



A systematic review of outbreaks of bloodborne infections (hepatitis B and C, HIV) transmitted from patient to patient in healthcare settings

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Abstract

Healthcare facilities have always played an important role in transmission of bloodborne infections. Procedures involving blood and blood fluids pose a risk of transmitting hepatitis B, hepatitis C and HIV not only to healthcare workers, but also to patients.

To assess the role of healthcare facilities in transmission of bloodborne infections and to identify risk groups among patients as well as transmission factors, a total of 75 outbreaks of hepatitis B, hepatitis C and HIV have been analyzed with reference to the data published in different countries in 2008–2020. The comparative analysis was conducted for the outbreaks in the United States during 1992–2008 and 2008–2019.

Most of the outbreaks of bloodborne infections at healthcare facilities were caused by non-adherence to standard precautions among healthcare workers: Reusing disposable items; improper handwashing; reusing gloves; non-disinfecting surfaces, reusable equipment and devices; non-sterilizing reusable instruments. In terms of bloodborne infections, high-risk facilities include hemodialysis centers, oncohematology clinics, outpatient clinics, nursing homes, residential care facilities, and diabetes treatment centers. High-risk groups include patients undergoing hemodialysis, oncohematological patients, and patients with diabetes.

Diagnosis of bloodborne infections on a regular basis, hepatitis B vaccination among high-risk patients, investigation of outbreaks, adoption of rules and procedures combined with training and compliance control of healthcare workers contribute to solution of the problem associated with nosocomial transmission of bloodborne infections.

Keywords: *review, nosocomial outbreak; healthcare-associated outbreak; bloodborne infections, hepatitis B, hepatitis C, HIV*

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Научный обзор
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Систематический обзор вспышек гемоконтактных инфекций (гепатит В, С, ВИЧ), передающихся от пациента к пациенту при оказании медицинской помощи

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Аннотация

Медицинские учреждения всегда имели значение в передаче гемоконтактных инфекций. Манипуляции, сопровождающиеся образованием крови, представляют опасность в распространении гепатитов В, С и ВИЧ не только для персонала, но и для пациентов.

С целью оценки значения медицинских учреждений в передаче гемоконтактных инфекций, выявления групп риска среди пациентов и факторов передачи проанализировано 75 вспышек гепатита В, С и ВИЧ, данные о которых опубликованы в разных странах в 2008–2020 гг. Проведено сравнение вспышек в США в течение 1992–2008 и 2008–2019 гг.

Основной причиной вспышек гемоконтактных инфекций в медицинских учреждениях является несоблюдение медицинским персоналом стандартных профилактических мер: повторное использование изделий однократного применения; отсутствие обработки рук; повторное применение перчаток; отсутствие дезинфекции поверхностей, многоразовых приборов и устройств; отсутствие стерилизации многоразовых инструментов. К учреждениям высокого риска в отношении заражения гемоконтактными инфекциями относятся учреждения, проводящие гемодиализ, онкогематологические, амбулаторные учреждения, дома престарелых, интернаты, клиники, где проходят лечение пациенты с сахарным диабетом. Контингентом высокого риска являются пациенты, получающие гемодиализ, онкогематологические пациенты и пациенты с сахарным диабетом.

Диагностика гемоконтактных инфекций на регулярной основе, вакцинация против гепатита В среди пациентов высокого риска, расследование вспышек, внедрение регламентов работы в сочетании с обучением и контролем приверженности персонала являются решением проблемы нозокомиальной передачи гемоконтактных инфекций.

Ключевые слова: обзор, нозокомиальная вспышка; вспышка, связанная с оказанием медицинской помощи; гемоконтактные инфекции, гепатит В, гепатит С, ВИЧ

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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Introduction

Bloodborne infections have always had a high potential of transmission in healthcare facilities, both among healthcare workers and among patients. Bloodborne infections are characterized by a long incubation period (up to 6 months), absence of symptoms or presence of mild, non-specific clinical manifestations. Infections may linger undetected for years, while patients may have multiple medical care encounters, becoming a source of nosocomial infection.

Prior to the 1990s, unsafe blood transfusions accounted for most of the healthcare-associated outbreaks; however, the adoption of effective measures aimed at safety of blood components made it possible to achieve considerable success in preventing transmission of bloodborne infections during blood transfusions [1]. The employment of highly sensitive diagnostic systems, quarantine of plasma and screening of blood donors helped reduce significantly the contribution of blood transfusions to transmission of bloodborne infections over the past few decades. Yet, in low-income countries, the problem still persists due to the lack of possibility to perform full-scale screening of all donors. According to the WHO Report, in high-income countries, 99.6% of donations were screened compared to 66% in low-income

countries¹. In the United States, the last blood-transfusion-associated outbreak of hepatitis B was recorded in 1997. In 1995, the United States reported the outbreak of hepatitis B during transplantation of autologous hematopoietic stem cells; the infection resulted from contamination of the liquid nitrogen from the damaged container of infected cells long before the infection event [2].

While the safety of blood transfusions receded into the background, the problem of bloodborne infections in healthcare facilities remained unsolved; furthermore, the role of unsafe injections and manipulations was uncovered. The Global Burden of Disease Study conducted in 2000 revealed that in 10 out of the 14 most affected regions, 39% injections were given with reused unsterile injection equipment. The researchers modelled a real situation of infection during injections, considering injection-associated risks, the proportion of unsafe injections, the total incidence, immunity, etc. The modelling made it possible to assume that in 2000, unsafe injections caused an estimated 21 million HBV infections, 2 million HCV infections and 260,000 HIV

¹ World Health Organization, Global status report on blood safety and availability 2016. <https://apps.who.int/iris/bitstream/handle/10665/254987/9789241565431-eng.pdf?sequence=1>

infections, accounting for 32%, 40%, and 5%, respectively, of new infections [3]. Since 2000, substantial efforts have been made by WHO, under the leadership of the Safe Injection Global Network, to reduce the risks associated with unsafe injections. Over the 2000-2010 decade, the number of unsafe injections decreased in 81% of countries; the proportion of re-use of injection devices dropped from 39.8% to 5.5%. In 2015, safe injections accounted for 97% [4]. The implementation of hepatitis B vaccination strongly contributed to resolving the problem of nosocomial transmission of hepatitis B, though nosocomial outbreaks of hepatitis B are still being reported due to the low vaccination coverage in developing countries and due to existing unvaccinated people among elderly groups in developed countries [2].

Hemodialysis centers have been historically associated with high risk of bloodborne infections both among patients and among healthcare workers [5]. Over the past few decades, some progress has been made in this sector: The incidence of hepatitis B and C has decreased [6–8]. As there is no possibility to vaccinate patients on hemodialysis against hepatitis B, the vaccination coverage of this group of population in the United States is as low as 56%. The prevalence during the post-vaccination period was 1% [9]. The hepatitis C prevalence among hemodialysis patients is 8% and exceeds the prevalence in the population approximately 5 times. The prevalence among patients and persisting outbreaks in the healthcare facilities demonstrate the significance of hemodialysis in transmission of bloodborne infections [10].

Oncohematological patients have always been seen as a high-risk group in terms of bloodborne infections associated with multiple blood transfusions and bone-marrow transplantation [11]. Before screening when donors were not examined, the prevalence of hepatitis B among patients in Poland before 1992 reached 62%, while the hepatitis C prevalence before 2000 was 54.3%. In 1999–2000, when screening of donors started, the hepatitis B prevalence among patients went down to 1.9% and the hepatitis C prevalence decreased to 2.8% [12]. The seroprevalence among oncological patients depends on the screening coverage of donors and on the prevalence in the population. For example, in Egypt, the seroprevalence of anti-HCV among children with hematological disorders is 81.6%, among children with oncological diseases — 17.6%, HBV-DNA — 38% [13]. In Brazil, the HBV seroprevalence among oncological patients accounted for 13.97% [14]. In Turkey, the seroprevalence of HBsAg among oncological patients was 4.2%, anti-HCV — 0.7% [15]. In the United States, the HBV seroprevalence is 6.5%, while the seroprevalence of HCV and HIV is 2.4% and 1.1%, respectively [16]. In addition, oncological patients have higher mortality when infected with viral hepatitis as compared to the overall population,

since chemotherapy enhances viral replication and contributes to the development of fulminant hepatitis [2].

Transplantation-related transmission of bloodborne infections is rarely mentioned in literature. The United States reported 2 outbreaks of hepatitis C, which were associated with transplantation [17].

Healthcare-associated transmission of each infection has different significance. Being the infection controlled by specific immunoprophylaxis, hepatitis B is of significance among unvaccinated groups. Hepatitis C, on the contrary, due to the absence of specific immunoprophylaxis is of high significance among all the groups of population, and the problem of nosocomial transmission remains unsolved even in developed countries. Heterogeneous spread of hepatitis C among regions and within a region signifies active artificial transmission in healthcare facilities and intravenous drug abuse². The role of the artificial mode of HCV transmission during medical manipulations may strongly vary in different countries and depends on the prevalence in the population. The higher the prevalence in the population, the higher the significance of artificial transmission. The dominance of senior-age people and people of all ages in the hepatitis C prevalence structure is indicative of an active artificial mode of transmission during medical manipulations [18, 19].

Despite the achieved success, healthcare facilities still pose a risk of bloodborne infections; in some areas the risk tends to increase due to growing numbers of invasive interventions as well as due to hepatitis C and HIV prevalence in population.

The purpose of the systemic review is to evaluate the significance of healthcare facilities in transmission of bloodborne infections, to identify risk groups among patients and causes of infection with hepatitis B, C, and HIV.

We analyzed publications about nosocomial outbreaks of bloodborne infections (hepatitis B, hepatitis C, and HIV) from the following information resources: PubMed, Outbreak Database, ClinicalKey, NCBI, EBSCOhost, Web of Science, Cambridge University Press, ResearchGate, and eLibrary. Outbreaks in the United States were analyzed with reference to the report from the Centers for Disease Control and Prevention [20].

Data about outbreaks of bloodborne infections in the world

For the analysis, we selected publications about outbreaks recorded in different countries, with the onset of outbreaks falling on the period from 2008 to November 2020. The analysis included the outbreaks with patient-to-patient transmission of infection, represented by 2 or more cases, characterized by epidemiological and

² World Health Organization 2017. Global Hepatitis Report 2017. Geneva. Available at: <https://www.who.int/hepatitis/publications/global-hepatitis-report2017/en>

genetic association. Outbreaks in hemodialysis centers, oncohematology clinics, and patients' long-term care facilities were analyzed separately, representing high-risk facilities. Tables 1–3 show the list of outbreaks, the causes and factors of their occurrence.

Since the data on outbreaks are best presented in the United States, we compared the analysis results for outbreaks of two periods, which were recorded in the United States, namely, the data obtained in this review (2008–2020) and the analysis data for outbreaks in 1998–2008 [21]. The comparison was based on outbreaks in non-hospital facilities, as in 2008–2020, there were no recorded outbreaks associated with patient-to-patient transmission in U.S. in-patient facilities (hospitals).

A total of 75 outbreaks (1,100 cases of infection) meeting the selection criteria were analyzed (Table 2). The report about outbreaks in the United States included the description of 60 outbreaks (428 cases of infection), including outbreaks of hepatitis B — 22 (181 cases), hepatitis C — 36 (233 cases), hepatitis B and C — 2 outbreaks (hepatitis B — 5, hepatitis C — 9 cases) [20].

Data about outbreaks of bloodborne infections in Russia

In Russia, no descriptions of outbreaks meeting the criteria were found. However, the problem of nosocomial transmission of bloodborne infections remains currently central in Russia. In 2019, the retrospective investigation of the cluster revealed multiple hepatitis C cases in the hematology department of the healthcare facility in the Amur Region³. Although there were no data on nosocomial outbreaks, departments of the Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing report a large percentage of hepatitis C cases (54.7%) associated with unidentified transmission modes in Russian regions from 2010 to 2019, thus implying that the clusters were not properly investigated. According to the data from the Federal Scientific and Methodological Center for the Prevention and Control of AIDS, from 1987 through 2019, in Russia there were recorded 463 confirmed cases of healthcare-associated HIV infection among patients in healthcare facilities, including 103 cases of infection during transfusion of blood and its components as well as 3 cases of HIV transmission during transplantation. In 2019, 9 cases with suspected infection in healthcare facilities when using unsterilized medical instruments were reported; 1 case was reported when the recipient was infected during the platelet transfusion from a blood donor.

Among the analyzed outbreaks, the largest number (25) is recorded in other facilities with the highest percentage of outpatient clinics (17 outbreaks). Hemodialysis centers reported 24 outbreaks. A total of 21 outbreaks were recorded in long-term care facilities including assisted-living facilities, residential care facilities, and nursing homes. A total of 5 outbreaks were recorded in oncohematology clinics.

The largest number of infection cases was recorded in other facilities — 596 cases, in long-term care facilities — 184, in hemodialysis centers — 173, and in oncohematology clinics — 147 cases.

Causes of infection

Other facilities (including outpatient clinics)

The outbreaks in other facilities were mainly caused by contaminated medication vials (12 outbreaks). Vials can become contaminated when medicine is withdrawn with a used syringe. Vials with the following agents were the cause of outbreaks: a saline solution, contrast medium, agents for procedural sedation and anesthesia (propofol, ketamine, marcaine, lidocaine, etc.) in 12 outbreaks. Multiple uses of single-dose vials were reported in 5 outbreaks. The outbreaks in Pakistan and India were caused by injections (2 outbreaks), namely, by reuse of syringes and needles. In Pakistan, blood transfusion also caused an outbreak. The HIV outbreak in China was caused by a line for lymphocyte collection and processing used during lymphocyte immunization therapy for infertility treatment. Hong Kong reported an outbreak caused by a contaminated holder of vacutainer tubes for blood collection.

Hemodialysis centers

The most frequent causes of bloodborne infections in hemodialysis centers are the absence of disinfection of surfaces (in 14 outbreaks): working surfaces, arm-chairs and arm-rests, the hemodialysis apparatus and surrounding surfaces. In 10 outbreaks, there were reported hand hygiene-related violations: hand-washing and using of gloves. In 4 outbreaks, the causes included non-delineated areas for preparation of infusions (the "clean" area), for work with blood samples (the "dirty" area) and for work with a patient (the "treatment" area); 4 outbreaks were caused by the improper intravenous catheter care that included routine flushing and dressing change. The outbreak in Pakistan was caused by the absence of personnel, absence of differentiation of equipment for infected and non-infected patients as well as patients' purchasing of blood components from unauthorized laboratories and banks.

Long-term care facilities

The occurrence of outbreaks in long-term care facilities (assisted-living facilities, nursing homes, residential care facilities) and their causes in Germany and the United States depend on the groups of patients in

³ The State Report on Sanitary and Epidemiological Wellbeing of the Population in the Russian Federation in 2019. https://www.rosпотребнадзор.ru/documents/details.php?ELEMENT_ID=14933

Table 1. The list of outbreaks of healthcare-associated bloodborne infections (hepatitis B, hepatitis C, and HIV) recorded in different countries in 2008–2020

Country, source	Type of a healthcare facility	Total outbreaks	Outbreak period	Number of cases	Infection	Causes of infection
Hemodialysis centers						
Holland [22]	Hemodialysis	1	2016	2	Hepatitis C	Hemodialysis apparatus (the pressure measurement port)
Vietnam [23]	Hemodialysis	1	2013	11	Hepatitis C	Hemodialysis apparatus Area delineation
USA [20]	Hemodialysis (outpatient)	21	2008–2018	104	Hepatitis C	See Table 2
Pakistan [24]	Hemodialysis	1	2016	56	HIV	Hemodialysis apparatus, using blood components from unauthorized laboratories and blood banks
Total						Hepatitis C — 117, HIV — 56, total outbreaks — 24
Oncohematology clinics						
Hungary [25]	Oncology	1	2007–2008	20	Hepatitis C	No data available
South Africa [26]	Pediatric hematology, oncology	1	2011–2013	49	Hepatitis B	Multiple violations. Absence of vaccination
Slovakia [27]	Oncology	1	2010–2011	22	Hepatitis B	Area delineation. Reuse of plugs. Handwashing. Waste management
				9	Hepatitis C	
				8	Hepatitis B and C	
USA (Michigan) [20]	Hematology, Oncology	1	2012	10	Hepatitis C	Unidentified
USA (New Jersey) [20, 28]	Oncology (outpatient)	1	2009	29	Hepatitis B	NaCl vial. Single-dose vials. Area delineation
Total						Hepatitis C — 39, hepatitis B — 100, hepatitis B and C — 8, outbreaks — 5
Long-term care facilities						
USA [20]	Home care facilities, nursing homes	20	2008–2016	133	Hepatitis B	See Table 2
				46	Hepatitis C	
Germany [29]	Nursing home	1	2010	5	Hepatitis B	Blood lancet for capillary blood sampling for blood glucose measurement
Total						Hepatitis C — 46, hepatitis B — 138, outbreaks — 21
Other facilities						
Switzerland [30]	Radiology (CT)	1	2013	4	Hepatitis C	NaCl vial
Israel [31]	Radiology (CT)	1	2018	12	Hepatitis C	Intravenous contrast media
Germany [32]	Orthopedic department	1	2009	5	Hepatitis C	Unknown
China [33]	Gynecology, obstetrics	1	2016–2017	5	HIV	Lines for lymphocyte collection and processing

End of Table 1

Country, source	Type of a healthcare facility	Total outbreaks	Outbreak period	Number of cases	Infection	Causes of infection
China (Hong Kong) [34]	Liver transplantation	1	2018	–	Hepatitis C	Blood tube holder
USA [20]	Outpatient facilities	17	2008–2019	14	Hepatitis B	See Table 2
				73	Hepatitis C	
Pakistan [35, 36]	Pediatrics	1	2019	5	Hepatitis B	Multiple violations
				453	HIV + hepatitis C + hepatitis B	404 patients — injections
				48		40 patients — blood transfusion
India [37]	Hospital	1	2009	15	Hepatitis B	49 patients — injections (reused needles) + blood transfusion
				25		Injections (reuse of syringes and needles)
Total	Hepatitis C — 94, hepatitis B — 44, HIV — 395, HIV + hepatitis C — 15, HIV + hepatitis B — 48, total outbreaks — 25					

Table 2. The total number of outbreaks and cases of bloodborne infections depending on the type of a facility; data on different countries in 2008–2020

Facilities	Hepatitis C	Hepatitis B	Hepatitis B + hepatitis C	HIV	HIV + hepatitis C	HIV + hepatitis B	Total outbreaks	Total cases
Hemodialysis	117	–	–	56	–	–	24	173
Oncohematology	39	100	8	–	–	–	5	147
Long-term care facilities	46	138	–	–	–	–	21	184
Other	94	44	–	395	15	48	25	596
Total	296	282	8	451	15	48	75	1100

Table 3. Causes of bloodborne infections during outbreaks in the United States in 2008–2020

Type of a facility	Cause, transmission factor								
	disinfection	hand hygiene	glucose measuring	contaminated vials	capillary blood sampling	single-dose vials	area delimitation	podiatric care	intravenous catheter care
Long-term care facilities	–	3	12	–	6	–	–	4	–
Outpatient clinics	1	–	1	10	–	5	1	–	–
Hemodialysis	13	10	–	–	–	1	4	–	4
Total	14	13	13	10	6	6	5	4	4

Table 4. Comparison of the review data on outbreaks of bloodborne infections in non-hospital facilities in the United States in 1998–2008 [21] and 2008–2019

Parameter	1998–2008 (11 years)	2008–2019 (12 years)
Other facilities		
Outbreaks		
hepatitis B	18	22
hepatitis C	16	36
hepatitis B + hepatitis C	–	2
Cases		
hepatitis B	173	186
hepatitis C	274	242
hepatitis B + hepatitis C	1	–
Outpatient clinics		
Outbreaks	12	19 (including oncohematology clinics)
Cases		
hepatitis B	76	43
hepatitis C	235	83
hepatitis B + hepatitis C	–	–
Main transmission factor	Contaminated vials	Контаминированные флаконы Contaminated vials
Hemodialysis centers		
Outbreaks	6	22
Cases		
hepatitis B	–	29
hepatitis C	40	104
hepatitis B + hepatitis C	–	–
Main transmission factor	Contaminated vials	Contaminated surfaces
Long-term care facilities		
Outbreaks	15	20
Cases		
hepatitis B	97	133
hepatitis C	–	46
hepatitis B + hepatitis C	–	–
Main transmission factor	Reuse of lancet	Contaminated glucometers

these facilities. The most common cause is glucose measuring, i.e. contamination of glucometers, which were not personal and were not disinfected between uses by multiple patients (12 outbreaks). The multiple use of a lancet for skin piercing during capillary blood tests, including blood glucose measuring was a contributing factor in 7 outbreaks. The application of unsterilized instruments for podiatric diabetic foot care contributed to 4 outbreaks. Hand hygiene-related violations were mentioned in 4 outbreaks.

Oncohematology clinics

The causes of outbreaks in oncohematology clinics included multiple violations related to standard precautions: delineation of "clean" and "dirty" areas, reuse of plugs and stoppers, violations related to hand hygiene, waste mismanagement, contaminated vials with saline solution for flushing of an intravenous catheter, multiple uses of single-dose vials. In South Africa, the outbreak occurred due to absent vaccination of children and multiple violations of standard precautions.

Comparison of the review data on outbreaks in the United States

The profile of outbreaks in the United States during two periods: 1998–2008 and 2008–2019 is shown in **Table 4**.

When comparing the two periods, we can note that the number of outbreaks increased, though the number of infection cases remained unchanged.

Although in outpatient clinics, the number of hepatitis C transmission cases decreased, the impact of contaminated vials is still a challenging issue. The high impact of outpatient clinics on spread of infections in the United States is explained by the fact that most of the medical services are provided in such facilities, including services to oncohematological patients and hemodialysis patients.

The number of bloodborne infection transmission cases increased significantly in hemodialysis centers. At the same time, in 2008–2019, contaminated vials being the main factor in 1992–2008 were of no importance. In the later period, contaminated surfaces and poor adherence to hand hygiene came to the fore.

The number of infections increased in long-term care facilities; the problem of capillary blood collection and blood glucose measurement remain of high significance.

Thus, the factors that used to be significant during the previous decades continue to contribute to nosocomial spread of bloodborne infections, while the significance of some of them is increasing.

Findings

The heterogeneity of outbreaks of bloodborne infections in different healthcare facilities is connected with nosology of main diseases of patients. Most of the

outbreaks occur in the healthcare facilities for patients with a weak immune system, end-stage renal disease, diabetes, cancer disease [2].

Oncohematological patients, patients, on hemodialysis and patients in long-term care facilities (assisted-living facilities, residential care facilities, and nursing homes) represent groups of high risk of healthcare-associated bloodborne infections. Oncohematological patients and hemodialysis patients, in addition to immunosuppression, have another risk factor — a venous catheter. Manipulations involving a venous catheter tend to produce small drops of blood. Studies show that the hepatitis B virus can be found on visually clean surfaces in the setting of a patient with hepatitis B infection after manipulations with the catheter or after the hemodialysis procedure [38, 39]. The significance of prevention of bloodborne infections among patients of long-term care facilities is increasing with the growing number of senior and elderly people in developed countries. Furthermore, outbreaks of hepatitis B in these facilities are frequently accompanied by fatal outcomes [21].

At present, the main factors of transmission of HIV, hepatitis B and C are healthcare workers' non-adherence to standard precautions: reuse of disposable items, low commitment to hand hygiene and using of gloves, absent disinfection of surfaces, reusable devices and equipment, absent sterilization of reusable instruments. Outbreaks caused by such manipulations as endoscopic surgery [40], myocardial perfusion imaging [41], computer tomography [30, 31, 42], endomyocardial biopsy [43] were also associated with non-adherence to the main preventive measures.

In hemodialysis clinics, the main contributor to infection transmission is absent disinfection of surfaces in the patient's setting; in oncohematology centers, the main contributor is multiple violations of standard precautions. In long-term care facilities, especially for patients with diabetes, the emphasis should be put on immunoprophylaxis of hepatitis B and using of personal devices for blood glucose measuring.

Today, blood transfusions involved in transmission of bloodborne infections are of significance only in low-income countries.

HIV is reported rarely as a nosocomial infection; however, the outbreak in Pakistan demonstrates the significance of the artificial mode of transmission of this infection in low-income countries as well as insufficient attention to this problem.

Conclusion

Bloodborne infections are characterized by a multiple number of latent forms, thus creating a threat of infection spread when standard precautions, which play a major part in nosocomial transmission, are not complied with. The regular screening of donors and patients from the high-risk group is of critical importance.

High-risk patients include hemodialysis patients, oncohematological patients and patients with diabetes.

To prevent transmission of bloodborne infections, it is important to investigate the outbreaks and to adopt rules and procedures (standard operating procedures) with the emphasis on adherence to standard precautions. The above measures require regular training of personnel, motivation and monitoring of the commitment to compliance. In the above outbreaks, where the causes and factors were not identified, the implementation of standard precautions, along with training and compliance control, had a critical role in prevention of

the further spread of infections. Adherence to standard precautions is important for all healthcare facilities; however, the adherence to preventive measures is of most significance in high-risk facilities such as hemodialysis centers, oncohematology and outpatient clinics, nursing homes, assisted-living facilities, and in diabetes treatment centers.

Hepatitis B vaccination is of importance for immunocompromised patients and older adults; in low-income countries, it is the mainstay of prevention of nosocomially transmitted hepatitis B among all the groups of population.

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