



2003 Chief Medical Officer of Health Report

Blood-borne Infections

A Message from Ontario's Chief Medical Officer of Health

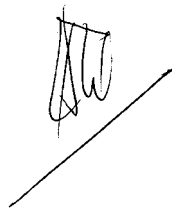
This year, I have chosen to report on blood-borne infections (BBI). Although Ontario has made great strides in reducing communicable disease in general, everyday this year, at least one Ontarian will be infected with hepatitis B or hepatitis C or HIV. All of these potentially fatal infections are preventable.

As travel and trade shrink the world, we in Ontario must be vigilant in identifying emerging and imported infections. In the last year, Ontario's health system has faced two such challenges in the form of West Nile virus (WNV) and Severe Acute Respiratory Syndrome (SARS).

BBI, like all health conditions, have risk factors. In the same way that people who smoke face greater risks of heart disease than people who do not smoke, people who engage in certain behaviours face increased risks of BBI. However, because BBI are transmissible, because infected people may not know they are infected and thus unwittingly spread BBI, and because all Ontarians may have friends or family members at risk for BBI, BBI affect us all.

Focusing on BBI is timely because it reminds us that infection control is a concern for everyone, not just a job for hospitals. Individuals, communities, healthcare organizations and governments all have roles to play – if any one of these drops the ball, the impact of the efforts of the others, no matter how committed, will be much diminished. In addition, the public health infrastructure and personnel vital to the monitoring of BBI, identifying effective measures to prevent transmission through research, maintaining a safe blood supply, and protecting the health of Ontarians plays two key roles: reducing the burden of illness from the BBI of today and equipping us to respond quickly and effectively to new infectious disease challenges.

Finally, progress against BBI will require that we confront some of the most private acts in our society – sexual behaviour and drug use. Recognizing that Ontarians have strong views on these matters, I want to stress that the microbes that cause these infections know no boundaries. We cannot afford to be blind to how these infections are spread or to ignore persons we perceive to be different from ourselves particularly when we have available the means to prevent their transmission. I urge you to read this report and do what you can in your own life, your community and your workplace to protect all Ontarians from BBI.



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Chief Medical Officer of Health

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What are Blood-borne Infections?

Introduction

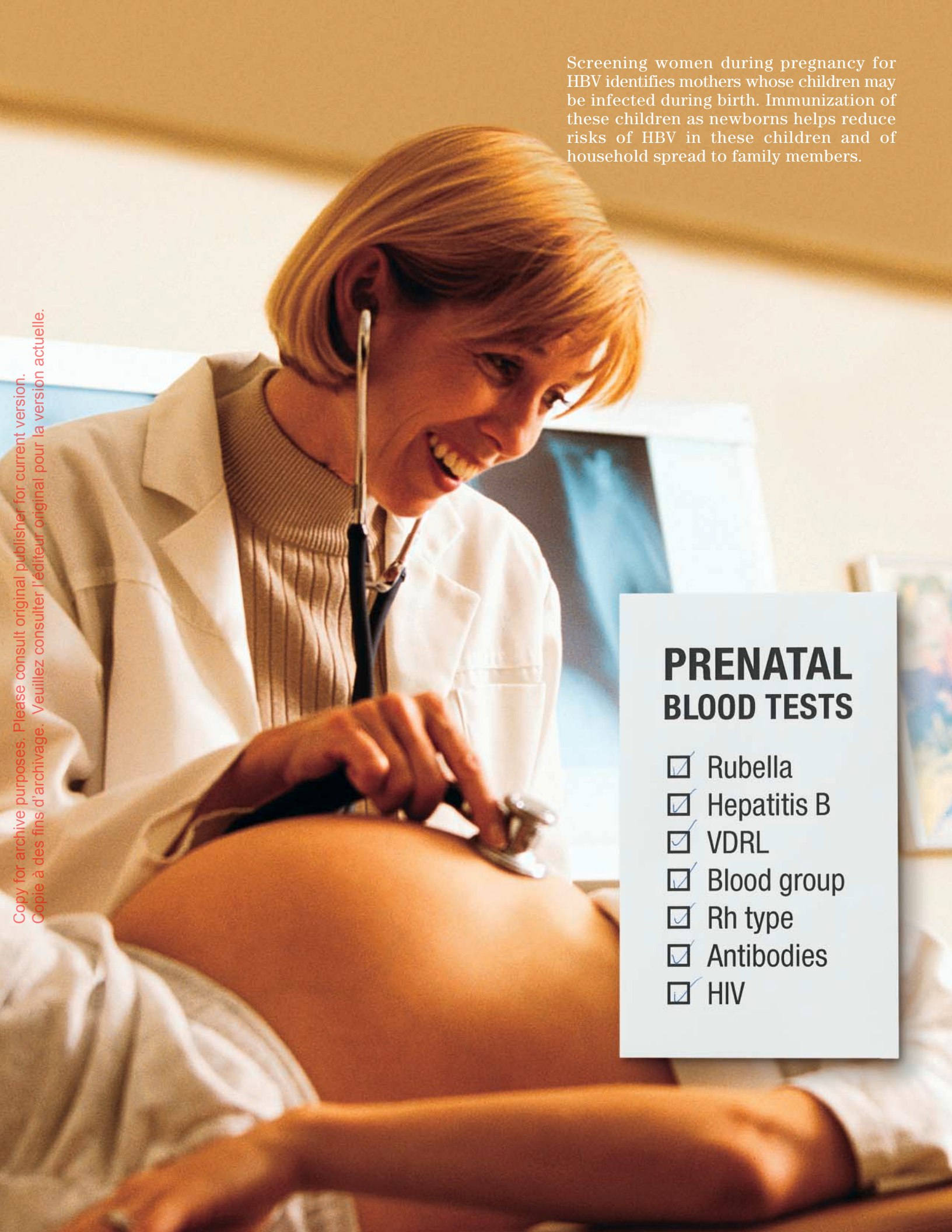
One of the most significant victories against ill health across Canada has been the dramatic reduction in infectious disease over the last century. Many Ontarians will have never experienced the devastation of a family member stricken with polio or measles. For most Ontarians, infectious disease is thought of primarily in terms of the upper respiratory tract infection known as the common cold.

Reductions in infectious disease in places like Ontario are due in part to improved living conditions and public utilities, particularly water and sanitation systems. However, as infections that are easily transmitted in substandard, crowded living conditions are reduced, a greater proportion of the total burden of infectious disease is due to blood-borne infections (BBI).

For this report, BBI refers to microbial organisms (viruses, bacteria and parasites) that are passed from human to human through blood or blood products. Humans can be exposed to BBI because of their behaviours (particularly sexual practices and drug use), injuries (e.g., needle stick injuries of healthcare workers), mother-to-child transmission during pregnancy, labour and delivery, insect bites for vector-borne infections, or as a consequence of receiving blood or blood products as part of the treatment for a health condition.

BBI, like all health conditions, have risk factors. In the same way that people who smoke face greater risks of heart disease than people who do not smoke, people who engage in certain behaviours face increased risks of BBI. However, because BBI are transmissible, because infected people may not know they are infected and thus unwittingly spread BBI, and because all Ontarians may have friends or family members at risk for BBI, BBI affect us all.

It may be tempting to imagine that protecting people from BBI acquired through blood transfusion is not at all related to protecting people from sexual transmission of BBI. On the contrary, reducing the burden of BBI in Ontario requires a comprehensive approach that can encompass multiple modes of transmission. For some BBI, large numbers of new infections occur in well-defined groups, such as drug users. Given that preventing new infections protects everyone, the health of all Ontarians is improved by implementing effective measures to prevent BBI, whether targeted to high-risk behaviours or the general population. Put another way, each prevented infection means a lower prevalence of BBI, which means fewer people infected. And if fewer people become infected, the episodic risk of transmission in any single exposure, whether blood transfusion, drug use, sexual contact or birth, is reduced.



Screening women during pregnancy for HBV identifies mothers whose children may be infected during birth. Immunization of these children as newborns helps reduce risks of HBV in these children and of household spread to family members.

PRENATAL BLOOD TESTS

- ☒ Rubella
- ☒ Hepatitis B
- ☒ VDRL
- ☒ Blood group
- ☒ Rh type
- ☒ Antibodies
- ☒ HIV

Which BBI?

From a global perspective, BBI are one of the leading causes of human illness and death. For Ontario, however, despite not being a leading cause of death, several BBI are particularly important. This report addresses two groups of infections; first, three particular BBI: hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), and second, a group of low prevalence or emerging potential BBI. This group includes malaria, West Nile virus (WNV), Creutzfeldt-Jacob Disease (CJD) and new-variant Creutzfeldt-Jacob Disease (vCJD). Malaria and WNV are spread by insect vectors. CJD and vCJD are rare conditions, approximately one case per million persons per year, that occur sporadically but may also be transmissible via blood products.

Hepatitis B Virus (HBV)

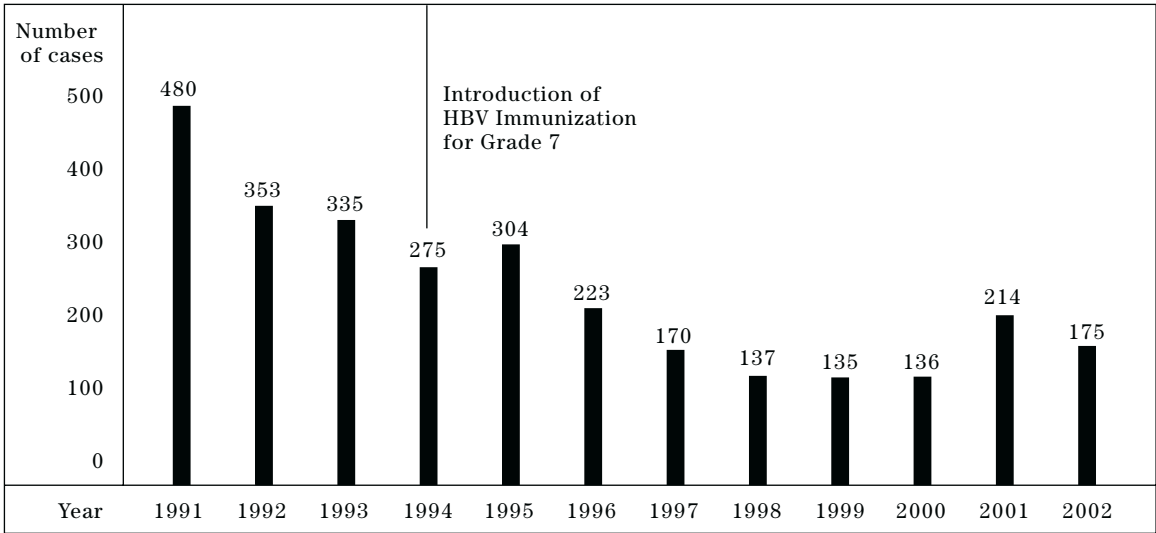
Hepatitis B virus (HBV) causes an acute infection, and in some people, a chronic infection. Acute infection primarily affects the liver and produces jaundice. Chronic infection or 'carrier status' can lead to cirrhosis and increased risk of liver cancer many years after infection. The risk of chronic infection is age-related. An estimated 5% of people infected as adults will develop chronic infection, while up to 90% of people infected in the first year of life will progress to chronic infection. A person who is chronically infected not only faces higher risks of severe illness (cirrhosis, liver cancer), but also may infect other people.

HBV infection occurs all over the world, meaning that effective control strategies in Ontario must consider the possibility of people importing the infection from places with very high levels of HBV to Canada and also include measures to prevent transmission in Ontario.

In countries with high levels of prevalence, such as many in Southeast Asia and Africa, most people are infected at birth or by household spread from one family member to another. By contrast, in developed countries with low prevalence, including Canada, sexual transmission and injection drug use among adults are the main modes of transmission.

In both Ontario and Canada, the number of new HBV infections has declined steadily over the last decade. Figure 1 shows the number of cases reported in Ontario over the period 1991-2002.

Figure 1: Hepatitis B in Ontario, 1991-2002



Effective vaccines are available against HBV. In 1994, Ontario instituted a universal HBV immunization program for all grade 7 students. In addition, Ontario’s 37 local public health units provide free vaccine for particular groups of people who are at higher risk of HBV. One such group is children born to mothers who are infected with HBV. Screening women during pregnancy for HBV identifies mothers whose children may be infected during birth. Immunization of these children as newborns helps reduce risks of HBV in these children and of household spread to family members. Another group, the Ontario Provincial Police and Correctional Officers, have received free HBV vaccine, on a voluntary basis, for more than a decade. Overall, HBV immunization’s impact grows over time as the accumulated number of people vaccinated increases. Moreover, HBV immunization potentially provides lifetime protection, meaning that both the number of new cases and the number of people living with HBV should continue to decline if immunization continues.

Hepatitis C Virus (HCV)

Unlike HBV, hepatitis C virus (HCV) does not produce a significant acute illness. As a result, people who are infected with HCV may not know that they are infected. Although roughly three of every four people infected with HCV will progress to chronic infection, the linkages among degree of liver damage, levels of HCV virus and transmission risks are still poorly understood. Once chronic infection is established, the virus will only rarely be completely cleared from the infected person’s blood. As a result, people with chronic HCV infection may be able to infect others, regardless of their clinical symptoms.

Although the likelihood of chronic infection with HCV is much higher than for HBV, the clinical course appears more variable. Estimates vary, but roughly one third of people who are infected will have no progression after 30 or more years while another third will have progression to cirrhosis in less than 20 years. About one in five people who are chronically infected will develop cirrhosis. In North America, HCV-associated cirrhosis has become the leading reason for liver transplantation.

Ontarians living with HCV represent two distinct groups. The first is people who received blood products or transfusions before June 1990 when screening of blood products for HCV was started. Since HCV was not identified until 1989, technology to prevent its transmission via blood products was not available until the 1990s.

The second group are people infected with HCV who did not receive blood products in the pre-screening era. People who use drugs can transmit HCV when they share drug use equipment. Risks are highest with injection equipment (e.g., needles), but BBI can also be spread by straws, pipes, and spoons involved in drug use. As with all BBI where the infectious agent is present in the bloodstream, sharing injection equipment is a very efficient means of spreading infection because the injection itself delivers the infectious agent directly into the bloodstream of the recipient, bypassing the body's natural defenses. In addition, for reasons that remain unclear, people tend to become infected with HCV very soon after beginning injection drug use – possibly because initial experimentation with injection drugs may be more likely to involve sharing equipment.

Sexual transmission of HCV also occurs, although less frequently than for HBV or HIV. Similarly, mother-to-child transmission has been reported, but this is also lower than seen with HIV. Children born to women infected with both HIV and HCV have an increased risk of HCV infection, suggesting that the two viruses may work together to increase the efficiency of transmission.

However, in a significant number of HCV cases, no risk factor can be identified. This highlights the need for investments in research to identify how HCV is spread so that effective prevention steps can be taken.

Human Immunodeficiency Virus (HIV)

Human immunodeficiency virus (HIV) is probably the most high-profile BBI in the world at present. HIV infection leads to acquired immunodeficiency syndrome (AIDS). Though AIDS remains a fatal condition, the development of effective drug therapies have reduced morbidity and mortality dramatically.

Unlike the viruses causing hepatitis B and C, HIV is a retrovirus. A retrovirus reproduces itself by inserting its genetic code into the cells of the infected human host. One of the target types of cells is the CD4 cell that is vital for the body's immune response. These cells reproduce in response to infection. As a result, the viral load of HIV can increase in response to any infection because each time these cells reproduce, they must copy their genetic material and thus, make more copies of HIV. Furthermore, cells with surface receptors that are targeted by HIV are widespread throughout the genital tract, which is thought to increase the efficiency of sexual transmission of HIV. Globally, sexual transmission accounts for the vast majority of HIV infections, and although for the purposes of this report HIV has been incorporated into the broader BBI category, most HIV transmission occurs as a result of exposure to infected semen or vaginal fluids. Injection drug use is the second leading cause. Without intervention, mother-to-child transmission of HIV occurs in 25-40% of children born to women with HIV.

In Ontario, an estimated 70% of all HIV infections (1985-2001) are attributable to men having sex with men (MSM). An additional 8% are due to injection drug use. The proportion of women with HIV who were infected from drug use is higher (19%) than among men (6%). Among newly diagnosed HIV-infected Ontario women in 2001, over 80% were infected during sexual

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Condom use requires not only access to supplies of condoms and information about their use, but also a social norming of condom use, meaning that condom use is expected.

intercourse with an HIV-infected man. Women now comprise over 25% of newly diagnosed HIV infections. As the figure below shows, women are diagnosed with HIV at younger ages than men. People from endemic regions (regions with high prevalence of HIV such as Sub-Saharan Africa and the Caribbean) saw an increase in HIV rates of 85% since 1996, representing nearly 3,000 persons with HIV/AIDS. In addition, Aboriginal communities continue to be disproportionately impacted by HIV. While there are no Ontario statistics specifically on Aboriginal people, the national picture with Aboriginal people representing 2.8% of the population but 10% of new AIDS cases in the first six months of 2002, suggest the need to pay attention to this population in the context of BBI.

The Changing Picture of HIV Infection in Ontario

The number of new cases has fallen significantly since the early 1990s. Females are accounting for a growing proportion of new cases.

	NUMBER OF CASES, (%) MALES	NUMBER OF CASES, (%) FEMALES
1985	326 (98.2%)	6 (1.8%)
1993	1255 (87.8%)	175 (12.2%)
2001	733 (74.3%)	254 (25.7%)

Average age at diagnosis of HIV infection for the period 1985-2001 was 35.0 years for males and 30.1 for females. Average age at diagnosis is rising slightly for all groups. Although age at testing does not exactly follow age at infection, these data suggest that young people may be heeding messages about how to prevent HIV infection.

AVERAGE AGE AT DIAGNOSIS BY PRIMARY RISK FACTOR (years)				
	MSM	IDU (M)	IDU (F)	HETERO (F)
1985	33.1	28.0	--	--
1993	35.4	31.2	29.3	31.8
2001	37.7	36.0	32.4	32.2

Risk factors for HIV infection show regional variation. Whether because injection drug use is more common outside metropolitan centres or because drug users in metropolitan centres have better access to sterile injecting equipment, the proportion of infections due to injection drug use is significantly higher in the northern and eastern regions than in western Ontario and Toronto.

	REGION						
EXPOSURE	Northern	Ottawa	Eastern, Other	Toronto	Central East, Other	Central West	Southwest
MSM	23.4%	39.1%	33.3%	70.3%	35.9%	40.1%	51.5%
M-IDU	2.9%	3.2%	2.7%	2.2%	3.4%	2.1%	4.2%
IDU	40.6%	23.5%	35.5%	4.8%	12.4%	16.4%	9.6%
HETERO	21.7%	19.6%	18.3%	13.9%	33.8%	25.7%	27.8%

In Ontario, HIV emerged in the early 1980s and the annual number of newly diagnosed HIV infections rose from 335 in 1985 to a peak of 2091 in 1990 before falling to 987 in 2001. There have been on average 1000 new infections each year in Ontario since 1997, with 1240 in 2002. Success in promoting use of condoms and clean drug injecting equipment has contributed to the overall success in curbing rates of HIV in the province. Recent increases are being carefully monitored. In addition, while treatment of HIV does not cure infection, it reduces the amount of virus in the blood and thus, reduces the risk of infection in any single exposure.

Low Prevalence and Emerging Infections

1) Malaria

Malaria is a parasitic infection spread by the *anopheles* mosquito. When the mosquito bites a human, it delivers the malaria parasite into the bloodstream. In the early part of the 20th century, summer outbreaks of malaria occurred in cities of Ontario and Quebec. However, in 2003, there is no endemic malaria in Canada. A review published in 2003 identified four known cases of transfusion-associated malaria in Canada.

Nevertheless, every year Canadians travel to parts of the world where malaria is common and return with clinical infection. If these people donate blood, there would be potential for transmission of malaria through blood products. In addition, if the ecology of Ontario were to change and *anopheles* mosquitoes appeared in significant numbers, it is possible that person-to-person transmission could occur, as happened in New Jersey in the mid-1990s.

Globally, malaria kills an estimated one million children and infects millions more every year. In areas where malaria occurs, many of these deaths could be prevented if all children slept under insecticide-impregnated bed nets and received prompt treatment with effective antimalarial drugs. For Ontarians who travel to areas where malaria is endemic, sleeping under a bed net impregnated with chemicals to kill mosquitoes and taking prophylactic antimalarial medicine appropriate for the area can significantly reduce the risk of being infected with malaria.

2) West Nile virus (WNV)

West Nile virus (WNV) is a blood-borne infection that is fatal to certain bird species and can also produce clinical disease in humans. WNV was first described in Uganda in 1937 and first appeared in North America in 1999. During 2002, there were approximately 404 human cases of WNV in Ontario (according to the Canadian case definitions of 2002 that included laboratory testing), highlighting the importance why emerging infections are an important public health issue.

From a microbiology perspective, humans are 'accidental hosts' for WNV. Although over 90% of humans who are infected with WNV may have no clinical symptoms or a mild flu-like illness, WNV infection can be severe in some humans. Severe WNV is more common among the elderly and people with chronic medical conditions and causes meningitis, encephalitis and in some cases, long-term neurologic disabilities.

During 2002, WNV transmission by blood transfusion was reported in the USA and Canada. The Canadian Blood Service introduced screening of all blood donations for WNV as of July 1, 2003. Donor screening should further reduce the risk of transfusion-associated WNV.

3) Creutzfeldt-Jakob Disease (CJD)

Creutzfeldt-Jakob Disease (CJD) is a transmissible spongiform encephalopathy (TSE). TSE are rare infections that can be passed from person to person (i.e., they are transmissible) and which produce a characteristic pathology in the brain (i.e., the spongiform encephalopathy) that leads to early dementia and death. CJD is linked to BBI because, although its mechanism of transmission is still not completely understood, there is concern that it may be transmissible in blood products. At this time, there is no test available to detect the causative agent, (called a prion), in blood samples. To put that risk in perspective, CJD occurs all over the world, including Ontario and Canada, at a rate of approximately one case annually per million population. Data collected by Health Canada and reported in the figure below suggest that this rate is not changing over time.

CJD in Ontario, 1999-2002

	CJD CASES, ONTARIO	RATE OF CJD/million population (CANADA)
1999	13	1.02
2000	11	1.14
2001	12	0.96
2002	10	0.92*

*data incomplete as of June 1, 2003 Source: Health Canada (<http://www.hc-sc.gc.ca>)

To date, no epidemiologic link has been made between CJD and blood transfusion and the long-term follow up of people who received transfusions from donors who subsequently developed CJD has not identified any cases among the transfusion recipients. Thus, CJD illustrates the challenges of emerging pathogens whose transmissibility may be theoretically possible.

4) New-variant Creutzfeldt-Jakob Disease (vCJD)

Concern about movement of TSE between species led the UK to establish a national surveillance system for CJD in 1990. This followed a widespread outbreak of bovine spongiform encephalopathy (BSE) – so-called ‘mad cow disease’ among cows in the UK and the recognition that human consumption of beef could lead to an increase in CJD if people had eaten BSE-infected beef and if BSE could trigger CJD in humans.

Between 1994 and 1997, 22 cases of what is now referred to as new-variant CJD (vCJD) were detected in the UK. The ‘new variant’ was so-named because the clinical picture was slightly different and a consistent genetic change was noted in the PrP gene when compared to PrP in people with CJD. Initial projections of the numbers of vCJD cases appear to have been overestimates.

In April 2002, Health Canada’s CJD surveillance system reported a confirmed case of vCJD in a man living in western Canada. Further investigation revealed that he had spent significant time in the UK during the BSE outbreak and consumed processed meat products in the UK. These products carry a higher risk of CJD. To date, no other Canadians have been diagnosed with vCJD.

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For insect-borne BBI, the key personal protective measure is reducing exposure to insect bites.

Why are Blood-borne Infections an Important Public Health Issue?

BBI are an important public health issue because of their impact on both infected people and uninfected people. HBV, HCV, and HIV are all potentially fatal. While currently available treatment interventions may prolong life, they are often expensive, poorly tolerated due to side effects, and may not be effective for all infected people.

In addition, because infected people may not have symptoms as soon as they are infected, they can unknowingly transmit the infection to others, including sexual partners, their newborn children, and persons with whom they share drug use equipment. For some BBI, high rates of new infections occur in well-defined groups, such as drug users. Some people may imagine that as long as they do not use drugs, they are not at risk but that is incorrect. People who use drugs have family, friends, and co-workers who, even if they are not themselves drug users, could be sexual partners or close household contacts at risk for BBI.

Effective public health means preventing new infections wherever they occur. In light of the principle that each new infection prevented protects everyone, the health of all Ontarians is advanced by efforts to prevent BBI, whether targeted to high-risk groups or to the general population. For example, a single infected blood donor whose donation contributes to a pooled product could expose dozens of people to BBI.

The transmission risks of BBI are a matter of biology – what makes BBI an important public health issue is that the effective interventions to reduce BBI transmission are squarely within the realm of public health and require ongoing public health investment and vigilance if the BBI are not to gain the upper hand. Similarly, continued support for community-based interventions that promote the prevention of HIV transmission are vital if we are to curb the spread of HIV.

BBI & PRISONS

- Rates of hepatitis C infection among inmates of Canada's prisons are among the highest reported in Canada. A 1998 study in a federal prison reported that 33% of participants were HCV-positive. A 1996 study reported 78% of female inmates at a provincial correctional centre for women were HCV-positive. More recent data from 2000 indicate that an estimated 19.2% of all federal inmates and 41.2% of all female inmates were infected with HCV. Rates of HIV, while lower than those for HCV, are much higher than in the population at large. Canada's rates are similar to those found in US and Australian prisons.
- Many HCV-positive inmates come to prison already infected. However, sexual behaviour, drug use and tattooing in prisons can facilitate transmission, particularly in the absence of condom use and provision of clean drug use equipment.
- Preventing HCV and other BBI transmission in prisons is important not only for the health of the prison population and those who work with them, but as a key component of reducing BBI overall. People in prisons, particularly provincial institutions, are released at the end of their sentences and thus, failure to prevent BBI transmission in prisons adds to the overall number of people who can transmit BBI in the community at large.
- As in society at large, no single intervention will prevent BBI transmission in prisons. At the federal level, a June 2003 report of the Commons Health Committee called for 'harm reduction strategies for prevention of HIV/ AIDS amongst drug users in correctional facilities similar to those used in the outside community.'

The Economic & Social Burdens of Blood-borne Infections

Measuring the costs of BBI is challenging. Given the small numbers of cases of people with BBI, much of Ontario's investment in BBI is not for treatment or care of infected individuals but for the systems to reduce risk of BBI, notably the blood supply system and public health interventions to reduce risk of person-to-person transmission.

In addition, even if one were to focus only on costs of care and treatment, the reality that current treatments may extend life but not provide cure suggests that a broader perspective on BBI is essential – one that includes surveillance systems to monitor emerging pathogens and public health infrastructure to identify infected individuals and ensure they are able to access effective measures to reduce the chances of their infecting others.

Notwithstanding these important issues, costs of care for BBI can be significant. In several instances, prevention yields savings based solely on the costs of care that can be avoided. Few data are available from Ontario but results from other provinces are a useful guide to action. Investigators in British Columbia have concluded that testing pregnant women for HIV yielded savings of \$75,000 per prevented case among pregnancies carried to term; an analysis of Edmonton's 'Streetworks' needle exchange concluded that preventing one HIV infection cost approximately \$9500, significantly less than expected treatment costs for one person infected with HIV; and Ontario researchers studying British Columbia's program of school-based HBV immunization in grade 6 concluded that with a net per-person cost of \$9 and net per-person savings of \$75, such a program was cost-effective.

With this evidence of economic benefits from preventing BBI, the argument for assertive program and policy action should be straightforward. In addition, preventing BBI also has social benefits, particularly when effective harm reduction efforts can reach drug users and potentially reduce the non-health impacts of drug use including property damage, litter, and foregone tax revenue on the proceeds of drug trade.

Particular attention to youth is important. Whether motivated by the principles embodied in Canada's ratification of the Convention on the Rights of the Child, the economics of prevention, or the desire to mitigate the devastation to persons and property resulting from drug use, effective efforts to work with young people to prevent drug use and reduce the harms associated with drug use are vital, not just in Ontario but globally.

In addition, the need to pay particular attention to gay and bisexual men in mid-life has become apparent in recent years, as this subgroup of gay men is being particularly impacted by new HIV infections.

Cravero comments

"...in an increasing number of countries across the globe, the faces of drug users are young faces. They are often young men and women who feel they have no options, no future and no access to treatment or services – in short, they have nothing to lose. And if we don't act now – with resources, energy and conviction – we will lose them, and with them the only real hope of reversing this epidemic.

There are many ways to approach the intersecting problems of drug use and HIV infection. We can convince ourselves that the challenges are insurmountable, IDU behaviour is unchangeable and solutions are unaffordable. And so our interventions will be flawed, under-resourced and half-hearted.

Or we can decide to act on what we already know to be true – that drug users respond well to services and treatment, take advantage of options to improve their lives and the lives of their partners and, given a chance, can act as positive forces for change. And then our efforts will be vibrant and effective, offering hope and opportunity, especially to the young now crying out for better, healthier futures."

– from remarks by UNAIDS Deputy Executive Director, Kathleen Cravero, April 2003

Detach and return to school

child's name

has permission to be vaccinated against Hepatitis B on May 7, 2004.

parent or guardian's signature

Governments in most provinces have implemented universal immunization programs for newborns or, as in Ontario, school-aged children.

What can be done to Prevent Blood-borne Infections?

The three major BBI all share risk factors because they are spread by many of the same mechanisms. Given the similar mechanisms of transmission, the following sections are organized by intervention, rather than by BBI. Effective prevention of BBI requires a comprehensive approach encompassing not only personal protective measures, but also policy interventions and investments in the public health infrastructure needed to reduce BBI risks to as low as possible.

For the three major BBI, prevention is two-pronged: i) measures to reduce the prevalence of infection among the population which reduces the risk of transmission in any episode of sex, drug use, blood donation or healthcare and ii) measures to reduce the episode-specific risks of transmission. Moreover, although several BBI are concentrated among population groups defined by particular behaviours, members of those 'high-prevalence' groups are not isolated from the rest of the population – they have sexual partners from outside the group, they require medical care, and they may donate blood. For these reasons, interventions among high-prevalence groups have important potential benefits for society overall.

Personal Protective Measures

Given that HIV, HBV and possibly HCV are all spread through sexual contact and sharing drug use equipment, interventions to reduce this transmission are central to reducing the overall burden of BBI. Latex condoms, used consistently and correctly, prevent sexual transmission. Condom use requires not only access to supplies of condoms and information about their use, but also a 'social norming' of condom use, meaning that condom use is expected. Reports of reduced condom use among men having sex with men in western urban environments highlight the importance of creating and maintaining a social norm that expects condom use. As well, factors such as mental health, social marginalization, and practical skills associated with limiting the negative impact of condoms on sexual intimacy and pleasure are examples of other, comprehensive measures needed in addressing BBI prevention with gay and bisexual men.

People who use drugs can transmit BBI when they share drug use equipment. Risks are highest with injection equipment (e.g., needles), but BBI can also be spread by straws, pipes, and spoons involved in drug use. Thus, access to clean, sterile drug use equipment can reduce risks of BBI transmission. In addition, provision of methadone or treatment services may enable injection drug users to curtail or stop injecting, with gains for their health in addition to reduced risks of BBI transmission. Despite widespread knowledge of the importance of clean injecting equipment, many drug users continue to share equipment, highlighting the reality that knowledge alone does not lead directly to behaviour change, and illustrating the need for addressing the mental, social, and economic health of drug users.

Needle exchange programs are one example of a public health intervention intended to assist people at risk of transmitting BBI or being infected with BBI to implement effective personal protective measures. By providing access to clean injecting equipment, often free of charge, together with alternatives to injection drug use (such as methadone), and HBV immunization to drug users, needle exchange efforts not only protect injection drug users, but by reducing transmission among drug users, also reduce the overall burden of BBI among the population.

For insect-borne BBI, the key personal protective measure is reducing exposure to insect bites. Thus, for Ontarians concerned about WNV infection, using DEET-containing insecticides, wearing clothing that covers exposed skin when outdoors, particularly at dawn and dusk, and draining standing water are key steps in reducing the risk of WNV. For Ontarians traveling to malaria-endemic areas, sleeping under insecticide-treated nets and completing a course of antimalarial prophylaxis medication as prescribed by a physician can dramatically reduce risks of malaria.

Vaccines against BBI

Over the last 50 years in Canada, polio has been eliminated, smallpox eradicated and measles significantly reduced. Vaccination played a part in all of these health triumphs; in fact, vaccination has been so successful that many Ontarians will never have seen a young child, stricken with polio and straining to breathe or, having survived the acute infection, struggling to walk.

BBI represent the current frontier of vaccine-preventable infectious disease. Several vaccines against HBV are available in Canada. Their effectiveness and the health benefits they confer are such that governments in most provinces have implemented universal immunization programs for newborns or, as in Ontario, school-aged children. For immunization against HBV to be maximally effective, it must occur prior to the initiation of sexual activity.

In addition, Ontario's 37 local public health units make HBV vaccine available to people at particular risk for HBV including those with high-risk sexual exposures and household contacts of people with chronic HBV infection. Most healthcare professional trainees are now required to be immunized against HBV before beginning their clinical training.

Individuals eligible for hepatitis B vaccine at no cost from Ontario's local public health units

- Grade 7 students in all Ontario schools
- Children <7 years old whose families have immigrated to Ontario from countries of high HBV prevalence and who may be exposed to extended family members with chronic HBV infection
- Injection drug users
- Men who have sex with men, and males and females with multiple sexual partners
- People who receive needlestick injuries outside healthcare settings
- People with chronic liver disease, including hepatitis C
- Household and sexual contacts of both acute and chronic infections
- Second and third doses are provided for people awaiting liver transplants, infants born to mothers with chronic HBV infection, and people on renal dialysis or requiring frequent blood products.

Research into effective vaccines against HIV and HCV continues apace, but even optimists expect that it will be at least five years before effective vaccines are commercially available.

Policy Interventions for Healthy Marketplaces

In Ontario today, many people display body art, most commonly tattoos and body piercing. Most of these are done in commercial establishments where, if attention is not paid to infection control measures that prevent BBI transmission, customers may find they receive more than the service they had in mind. Any service that involves intentional or inadvertent breaking of the skin can facilitate BBI transmission.

Personal service enterprises (PSE) include not only establishments offering tattoos and ear or body piercings but also estheticians, hair removal facilities, hair salons, barber shops, and nail shops. A healthy marketplace is one where consumers can find assurance that their PSE provider has implemented effective infection control measures to prevent BBI transmission. Public health departments are mandated to inspect these premises but due to the small-scale nature of many PSE, it can be difficult to identify all PSE in a community.

What consumers can do is ask about infection control practices before purchasing any service, request sterile, single-use equipment, and ensure that the PSE staff take equipment from an unopened package before use. For tattoos, tattoo dye should also be taken from single use packages. For services provided on an ongoing basis, such as manicure or pedicure, some establishments provide their customers the option of having a personal set of equipment that is reserved for the individual who purchases it. Inspections may provide some safeguards against BBI transmission but the informed, health-conscious consumer is a far more effective intervention.

Why Treatment is also about Prevention

One measure of success in treating HIV with antiretroviral drugs (ARV) occurs when the amount of virus in the blood becomes undetectable. Not only does this generally translate into improved health and longevity for the person taking the drugs, but it also reduces the risk of transmission from that person to others. Lower viral loads can lower transmission risks in any contact episode. Governments in Canada and Ontario have recognized this in their efforts to inform people of treatment options and to reduce financial barriers to accessing treatment. By creating conditions that assist people with BBI to access treatment, the overall burden of BBI can be reduced.

In addition, providing ARV to pregnant mothers who are infected with HIV is effective in preventing mother-to-child transmission of HIV. In Canada, the move to universal HIV testing of women during pregnancy was driven by the recognition that identifying HIV-infected women would enable pregnant women living with HIV to be offered drug treatment to slow their progression to AIDS, but also to offer them a triad of interventions to reduce HIV transmission to their children. That triad, composed of ARV treatment, delivery by elective cesarean section and provision of breast milk substitutes, can reduce the risk of transmission from approximately 40% to less than 1%.



Any service that involves intentional or inadvertent breaking of the skin can facilitate BBI transmission. Personal Service Enterprises (PSE) include not only establishments offering tattoos and ear or body piercings, but also estheticians, hair removal facilities, hair salons, barber shops and nail shops.

For children born to mothers who have chronic HBV infection, the Canada Immunization Guide recommends both immunization of the newborn and administration of hepatitis B immune globulin (antibodies to hepatitis B collected from blood donors) to reduce the likelihood of HBV in the newborn and also the risk of household transmission from the newborn to other household members. Ontario's 37 local public health units provide this vaccine free of charge. During 2002, 602 pregnant women with HBV were identified in Ontario; immunizing their children and household members is estimated to have prevented hundreds of additional HBV infections.

Healthcare Settings: Preventing BBI Transmission

Healthcare settings are critical to managing BBI in Ontario. Given the relatively low prevalence of BBI in the general population, hospitals and practitioners' offices are important settings to intervene to reduce BBI transmission. The range of effective interventions is broad but the message is the same – attention to infection control and measures to reduce transmission protect both patients and healthcare workers. In Canada, all acute care hospitals and long-term care facilities are required to have both infection control programs and staff trained to implement and manage infection control.

In addition, both the College of Physicians and Surgeons of Ontario (CPSO) and College of Nurses of Ontario (CNO) publish infection control guidelines for their members. The guidelines of both Colleges include a duty to ensure that members (doctors and nurses) infected with transmissible diseases modify their practice to minimize risks to their patients. These positions are consistent with those of health professional associations. For example, the Canadian Medical Association (CMA) strongly encourages all healthcare providers to be immunized against HBV. Furthermore, the CMA recommends that any physician or medical student who tests positive for HBsAg, (indicating circulating virus in the person's blood), should cease any activity that could put patients at risk until an expert committee has advised about how to ensure the safety of the patients in that person's care.

Practitioners' offices and the procedures performed there can be similar to PSE. A Toronto-area hepatitis outbreak linked to office-based EEG testing highlights the importance of infection control in all office settings, regardless of whether the healthcare worker is covered under the *Regulated Health Professions Act* or not. Inspections of office practices are one component of ensuring adequate infection control by office-based healthcare providers, but inspections alone will never be sufficient.

Blood Product Transmission

Through the 1990s, Canada's blood system came under intense scrutiny as the public and government wrestled with the legacy of decisions made under uncertainty. One of the positive consequences of that scrutiny is today's blood system where risks of BBI transmission, while not zero, are among the lowest in the world. Every year in Ontario, approximately 400,000 units of blood are donated. Maintaining confidence in Canada's volunteer-donor-based blood supply requires a delicate balance between the precautionary principle – making every effort to prevent any transfusion-associated infections, and the reality that donor screening must be targeted or else there will be no one eligible to donate blood.

Preventing BBI transmission through blood products is a multi-step process. Donor screening by questionnaires that ask about risk behaviours for BBI is an important first step in reducing the prevalence of BBI among donors. But those questionnaires are only the first step. After collection of donated blood, the combination of laboratory screening and leukoreduction is key to reducing BBI risks to as low as possible. Laboratory screening involves tests for antibodies to BBI and, in some cases, the actual organisms themselves. Blood products that test positive are then withdrawn so as to prevent infection of the recipient. Leukoreduction involves technologies to remove most white blood cells, thus reducing the likelihood of transmission of BBI, which may be present in these cells. Current risks of BBI transmission are shown in the table below.

Estimated Risks of Transfusion-Associated BBI

HIV	HCV	HBV
1 infection/3.9-4.7 million donations	1 infection/2.6-3.1 million donations	1 infection/82,000 donations
1 infection every 7.8-9.4 years	1 infection every 5.2-6.2 years	6 infections/year* (of which <50% (i.e., 2-3) will lead to chronic HBV infection)

Source: E.Vamvakas, Canadian Blood Services

These risks, while very low, will never be zero because of the 'window period.' The window period refers to the time between infection and when available technologies can detect infection. Blood donated during the window period may thus transmit BBI. The shorter the window period, the lower these transmission risks. Because risks will never be zero, the screening questionnaires and testing technologies are supported by two important systems. The first is record keeping – maintaining information about donors and recipients that can be used to identify people who may have been exposed to a BBI when receiving donated blood products. The second is surveillance and monitoring of emerging pathogens to ensure that the blood supply can respond to new BBI or imported BBI. In 2002, when WNV was reported to be transmitted by transfusion, efforts to prevent such transmission in Canada swung into high gear with the result that tests to screen for WNV in donated blood have been implemented in July, 2003. Implementing blood product screening for WNV in just eight months rather than the previous norm of 18-24 months, highlights the importance the blood system attaches to keeping risks of transfusion-associated infection as low as possible. Given that microbes are adept at traveling the globe and changing ecology may facilitate sustained transmission of vector-borne exotic infections, ongoing surveillance is integral to Canada's blood system and vital to maintaining the availability of potentially life-saving blood products.

Organ Transplantation

Organ transplantation is one of the triumphs of modern medicine. Ontario hospitals are among Canada's leaders in transplantation. Despite the dramatically improved quality of life that may come with organ transplantation, many transplant recipients must rely on lifelong drugs that prevent their body rejecting the transplant but which may also weaken their immune systems, making them more susceptible to infection.

All organs considered for donation are tested for the presence of HBV, HCV and HIV. Ensuring that donated organs are free of HBV, HCV, and HIV is vital for the health of the recipient. However, immunosuppression makes cytomegalovirus (CMV) a BBI of particular importance to transplant recipients. CMV is a viral infection that typically occurs 1-4 months after solid organ transplantation and may cause systemic illness and directly damage the transplanted organ.

As CMV was recognized as a particular challenge in transplant recipients, a first step was CMV matching of donor organs and blood products to recipients. Thus, a potential recipient without CMV antibodies would be ideally matched to donor organs and blood products which are also CMV-negative. A second line of defense is prophylactic antiviral medication, particularly for people who have had CMV before transplant, in whom immunosuppression may reactivate CMV infection.

The case of CMV among transplant recipients may seem very rare from a population perspective but it highlights several key elements of reducing the burden of BBI, including the need for ongoing surveillance and research, the need to update knowledge and practice in light of research findings, and the lesson that success is rarely about a single intervention but requires multiple interventions at multiple points.

An analysis of Edmonton's Streetworks needle exchange concluded that preventing one HIV infection cost approximately \$9500, significantly less than expected treatment costs for one person infected with HIV.



Agenda for Action: Recommendations

1) For Individuals

The first step for individuals is information. Knowledge of how to prevent BBI is essential to many of the protective measures which require an individual to do something – use a condom, become informed about the health risks of travel destinations, or select a tattoo artist. In addition, knowledge of infection status can assist people in acting responsibly to take steps to prevent transmission to others by using condoms, not sharing drug use equipment, and not donating blood.

Using personal protective measures of demonstrated effectiveness is critical. These include condoms to prevent sexual transmission, clean injecting equipment for injection drug users and single-use sterile, disposable equipment for tattooing and body piercing. In addition, protective clothing and insect repellents can reduce the chances of mosquito bites, thus reducing the risk of WNV infection. Travelers to areas where malaria or other vector-borne diseases are present can significantly reduce their risks of insect-borne infections by sleeping under insecticide-impregnated bed nets and taking appropriate antimalarial prophylactic medication.

Because many individuals may never be exposed to BBI through these modes of transmission it can be tempting to treat BBI as a matter of ‘lifestyle choice’ – if you inject drugs and become infected with HIV, that’s your problem. In reality, however, BBI put everyone at risk – people who are infected with HBV, HCV, or HIV may not know they are infected (since symptoms can take years to appear), and thus, can unwittingly infect others. For example, sexual partners can transmit it, during unprotected intercourse.

Individuals make choices about sex and drug use in a wide range of ways and under a range of social, emotional and economic conditions. Regardless of which decisions people make, what is crystal clear is that if the use of effective personal protective measures is treated as a completely private decision, these measures will be underused and the rising burden of BBI increases risk for everyone. In this context, communities play a critical role in creating conditions that facilitate individuals making choices that reduce their personal risks of infection and benefit the community by reducing the overall burden of BBI.

2) For Communities

Sexual transmission of BBI plays a significant role in determining Ontario’s overall burden of BBI. For this reason, communities that place a priority on good health will ensure that all of their young people have access to accurate age-appropriate information about sexual and reproductive health and to personal protective measures to reduce their risk of BBI, regardless of their sexual orientation.

Similarly, drug use affects virtually all communities in Ontario. Reducing BBI associated with drug use means a comprehensive set of measures, including efforts to engage young people in drug-free lifestyles but particularly harm reduction for those who inject drugs, assisting them to use clean injection equipment and eventually, to stop injecting drugs. Evidence from other jurisdictions points to the importance of access to clean injecting equipment as a way to reduce HIV transmission – where possession of injecting equipment for distribution is treated the same as possession of drugs with intent to traffic, ensuring availability of clean injecting equipment has been near impossible, and rates of HIV infection among IDU remain high. Furthermore, the global consensus is clear that needle exchange programs can prevent HIV infection and do not cause an increase in the number of injection drug users.

On the emerging infection front, many Ontario communities have moved to implement programs of mosquito control, including draining of standing water and larviciding. Although the lead on implementing these measures may come from municipal government, community sentiment regarding the balancing of risks and benefits is a crucial element of making decisions about mosquito control.

3) For Healthcare Providers

Healthcare workers (HCW) face particular risks of BBI in their work and if themselves become infected, can spread BBI to patients. Routine practices (referred to as ‘universal precautions’ in older sources), are standards of practice designed for the care of all patients – since it is not possible to know which patients are infected with which BBI. Routine practices are based on the reality that all blood or body substances (e.g., vomit, feces, secretions) may harbour organisms that cause BBI, even if the patient does not have symptoms of infection. Healthcare facilities have a range of measures to enable HCW to implement these practices, including sharps safety programs, splash protection, and well-designed access to handwashing facilities and critical equipment such as gloves and gowns.

Nevertheless, breakdowns in routine practices do occur and in these situations, interventions are available to reduce the risks of infection. Most effective among these is post-exposure prophylaxis (PEP) – antiviral drugs given to reduce the chance of infection after exposure to blood from a known or potentially infected person. All HCW in Ontario should have access to PEP.

In addition, all HCW should be immunized against HBV. Supportive measures and resources are needed to assist career transitions for HCW who become infected with BBI, regardless of whether infection occurred in the workplace, so that risks of transmission to patients are minimized.

Finally, an often overlooked role of HCW is their role as educators of the public and patients. An HCW working with a patient who is infected with a BBI can provide that person and her/his family with the information and support they need to take steps to prevent further transmission. While Ontario has leading specialists in infectious disease, it is primary care physicians, nurses and other HCW who have ongoing relationships with patients and thus, who can reinforce the importance of taking steps to prevent transmission.

4) For Federal, Provincial and Municipal Governments

Public Health Infrastructure

- invest in and coordinate surveillance for BBI and for emerging pathogens
- maintain vigilance regarding blood system safety and chain of custody record keeping
- support global efforts to reduce BBI and publicly fund research on emerging BBI; this is important for two reasons: i) research is a global good, meaning that research in Canada can benefit others around the globe and research in other parts of the world can benefit Canadians, and ii) more effective control of BBI globally reduces the risk of imported infections in Canada. Given the large movements of people and goods to and from Canada, reducing malaria in Africa not only saves lives in Africa, but also protects Canadians and the Canadian blood supply from imported malaria infections.

Deliver Effective Interventions

- implement harm reduction (reduce drug use, reduce use of contaminated equipment, provide methadone, make condoms more accessible) in prisons to reduce BBI transmission. Such efforts will not only support prisoners in avoiding BBI, but will benefit society as a whole since most people in prisons are released back into the community, increasing risks of onward transmission
- increase methadone availability
- develop and implement comprehensive approaches to prevent the onset of substance use with particular attention to activities for young people and efforts to ensure every young person has a positive connection with an adult
- provide residential drug treatment programs for youth
- establish public funding for PEP for all sexual assault victims and persons at risk for HIV through high-risk sexual encounters, such as condom breakage in a sero-discordant couple
- publicly fund 'filling the gaps' HBV immunization for people not in the existing eligible groups and implement HBV screening of new arrivals to Canada to ensure that those who can benefit from immunization are identified and immunized
- promote HIV and HBV testing for all pregnant women to increase the current level of HIV testing from 82% and to maintain near 100% HBV testing.

Implement Healthy Policy

- enhance access to effective treatments for BBI and facilitate confidential testing for HBV, HCV, and confidential anonymous testing for HIV
- develop consumer-oriented systems for PSE licensing, inspection, and rating to communicate clearly establishments compliance with infection control; such licensing regimes could also generate revenue to offset costs of inspection
- ensure that drug laws at the provincial and federal level are harmonized with public health goals of reducing BBI transmission, such as increased emphasis on identifying traffickers of drugs and financial beneficiaries of the drug trade rather than users
- develop effective means of ensuring that persons entering prison have at least the access to harm reduction measures and medical care for substance use, particularly methadone, that they would have in society at large.

Conclusion

Blood-borne infections are an important public health issue for all Ontarians. The major blood-borne infections of concern in Ontario are hepatitis B, hepatitis C and human immunodeficiency virus. As Ontario's connections to a globalized world have demonstrated, our surveillance, prevention and infection control measures must also be able to respond to newly arrived organisms such as West Nile virus.

Although the number of people infected with these organisms in Ontario is relatively modest, providing treatment and implementing effective prevention are essential to all of us. Each prevented infection, whether in a child at birth, an adolescent at sexual debut, a blood transfusion recipient or an injection drug user reduces the overall burden of BBI for everyone.

Progress against BBI requires action by individuals – taking responsible steps to prevent infection and transmission, by communities – equipping young people with the knowledge and skills to remain drug-free and to reduce their risks of sexual transmission regardless of sexual orientation, healthcare providers – to implement effective infection control measures, and all levels of government – creating the healthy public policy and investing in the infrastructure needed for surveillance, blood safety, and research that will yield even more effective interventions to prevent and treat BBI.

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References

Infection prevention and control practices for personal services: tattooing, ear/body piercing, and electrolysis. Canada Communicable Disease Report, July 1999, vol. 25S3.

Canadian HIV/AIDS Legal Network. HIV/AIDS and hepatitis C in prisons: the facts, 2001. <http://www.aidslaw.ca>

Canadian Medical Association. Prevention of transmission of hepatitis B in the healthcare context (update, 2001). <http://www.cma.ca>

Canadian Paediatric Society. Transfusion and risk of infection in Canada. The Canadian Journal of Infectious Diseases, 2003, 14, 81-83.

College of Nurses of Ontario. Infection control guidelines. 1999.

CTV Wire. Commons committee urges prison needle exchange. Filed June 5, 2003, @ 2138 ET.

Food and Drug Administration. Guidance for industry – revised recommendations for the assessment of donor suitability and blood and blood product safety in cases of known or suspected West Nile virus infection. May 2003. <http://www.fda.gov/cber/gdlns/wnvguid.pdf>

Guay, M., Clouatre, A.M., Blackburn M., et al. Effectiveness and cost comparison of two strategies for hepatitis B vaccination of schoolchildren. Canadian Journal of Public Health, 2003, 94, 64-67.

Gully, P.R., Tepper, M.L. Hepatitis C. Canadian Medical Association Journal, 1997, 156, 1427-28.

Health Canada. Update: CJD in Canada. May 2002. http://www.hc-sc.gc.ca/pphb-dgspsp/bbp-apdh/cj_e.html

Jacobs, P., Calder, P., Taylor, M., et al. Cost-effectiveness of Streetworks' needle exchange program of Edmonton. Canadian Journal of Public Health, 1999, 90, 168-71.

Krahn, M., Guasparini, R., Sherman, M., Detsky, A.S. Costs and cost-effectiveness of a universal, school-based hepatitis B vaccination program. American Journal of Public Health, 1998, 88, 1638-44.

Lauer, G.M., Walker, B.D. Hepatitis C virus infection. New England Journal of Medicine, 2001, 345, 41-52.

Patrick, D.M., Money, D.M., Forbes J., et al. Routine prenatal screening for HIV in a low-prevalence setting. Canadian Medical Association Journal, 1998, 159, 942-47.

Remis, R.S., Swantee C., Major C., et al. Report on HIV/AIDS in Ontario, November 2002.

Zou, S., Tepper, M., Giulivi, A. Hepatitis C in Canada. Canada Communicable Disease Report, 2001, 27S3.

This publication is available on the Ministry of Health and Long-Term Care website at: www.health.gov.on.ca.