunodeficiency, multiple breaches of mucosal or parenteral barriers and use of contaminated equipment. In the UK, immunization against HBV is recommended for patients already on haemodialysis or renal transplantation programmes and for other patients with CKD as soon as it is anticipated that they may require these interventions [3]. However, vaccination in individuals with CKD is only between 45 and 66% effective in promoting an adequate immune response [4]. Guidance on vaccination for hepatitis B in CKD patients is located within the Renal Association Clinical Practice Guidelines for Prevention of Blood Borne Virus Infection in the Renal Unit [5], 2002 Department of Health guidance [6] and Immunisation Against Infectious Disease (The Green Book) [3].

This article aims to outline the process of identification and management of possible transmission of acute HBV in a renal ward, outlining the difficulties of implementing UK guidelines on HBV vaccination in patients with CKD.

Materials and methods

Identification and risk assessment of index case

In October 2011, the Cheshire and Merseyside Health Protection team received a notification of acute HBV infection in an 83-year-old man with a 2-week history of abdominal pain and jaundice. A risk assessment of the index case was carried out by the Health Protection team through patient interview. His past medical history included diabetes, CKD, recent hospital admission to a Merseyside Hospital renal ward for surgery for peritoneal catheter insertion and recent commencement of peritoneal dialysis. HBV markers (HBsAg, anti-HBc) tested 4 months before initiation of peritoneal dialysis were negative.

Epidemiological, virological and environmental assessment

An outbreak control team was convened with a range of professionals including health protection, microbiology, infection control and renal physicians. Investigation to identify a source case or any linked cases was undertaken by comparing lists of patients and staff who may have been in contact with the index case while admitted to the renal ward with hospital and Health Protection HBV databases.

A possible source patient was identified during the recent renal ward admission, who was co-infected with HBV and hepatitis C virus (HCV). The source patient was diagnosed with chronic hepatitis B in 1996 (hepatitis B core antibody positive, hepatitis B e antigen negative). The source patient was known to have diabetes, chronic kidney failure, not on dialysis and was admitted with bilateral foot ulcer that led to surgical debridement and the amputation of a toe.

Case notes of other patients with shared risk factors were reviewed to identify further cases. In addition, HBV and HCV screening was undertaken for patients admitted to the renal ward at the same time as the source patient and for 1 week after (to take account of virus survival in the environment). As patients dialysing in the renal ward during that period had moved to satellite units, all dialysis patients in the programme were also screened for HBV and HCV. Independent, unannounced infection control inspections reviewed infection control standards in the renal ward. In addition, an external peer review assessed service quality.

Hepatitis B vaccination audit

After identification that the index case was not vaccinated in line with national guidance, an audit of HBV vaccination in dialysis patients at the hospital was undertaken. The audit was conducted between November 2011 and February 2012 to identify the proportion of patients undergoing dialysis who were appropriately vaccinated and who had serological testing for anti-HBs antibodies, in line with national guidance. Based on the three national documents outlining guidance for HBV vaccination of CKD patients, patients should be offered vaccination with high-dose vaccine at 0, 1 and 6 months before they require dialysis. Serological testing 1–4 months after the course is advised, then annual anti-HBs serology, with booster vaccinations as required [3, 4, 6]. The audit investigated whether vaccinations were given and serology taken at appropriate times, based on the guidance above. All dialysis patients were audited for hepatitis B vaccination. Vaccine history was obtained from the patients' GPs and/or patient hand-held records. Patients were excluded from the audit where vaccine history was not possible to obtain from GP practices. Serological testing were identified from local laboratory results.

Results

Risk assessment of index case

The risk assessment of the index case identified no family, sexual, travel or social risk factors. The index case was known to be diabetic and had been injecting insulin once daily for 1 year, using pre-filled syringes. The patient undertook self-monitoring of blood glucose using an enclosed lancet system and denied sharing monitoring equipment. The index case had CKD and underwent a peritoneal dialysis cannula insertion in May 2011, admitted to a renal ward in the Merseyside Hospital for 8 days. The admission was prolonged due to difficulties with unstable blood glucose. Peritoneal dialysis was commenced 4 weeks prior to the patient's October 2011 hospital admission with acute hepatitis, with the patient receiving training on the renal ward twice a week from the initiation of dialysis. As the index patient had screened negative for HBV 4 months prior to his diagnosis of hepatitis, it was suspected that he may have contracted the virus while an inpatient in the renal ward in May 2011.

During the risk assessment, it was identified that the index patient had been given an accelerated hepatitis B vaccination course with three vaccines each a month apart in the community 2 years before this incident, with an inappropriately low dose of vaccine. He had not had the recommended annual post-vaccination serology and booster vaccinations.

Epidemiological assessment

The investigation comparing patients and staff who would have had contact with the index case during the renal ward admission with hospital and Health Protection hepatitis B databases identified a patient with chronic HBV who had been admitted to the renal ward during the index case's admission in May 2011. No additional patients or staff were identified as having HBV. Common factors identified between index and source case are given in Figure 1. The two patients were in adjacent beds in the ward for 6 days. They both required frequent blood

glucose monitoring to be undertaken using glucometers. Auto-disabling single-use needles were used for blood sampling. The patients underwent surgery in different theatres involving different surgical teams.

Virological assessment

Genotypic investigation of the viruses showed both to be genotype A. The viruses were reported as being 100% identical on sequencing of the X/precore/core region and 99% identical on surface and polymerase gene sequencing with just one single base pair difference. Therefore, it is highly likely that this virus strain was transmitted from patient to patient.

All patients on the ward, dialysis patients and staff were screened for HBV and HCV. Sixty-nine out of 72 patients (96%) and 65 out of 67 members of the staff (97%) were screened; two members of the staff were no longer working at the Trust and refused testing and three patients were offered screening but did not attend. All patients and staff were found to be HBV and HCV negative. The renal ward transfers its stable haemodialysis patients to three chronic haemodialysis units, where patients have routine HBV tests every 3 months. All results for these from the latest screen at the time of the incident were negative for HBV. In December 2011, an additional screen was undertaken in all 184 chronic dialysis patients, including 27 on home dialysis. All screened negative except one patient with evidence of past resolved HCV infection prior to this incident. Patients who were awaiting a renal transplant were suspended from the transplant list until negative screen results were obtained. These patients were quickly reinstated after screening negative.

Environmental assessment

The index and source patients had been admitted to a renal ward, with 24 beds, including a number of general medical beds, a day case unit and a haemodialysis unit. An assessment of the ward by Health Protection, Infection Control nurses and microbiology professionals was conducted. A number of concerns about infection control procedures and practice on the ward were identified, including poor hand hygiene, visible contamination of blood glucose testing equipment and other shared equipment with blood, visible blood within the procedure room and lack of clarity of ward cleaning procedures. In addition, the inspection identified that the ward was cramped and cluttered with equipment. There was also a high turnover of patients.

Discussion with staff on the ward identified that the source patient had an open surgical wound on his diabetic foot, which he would not allow staff to dress appropriately. The patient repeatedly removed the dressings and frequently contaminated the floor and his bed linen with blood. Although this blood was promptly cleaned, staff did not identify his behaviour as a public health risk and therefore did not escalate the situation. The source patient was not aggressive but did not comply with repeated requests from staff to avoid weight bearing to enable healing of his wound. He also would not stay around his bed space to prevent contamination of the environment and frequently sat on the index patient's bed. Staff did not escalate this issue to managers as his behaviour was not felt to be threatening. The environmental risk assessment indicated the patient-to-patient transmission was likely to have occurred on the renal ward due to multiple failures in infection control.

Hepatitis B vaccination audit

The hepatitis B vaccination audit reviewed 82 patients on dialysis. Of those, 74% (61/82) received the first vaccination, 72% (59/62) received the second vaccination and 59% (48/82) received the third vaccination. Fifty-one per cent (30/59) of patients who received the second vaccination were given it within the recommended timeframe of 1 month (±7 days) and 58% (28/48) of patients who received the third vaccination were given it within the recommended timeframe of 5 months (±7 days) since the second.

There was no record of antibody testing in 23% (19/82) of patients. Guidance recommends antibody testing 1–4 months after vaccination [5]. In total, 44% (36/82) had antibody testing after three vaccinations. Only 4% (3/82) of patients had their antibodies tested within 1–4 months of third vaccination. Of those who had antibody testing, only 31% (11/36) were immune (anti-HBs antibody levels $\geq$10 mIU/mL).

Discussion

This report outlines a case of patient-to-patient transmission of hepatitis B infection in a renal ward in the UK due to multiple failures in infection control. Transmission from patient to patient was confirmed using epidemiological, virological and environmental assessment of the incident. No other linked cases of HBV were identified in patient or staff contacts. A number of cases of patient-to-patient transmission have been reported in diabetic residents of long-term care nursing facilities as a result of inappropriate sharing of equipment and inadequate aseptic technique during finger-stick blood glucose monitoring [7–9]. However, extensive review of the literature identified that no recent published incidents relating to glucose monitoring involving hospital settings were identified. Two recent studies outlining HBV patient-to-patient transmission incidents involving multiple failures in infection control have been published, one in Ireland [10] and the other in the USA [11]. No published reports of incidents regarding patient-to-patient transmission of HBV related to possible non-specific environmental contamination, i.e. not including blood glucose testing equipment, multi-vial injections or podiatry, or as a result of direct patient-to-patient transmission relating to close contact were identified.

The ward was found to have a variety of problems with infection control including inadequate storage and cleaning failures. One of the main issues identified by the incident control team that may have contributed to this incident was the high throughput and the multi-functional use of the ward for general medical, renal inpatients and some outpatient follow-ups, with side rooms used for patients with confirmed or suspected infections, and a growing dialysis unit. Ward staff experienced increasing demands on their time, managing a growing number of patients with increasing complexity and comorbidity. The high patient turnover and high complexity of patient illness was thought to contribute to the infection control failures. Understaffing and overcrowding are frequently cited as reasons for poor infection control practices [12].

	Index case	Source case
Admitted to ward	✓	✓
Hepatitis B	✓ Acute	✓ chronic
Hepatitis C	x	✓ chronic
Surgery	✓ peritoneal catheter insertion	✓ toe amputation
Insulin dependent diabetes	✓	✓
Chronic kidney disease	✓	✓

Fig. 1. Common risk factors for source and index patients.

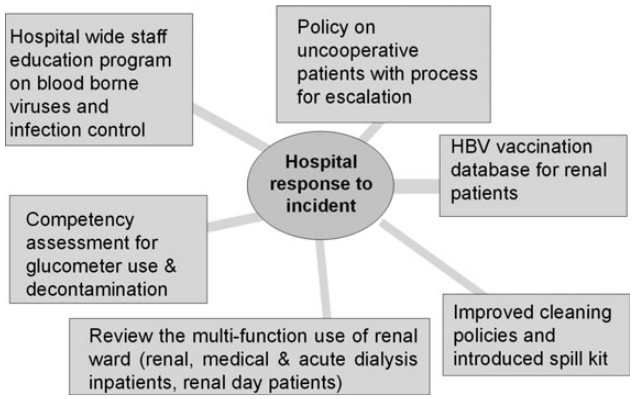

Fig. 2. Overview of hospital response to incident.

In response to this incident, the hospital undertook a programme of policy review and education to prevent further incidents (Figure 2). Cleaning policies were tightened and spill kits were introduced to deal with body fluids. The hospital developed a new standard operating procedure for the use and cleaning of near-patient testing equipment including glucometers which involves competency assessment and signing out of equipment, daily inspection by nominated ward staff and unannounced inspection by infection control teams. This was rolled out throughout the hospital through education and information for all relevant staff, and a hospital-wide blood-borne virus education programme was introduced for all staff during their induction period. In addition, a policy was developed on non-compliant patients which includes isolation of patients exhibiting risky behaviours and escalation of non-compliant patients to senior staff. This policy is in addition to the hospital policy on dealing with aggressive patients, which most hospitals have. The ward reduced its multi-function purpose, outpatient services were moved off the ward and plans for increased isolation and storage on the ward were implemented.

The index case was not vaccinated according to national guidance. Guidance on vaccination for hepatitis B in CKD patients is located within 2002 Department of Health guidance [5], Immunisation against infectious disease (The Green Book) [3] and Renal Association Clinical Practice Guidelines for Prevention of Blood Borne Virus Infection in the Renal Unit [6]. These guidelines are relatively similar, although there are some important differences and omissions across them, such as advice on checking titre levels post-vaccination and associated follow-up (Figure 3). The Green Book, which is used by immunizers in the community, has little information about follow-up for chronic renal failure, which may lead to omissions in follow-up in the community.

The audit on HBV vaccination of patients with CKD identified that patients were not appropriately vaccinated and tested. There is no clear guidance on which part of the health service should be responsible for vaccination, either general practice or renal services. As a result of this incident, locally a section has been included in the patient's hand-held kidney patient care plan on HBV vaccination to enable secondary care physicians to check that patients have received correct and timely high-dose vaccinations. The hospital is also investigating the possibility of introducing an in-house hepatitis B vaccination programme for patients with CKD.

Conclusion

Patient-to-patient transmission of HBV was shown to have occurred in an inpatient renal ward in the UK, due to multiple failures in infection control. A number of policy

	Department of Health 2002	Green Book	Renal Association
Immunisation schedule	Use of higher doses of vaccine (e.g. 40 μg), schedule as per Green Book	Fendrix® 20μg at 0, 1, 2 and 6 months or HBvaxPRO40® 40μg at 0,1, 6 months	Initial HBV immunisation schedule should involve high doses, frequent doses or both (Fendrix 20μg at 0, 1, 2 and 6 months; Engerix B 40μg at 0, 1, 2 and 6 months; or HBvaxPRO 40μg at 0, 1 and 6 months)
Checking titre after immunisation	1-4 months after completing immunisation	Not stated	8 weeks after completing immunisation
Post-vaccination: Action if <10 mIU/ml	Repeat course of vaccine should be considered	Not stated	Not stated
Post-vaccination: Action if anti-HBs between 10-100 mIU/ml	Give booster	Not stated	Not stated
Continuing monitoring of titre	Annual	Annual	Annual
Continuing monitoring: Action if <10 mIU/ml (in previous responder)	Give booster	Give booster	Give booster

Fig. 3. Summary of guidance of vaccination for chronic kidney disease.

changes led to improvements in infection control, including reducing multi-function use of wards, developing policies for non-compliant patients and improving cleaning policies. HBV vaccination of renal patients may prevent patient-to-patient transmission of HBV. Department of Health and the UK Renal Association should ensure that their guidance for HBV vaccination of CKD patients is consistent and clear pathways should be in place between primary and secondary care to ensure appropriate HBV vaccination and serology.

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Conflict of interest statement. None declared.

(See related article by Esteban *et al.* Healthcare-associated infections: new challenges looking for answers. *Clin Kidney J* (2015) 8: 100–101.)

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