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Effective and Simple Methods of Preventing the Transmission of Viral Diseases.

A. Taqaddas [1],
[1,] Research Medical Physicist, Therapeutic Radiographer, RPS – Research Worm hole, Canada
*Corresponding author: A. Taqaddas, Email: taqaddasa@gmail.com

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ABSTRACT:
Viral infections have always been of major concern in communities, health care settings and medical fields including radiotherapy and Radiology. Recently corona virus infection has attained global attention in the wake of covid-19 outbreak and consequently highlighted importance of viral prevention, diagnostic and therapeutic strategies to control and treat viral disease. In view of the recent events, the author reviewed the current and past literature to discuss contagious versus infectious viral transmission, as well as simple and effective ways of preventing the spread of viral diseases in community and health care setting so that this information can be used for preventing viral transmission at all levels. The article is written for a wide variety of audiences i.e. scientific and medical communities policy makers and general public.

Keyword: *Corona virus, Education, HIV, Immunization, Transmission, Viral Prevention*

INTRODUCTION:

Viruses are found wherever life exists in the environment and are the most abundant biological entities on earth [1]. Thus Viruses infect almost all living beings and can cause disease in their hosts [2]. They spread from one host to another by a number of ways. Some of the viruses show contagious mode of viral transmission whereas others spread via indirect contact. Health care associated infections (HAI) including viral infections are of vital concern in Medical field including radiotherapy. They can be managed by surveillance, infection control and prevention programs otherwise they could prove fatal [3]. HAI have financial implications as well as they can cost NHS about 1 billion/year [3]. The radiology department receives huge number of patients and therefore there is a high risk of spreading the nosocomial infections among patients and to radiological staff. Non-disinfectant equipment and poor hygiene can lead to viral and bacterial growth on radiological equipment such as cassettes, x-ray machines and treatment couch. Hence it is important to learn how to prevent the spread of viral infections. The aim of this essay is to briefly describe the contagious versus infectious transmission of viruses and discuss effective, simple and inexpensive ways of preventing the spread of viral diseases. The article also explains HIV viral entry process into host cell and how fast it multiples inside human cells.

Discussion

Oxford medical dictionary [4] describes Contagious disease 'originally a disease transmitted only by direct physical contact: now usually taken to mean any communicable disease' Contagious transmission of viruses thus refers to transmission of viruses from one host to another only by direct physical contact otherwise it is described as Infectious viral transmission. Viruses can be transmitted directly via contact between an infected host and a non-infected host or indirectly through contamination of the environment [5]. For instance transmission of HIV virus from one host to another can occur via direct sexual contact or transmission of hepatitis virus through use of contaminated drinking water.

Modes of viral transmission can be broadly divided into 2 categories namely Horizontal and vertical transmission. Horizontal transmission takes place between individuals within a population at risk and includes direct contact transmission, indirect contact transmission, common vehicle transmission, vector borne transmission whereas vertical transmission involves transmission from mother to off springs [6]. Horizontal viral transmission can also be described in terms of mucous membranes via which viruses enter and infect their hosts. Most of the mucous membranes infected are of epithelial cell origin.

Mechanism of Viral Infection:

Before we go any further to discuss types of infections, it will be helpful to have a basic idea how viral infection takes place at cellular level. In case of HIV virus for example, the first step of infection involves protein to protein contacts i.e. the viral surface glycoprotein gp120 binds to CD4 receptor that exists on host cell. Consequently all CD4+ cells in the host are prone to HIV infections e.g. T helper cells, dendritic cells, macrophages and astrocytes [7-10]. See figure 1 that shows structure of HIV (Note: The diagram is hand drawn by the author so it is not perfect).

The fastening of gp120 to CD4 molecules causes conformational changes in both proteins which in turn enables gp120 to attach itself to a co-receptor on the host cell called chemokine receptor 4 or 5 (CXCR4,CCCR5) [8,9]. This additional binding leads to further conformational changes in gp120 and subsequently in gp41 resulting in the appearance of N-terminus of gp41 on viral surface [11].

This hydrophobic N terminus forms a fusion pore and thus viral envelope is fused with host plasma membrane followed by translocation of viral capsid into cytoplasm [12,13]. In the cytoplasm the phagosome carrying viral capsid interacts with an early endosome (a vesicle pinched off from Golgi body within the cell), then with a late endosome and eventually with a lysosome. The acidic nature of lysosome causes the release of capsid contents into cytoplasm [13].

In cytoplasm, HIV Reverse transcriptase (RT) becomes activated and transcribes single strand RNA genome into a complementary DNA (cDNA). At the same time viral RNA is degraded by viral RNase H enzyme. After that cDNA is converted into pro viral double stranded DNA by RT [14, 15]. The linear or circular pro-viral DNA along with integrase is transported into cell nucleus via nucleopores [14,15]. Once inside the host nucleus the integrase, integrates pro-viral DNA into host genome unselectively (Craigie and bushman, 2012) –

[15]. The assimilation of pro-viral DNA into host genome completes HIV infection of the cell.

After integration, the pro-viral DNA makes use of host cell division processes to reproduce viral mRNA and genomic RNA resulting in productive infection [7]. Table 1 shows HIV virus infection time line.

One of the reasons HIV virus infection is difficult to control is due to the fact that Reverse transcriptase lacks proof reading ability resulting in statistically one faulty nucleotide per transcription round being included into pro-viral DNA [7]. This means an unlimited HIV replication can result in the production of 108-109 viral particles per day and if the mutation rate is supposed to be 1 in 104 nucleotides per genome during one replication cycle this will lead to generation of wide ranging quasis-species in the patient over time [16,17]. Mutations also alter epitopes (part of the virus that is identified by the neutralizing antibodies) enabling these HIV mutants to continuously evade the immune system [18].

Table 1: Viral Infection Time line

Viral Infection processes	**Time**
Joining of HIV to a CD4+ cell, takes	30min -2h
Viral RNA genome transcription into pro-viral DNA	6h
Viral DNA integration into host chromosome takes	6h
First viral particles are identifiable after	12h
First progeny viruses are liberated from the infected cells	Approx. 24h after infection

Source: [7]

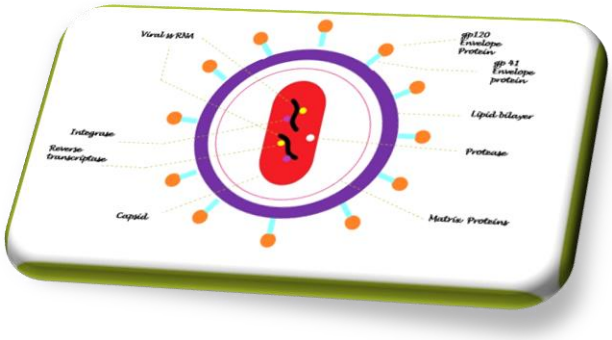

Figure 1: Schematic view of structure of a typical HIV virus

Contagious Viral Transmission Involving Direct Physical Contact

Direct Contact transmission 'occurs when the transfer of microorganisms results from direct physical contact between an infected or colonized individual and a susceptible host [19]. 'It involves actual physical contact between an infected and susceptible person by hand or body contact including kissing and various types of sexual contact such as in case of transmission of herpes, papilloma and pox viruses [6, 20]. Horizontal transmission of HIV virus includes sexual contact, or when blood of the new host comes into contact with infected person's blood or mucosa-blood transmission [21]. HIV can be transmitted by organ transplant including bone marrow transplant approximately from day 5-6 after infection of the donor [7]. Blood transmission includes sharing infected injection equipment, infected blood products and needle stick injuries [21]. In addition to it vertical transmission is also common [5]. No evidence of transmission exists via other routes such as casual contact or aerosol route. Although virus can exist in many body fluids of the infected person such as tears, sweat, saliva, respiratory droplets only blood poses risk of transmission [22] . However in 2013 a case was reported from China indicating transmission of HIV from 29 year old daughter to her mother in family setting. The authors concluded that mother got infected by the virus present in her daughter's blood or other body fluids [23]. The study also showed that close personal contact in the same family can cause HIV transmission.

In 2018 sexual activity accounted for about 93% of diagnosed HIV infections in USA that included 70% male to male sexual interaction whereas heterosexuals (both male and female) accounted for 24% of HIV diagnoses. Drug injection accounted for 7% HIV diagnoses [24]. Infection by Artificial insemination has also been recorded [7].

Needle drug abuse ranks second after sexual activity as a source of HIV virus transmission in USA. Transfusion with contaminated blood products and vertical transmission are of less importance compared to sexual and needle or injection drug abuse [25]. This is because anti-HIV screening is mandatory for blood donors and prevalence correlate with incidence in the general population. The residual risk of HIV transmission via a blood unit is in the range of 1 in 1000 in some African areas, 1 in 10,000 in some Asian centres, and 1 in 100,000 to 1 million in Europe and North America [26]

Intestinal Tract

Enteroviruses (replicate in gut but do not cause gastroenteritis) and enteric virus (cause gastroenteritis) such as Rota viruses, Picornaviruses (e.g. Poliovirus), hepatitis A and E virus spread mainly by faecal oral route. These are the viruses that replicate primarily in intestinal gut [27]. In faecal oral route virus is shed in faeces and may enter new hosts ingesting faeces contaminating food or water [5]. The polio virus replicates in the lymphoid tissue of the pharynx and gut including Peyer's patches followed by a viraemic phase that results extension of virus to central nervous system. The viruses are shed in faeces. The faecal oral mode of transmission is favoured by the ability of the polio virus and other enteroviruses to survive for some weeks in water and sewage [27]. Viruses infecting humans and mammals via gastrointestinal route are quite stable at low PH values i.e. they are acid resistant enabling them to survive passage through the stomach. Examples include Rotaviruses and Picornaviruses [27].

Droplet Transmission

Spread of viruses via respiratory route can occur via droplets. Droplets consisting of infectious particles are produced by sneezing, coughing, talking and are quickly transmitted over considerable distances [28]. These infectious viral particles can land on mucous surfaces such as nasal or oral mucosa of susceptible host or in their immediate environment [19]. These large droplets travel less than 1m distance in air before being deposited onto a surface. They do not remain suspended in the air. Large droplet transmission is major mode of influenza virus transmission [29]. A review [19] has concluded that natural influenza transmission in human beings occurs over short distances rather than over long distances and that natural influenza virus transmission occurs primarily by droplet and contact routes. Although in theory influenza virus can spread via aerosol route there is a debate among researchers whether aerosol route is an important mode of influenza

viral transmission in natural settings. Some researchers consider airborne as an important mode of Influenza virus transmission as discussed in section 'Airborne route'[30-32]. Other Respiratory viruses such as Respiratory Synctial Virus, parainfluenza viruses 1 to 3, rhinoviruses, and adenoviruses are all capable of droplet transmission [28].

Airborne Transmission

In airborne transmission of viruses viral particles are contained in droplet nuclei which are produced as a result of evaporation of large droplets mentioned above. These airborne particles are less than 5um in size. More over these viral particles could be present in dust particles containing skin squamous cells and other debris that remains suspended in air for long duration [19]. Hence in airborne transmission viruses are extensively disseminated by air currents and inhaled by vulnerable hosts who may be some distance away from the infected individuals, even in different rooms or hospital wards. Control of airborne transmission is the most difficult because it requires control of airflow through special ventilation systems [19].

Airborne particles remain suspended in air for long periods of time due to their long settling time. Particles of 5um in diameter the settling time is 62min, particles with 10 um in diameter settling time is 17min and particles with a diameter < 3um essentially do not settle [33, 34]. Hence coughing and sneezing can produce viral particles in form of large droplets which can shrink by evaporation producing a large number of aerosols or also known as droplet nuclei [33, 34]. These particles on inhalation and exposure to humid air as in lungs swell back. Experiments have shown that such inhaled hygroscopic particles are kept in lungs or lower respiratory tract with greater efficiency [33].

Staff and patient contact is long in radiological clinics and in areas of poor ventilation it can lead to emergence of air borne infections.

An interesting case of coronavirus infection was reported during 2002-2003 outbreak in Hong Kong involving outdoor airborne transmission. About 300 residents of a high rise building got infected by coronavirus after visit form one Coronavirus infected person who had high viral loads in urine and fecal samples. Computational modulation showed transit of virus aerosols via poorly sealed plumbing U-Traps and air shafts followed by transmission of virus by prevailing winds into adjacent buildings 60 m apart [35, 36]. Another study of SARS coronavirus showed that even 0.5 ^{o}c difference in temperature between corridor and wards can cause two way air flow at ward entrances thus allowing virus entry into patient wards [37].

Indirect Transmission occurs by the passive transfer of microorganisms to a susceptible host via an intermediate object such as contaminated hands that are not washed between patients, or contaminated instruments or other inanimate objects in the patient's immediate environment [19]. Some strains of influenza A virus can also be transmitted via formites on hard surfaces such as stainless steel where it can survive for up to 2 days [38]. Hepatitis A virus can spread via consumption of contaminated food or water.

Vertical & Vector Transmission is the transmission of virus from mother to off springs and occurs via placenta or breast feeding. Many viruses undergo vertical transmission such as HIV virus, Hepatitis viruses, Human T lymphocytic virus type 1, Cytomegalovirus, Varicella Zoster Virus, Herpes Simplex Virus, Human Papilloma virus [39].Vectors are organisms that transmit viruses between hosts by feeding on them. Most of the viruses are transmitted by arthropods who act as vectors. Such viruses of vertebrates are known as arboviruses. Examples of vertebrate virus vectors include mosquitoes transmitting yellow fever & West Nile Virus to humans, midges transmitting blue tongue virus to sheep and ticks spreading Louping ill virus with sheep as a virus host [5].

Strategies for Prevention of Viral Transmission

Good Hygiene

Good hygiene and sanitation greatly affect the incidence of enteric infections. Hand contaminated at the time of defecation and inadequately washed may transfer viruses directly or indirectly to food and seeping of sewage into wells, streams and other drinking water supplies particularly after heavy rains can contaminate it with viruses [6].

Hand washing is one of the most important means of preventing the spread of infections including those that cause diarrhea and vomiting and respiratory diseases. It is advised to always wash hands after using toilet, before having meals or handling food and after handling animals by using liquid soap, water and paper towels [40] washing with soap and water is extremely useful in preventing hospital acquired viral transmission [28]. Recently Department of Health and Social care in UK has launched a public information campaign that focuses on handwashing in order to prevent the spread of coronavirus by increasing public awareness about handwashing [40]. Public health agency of Canada [41] recommends the use of regular hand washing and vaccination each year to prevent the risk of becoming infected with influenza (flu) virus. In hospital settings many infections are spread by the hand of staff and the aim of hand washing is to remove transient microorganisms and prevent transfer to another patient [42, 43]. As a radiological technologist and student it is important that we practice proper hand washing and other preventable strategies on every patient in order to reduce patient infection rates.

Wet Markets and animal handling practices to be revised

Some viruses causes a number of diseases in both animals and humans e.g. Coronavirus infects bats, ruminants (camels, elk, deer), rodents (rats), piglets, Cats, Chicken [44]. These viruses are capable of cross species transmission including from animals to humans. The SARS-CoV virus (a β-Corona virus) that caused SARS in 2002-2003 originated in horse shoe bats in China [45, 46] and then jumped the species barrier to infect humans causing a major outbreak in many countries. Currently another variant of corona virus (covid-19) is causing unprecedented viral infection and mortality across the globe (Dec 2019-2020). Corona viruses [44, 47] can spread via direct contact and in some cases via air borne route (35, 36,37)

Handling of animals in wet market is considered as a source of wide spread corona viral infection. Serological data has shown coronavirus strains were already circulating in people dealing with animals in wet market without causing any symptoms [48].

Recent News reports have described ghastly and extremely unhygienic conditions in wet markets in Indonesia. It was reported animals in Indonesian wet market were subjected to horrifying treatment in wet market e.g. animals torched from below and dismembered while alive [49].

Currently WHO has been asked by various entities to come up with a way to contain viral spread via wet animal markets in Asia and Africa. US and Australia are demanding G20, WHO and China to impose a ban on wet markets as they consider wet markets selling live wild life and exotic animals to be a big human health and biosecurity risk [50] . It is difficult to say whether these animals were obtained legally or illegally. China has imposed a ban on

illegal trading of wildlife inside china in response to covad-19 outbreak and WHO is currently formulating guidelines on safe operation of wet market [50, 51].

Thus it seems that unhygienic living conditions and practices in animal wet market can contribute to transmission of virus from animals to humans on a large scale. Thus measures need to be taken to ensure that viral strains roaming in wet market are contained and wet markets are made to operate in more hygienic ways minimizing wide spread and local transmission of virus.

Immunization

Immunization is aimed at primarily at marking the individual resistant to infection. Immunization may be active i.e. initiation of an immune response by administration of antigen (vaccine) or passive that is administration of antibody (immunoglobulin)[6]. UK immunization programme includes immunization against measles, mumps and Rubella, Hepatitis A, B, Influenza, Varicella and Human Papilloma Virus [52, 53]. A number of randomized controlled trials have shown that the administration of trivalent influenza vaccine was effective in 80% cases and resulted in reduced morbidity and absence from work or school and hence both Trivalent and Live attenuated Influenza vaccines are recommended by CDC's Advisory Committee to reduce the risk of spreading influenza to others and becoming infected with influenza [54]. All attempts to made a HIV vaccine have been unsuccessful so far [7].

Global coverage of Hepatitis-B vaccines for children reached 75% by 2010 [55]. However 19.3 million children worldwide failed to receive normally recommended vaccines and about more than half of these under-vaccinated children were in 3 countries namely, Congo, India and Nigeria [55]. Human Papilloma Virus vaccines to protect against cervical cancer are now also available. Two HPV vaccines were approved by FDA namely Gardasil and Cervarix in past whereas in 2018 FDA authorized use of Gardasil 9 (that has replaced Gardasil) vaccine, for women and men in the wide age range of 27-45 [56]. Gardsil 9 inhibits certain cancers and diseases triggered by nine HPV types covered by the vaccine. A study reported on FDA website concludes that Gardasil9 used in women from age range of 27-45 was "88% effective in the prevention of persistent infection, genital warts, vulvar and viginal precancerous lesions, cervical precancerous lesions and cerival cancer related to HPV types covered by the vaccine" [56]

Equipment Sterilization Viral Infections such as Hepatitis B and C can be transmitted through use of unsterile or improperly decontaminated needles and medical equipment [57-60]. Hence equipment should be either sterilized or single use i.e. disposable to prevent spread of infection from patient to patient or from patient to health care worker due to accidental needle stick injury [61]. To prevent the spread of blood borne pathogens through shared needles is to use a germicide to disinfect needles between uses such as domestic bleach [62].

Adeno virus spread by intimate personal contact (e.g. touching, kissing) and via air (e.g. coughing, sneezing) and also by water in swimming pools [63]. Therefore it is vital to maintain sufficient levels of chlorine in swimming pools to inhibit outbreaks of conjunctivitis caused by adenoviruses [63]. It can also spread via infected person's stools. There is a vaccine that covers adeno virus type 4 and 5. However this vaccine is reserved for US military use only and not for general publiLike adeno virus Respiratory syncytial virus also spreads via intimate contact and by sharing eating utensils [64]. There is some evidence that RSV can also spread via aerosols [65]

Immunocompromised children or children with congenital diseases and premature infants are particularly susceptible to RSV infection. Adults with weak immunity and co-morbidity can easily acquire RSV infections as well [66]. Palivizumub is FDA Licensed drug for RSV prophylaxis only in premature babies and those born with cardiovascular conditions. No vaccine or treatment is available for active RSV infection [66]

Condom Use

The use of condom is strongly recommended in individuals with more than one partner, with sexually transmitted diseases and for intravenous drug users [67, 68]. A meta-analysis of studies showed that latex condoms are 93-95% effective at preventing transmission of HIV when used consistently and it can effectively reduce an individual's risk of becoming infected [69]. However data is inconsistent regarding protective effect of condom use on transmission of HPV and protection from HPV related conditions and prevention of cervical cancer [70]. However the meta-analysis of a number of studies showed that condoms seem to provide some level of protection against genital HPV infection [70].

Education and mass media campaigns

Centers for Disease Control -CDC recommends use of education campaigns aimed to prevent initiation of drug use especially for adolescents to reduce harmful behaviour and to avoid syringe sharing, needles, water, or drug preparation equipment. HIV prevention educational campaigns in Uganda have resulted in reduced HIV prevalence and incidence from 14% in 1990 to 6.3% in 2005 [71]. An analysis of HIV prevention interventions in countries of sub Saharan Africa and South East Asia showed that mass media campaigns including television and radio episodes and inserts in key newspapers are most cost efficient in reducing HIV transmission in settings of extreme resource constraints [72]. The analysis further showed that school based education aimed at youths aged 10-18 years to promote prevention of HIV is costly than mass media campaigns and first line antiretroviral therapy. However inclusion of these interventions will maximize the health gain.

Education of persons caring for or are in contact with HIV infected persons in household settings is also recommended [23]. The American Academy of Pediatrics committees on Pediatric AIDS and on Adolescence recommend that pediatricians provide information about HIV prevention and spread as part of anticipatory guidance for adolescents [73].

Counselling

A study identified that children and family members of HIV-infected parents experience transmission related fears including blood contact, kissing/hugging, sharing food and meals and contact with bathroom items [74]. Most of the transmission related fears held by children and family members were found to be based on misconceptions regarding household spread of HIV virus. This study suggested that pediatricians, clinicians and others doctoring and caring these children may be able to offer counselling to remove fears that they have with respect to household spread of HIV virus. The counselling should suggest age-appropriate measures to dispel fears of children and other members of the same household [73, 74].

Counselling and education can not only eliminate unnecessary fears but also can inform members of the same household about modes of viral spread and ways to decrease HIV transmission from parent e.g. educating children to

avoid parents while they are bleeding until wound is rinsed and dressed to prevent viral transmission via blood contact. Thus education of HIV infected parent is as vital as education and counselling of Children of HIV infected parent. This is because Parents knowledge can affect the development of child's fear about getting viral infection from the HIV infected parent [75].

Antiretroviral Interventions

Antiretroviral (ART) interventions reduce transmission of HIV-1 by reducing HIV- 1 load in the blood and genital tract of HIV-1 infected person. ART seems to reduce both susceptibility to HIV-1 by means of post exposure prophylaxis (PEP) or pre-exposure prophylaxis (PREP) and transmission of HIV-1 from infected person to his or her partner or from mother to child. However the former case is still under investigation whereas in the latter case ART has been proven to be effective in preventing vertical transmission from mother to child [76-80]. A clinical trial investigating the efficacy of antiretroviral therapy in preventing mother to child transfer of HIV demonstrated that prescribing antiretroviral therapy to HIV infected pregnant women results in two third reduction of mother to child HIV transfer [76]. All pregnant women should be offered antiretroviral prophylaxis to prevent mother to child transfer of HIV [81].

Highly active antiretroviral therapies have resulted in substantial reductions in AIDS incidence and deaths in the UK and reduction in mother to child transfer in Western and central Europe [81, 82]. It is important to realize that provision of antiretroviral therapy is not cheap and thus availability is restricted especially in low and medium cost countries. However, the annual cost of first line antiretrovirals has gone down from about US$10 000 per patient to as low as $140 [83]. An analysis performed by Hogan and colleagues [72] showed that first line antiretroviral therapy is less costly than school based education in sub- Saharan and South East Asian countries (low and medium cost countries) and thus should be included in a package of interventions for HIV/AIDS on basis of cost effectiveness. Treatment with antiretrovirals such as HAART not only provides good value for money in terms of population health outcomes but also availability of treatment may encourage people to come forward voluntarily for counselling and testing which is a crucial step in defeating denial, stigma and discrimination - the main barriers to effective prevention.

Impact of Patient organizations and advocacy Groups

A report of a meeting organized by Viral Hepatitis Prevention board and European Liver Patients Association has highlighted the importance of Patient Organizations and advocacy Groups [84]. Patient organizations and advocacy groups play a vital role in targeting difficult to reach population groups such as drug addicts, immigrants and teenagers dropped out of school. These organizations enable these challenging target groups to access information relating to prevention and treatment of viral infections via counselling and screening and hence assisting in providing vaccination and treatment to them. For instance awareness about viral hepatitis has enormously increased by the Asian Liver Centre's Jade Ribbon Campaign in California [84]. Similarly activities of European Liver Patients association led to the production of a written declaration in European parliament on improved management of Hepatitis B including prevention in Europe in 2007 [77]. Other achievements include highlighting the violation of good prevention practices in health care sector, helping government bodies in developing policies by increasing their awareness of the viral infection and acting as auditors and monitors of various activities such as implementation of guidelines [84]. All this is possible because these patient based organizations have a large target audience ranging from individuals to national and international professional and governmental bodies.

Administration of post-exposure Prophylaxis strategies after needle-stick injury

Health care workers can acquire HIV infection after needle stick injury from HIV infected blood.

According to 1997 post-exposure prophylaxis Guidelines issued by Department of health, it is recommend to offer triple therapy to health care workers ideally within one hour of injury. The triple therapy includes zidovudine, lamivudine and indinavir antiretroviral drugs [85]. However studies have shown that health care workers ignore these guidelines thereby putting themselves at increased risk of HIV seroconversion and many health care workers e.g. anesthetists and surgeons do not know what are high risk fluids, what is the correct action to follow after a needlestick injury, where to get post-exposure prophylaxis out of normal working hours and to begin post-exposure prophylaxis ideally within 1h of the injury [86-88].

The accurate procedure after a needle stick injury involves encouraging active bleeding of the wound and rinse the wound thoroughly with soap and running water [88]. Furthermore the risk of exposure can be greatly reduced by adopting a policy of universal precautions i.e. wearing of disposable gloves, using eye protection where necessary, avoiding re-sheathing needles, not handing over needles directly to another person, making sure that all sharps are placed in disposal bins as well as blood and high risk fluids from any patient that is considered potentially infected [89]. All this warrants that more knowledge and information needs to be distributed regarding high risk fluids, risks from needle stick injury and correct action after a high HIV risk needle stick injury. This information should be made available to health care workers and should be part of clinical governance, risk management, teaching and continuous professional development [88]. Centers for disease control recommends that Post exposure prophylaxis should be offered after Hepatitis A infection ideally within 2 weeks of exposure in the form of Hepatitis A vaccine to all unvaccinated people aged >=12 months who have been newly exposed to Hepatitis A virus [90]. In some situations vaccine is co- administered with GamaSTAN S/D immunoglobulin (0.1mL/kg).

Use of Quarantining

Quarantining was successful applied in controlling corona virus transmission and infection in 2003 as virus spreads via direct contact as mentioned above. Quarantining is currently being enforced pretty much globally to achieve the same purpose. Despite applying prevention strategies the incidence rate of corona virus infection and corona virus-mortality rate are very high. This highlights the importance of implementing prevention and diagnostic strategies in good time and following general hygienic practices all the times. Delaying the implementation strategies for controlling the spread of virus can result in huge mortality rates.

Other Prevention Measures

Stop sharing of syringes, reduce the number of sexual partners to decrease the chance of being exposed to an infectious person to prevent HIV and sexually transmitted viral diseases, removal of stray animals, vaccination of all domestic dogs and cats to control or prevent rabies [27, 53]. Isolation of infected patients or closing hospital wards and

keeping children away from school when they have viral infections such as measles are also some of the effective preventive measures that could be taken to prevent viral spread in institutions and communities. Cohort isolation may be required in an outbreak situation whether the source is within hospital or community [28]. This means separating infected, exposed and uninfected individuals and if anyone in uninfected or exposed group develops the infection moving them immediately to the infected cohort [28]. X-rays of patients who are highly prone to infection should be carried out in the relevant wards with mobile apparatus. Table 2 shows various modes of transmission used by some viruses.

Modes of Transmission	
HIV	Direct physical contact (e.g. Blood, body fluid, sexual contact, organ transplant, Artificial insemination) [7,20,21,23-26], vertical transmission e.g. via placenta, breast feeding [5].
Respiratory Viruses:	
Influenza Virus	Mainly by Contact, & droplet route [7,29]. Also by aerosol [30-32] (limited data). Indirect transmission via fomites (Influenza A) [38].
Adeno Virus	Contact, Possibly droplet and/or aerosol [28, 63]
RSV	Direct & indirect contact, droplet route [28, 64]
SARS Corona virus (CoV)	Direct contact [47], Airborne transmission: aerosol [35-37]
Enteric Viruses:	
Hepatitis A, E	Vertical transmission [39], Indirect transmission (via contaminated drinking water & food), Direct contact-close personal contact (e.g. caring for someone who is ill or via sex, people working with non human primates) [27, 90]
Hepatitis B, C	use of unsterile or improperly decontaminated needles and medical equipment [57-60], blood to blood contact (e.g. sharing needles, syringes, needle stick injuries, sharing razors or tooth brushes that may have come in contact with blood of Hep C infected person), sexual contact (low risk), vertical transmission (pregnant women to unborn child)
Rota viruses	Indirect transmission (faecal-oral route) [27]
Picornaviruses	Indirect transmission (faecal-oral route)[27]
Other Viruses:	
HPV	Vertical transmission [39], direct physical contact [6,20]
Cytomegalovirus	Vertical transmission [39]
Herpes Virus	Direct Physical Contact [6, 20]
Arboviruses *(e.g. West Nile, Blue tongue, Louping Ill virus)*	Vector transmission [5]

CONCLUSION

There are number of ways by which viruses can spread from host to host and some viruses use a combination of more than one mode for their transmission increasing their chances of infecting a large number and variety of organisms. Each mode of viral transmission carries its own advantages and disadvantages from viral spread and survival point of view. There are many simple and effective ways to prevent viral spread. The issue is to educate people about the importance of these preventive measures and also make these preventive tools available to everyone especially to people who are at greatest risk of acquiring these viral diseases by overcoming financial and other structural barriers.

It is important to continuously observe the circulating viruses as many viruses are genetically variable and therefore capable of producing new variants. The early detection of new variants will enable us to implement improved viral detection systems and design appropriate preventive strategies to stop viral transmission to devise new treatment strategies to treat vial infections and develop vaccines. Hence continuous research is required. Safe preventive practices should be reinforced among radiography students to reduce infection rates among patients.

REFERENCES

1. Kimura M., Jia Z., Nakayama N., and Asakawa S., "Ecology of viruses in soils: Past, present and future perspectives", Soil Science & Plant Nutrition, 2008, 54, 1-32.
2. Alcami A., and Koszinowski U., "Viral mechanisms of immune evasion", Immunology Today, 2000, 21, 447-455
3. Bourne J., "The Management and Control of Hospital Acquired Infection in Acute NHS Trusts in England", National Audit Office, 2000.
4. Oxford Concise Colour Medical Dictionary. 3rd ed. Oxford: Oxford University Press; 2003.
5. Carter J., and Saunders V., Virology Principles and Applications. Chichester: John Wiley & Sons Ltd; 2007.
6. White D., and Fenner F., Medical Virology. San Diego: Academic Press Inc; 1994.
7. German advisory committee Blood (Arbeitskries Blut), Sub group 'Assessment of Pathogens Transmissible by Blood'., "Human Immunodeficiency virus (HIV)", Transfusion Medicine and Hemotherapy, 2016, 43, 203-222.
8. Dean M., Carrington M., Winkler C., Huttley G., Smith M., Allikmets R., et al., "Genetic restriction of HIV-1 infection and progression to AIDS by a deletion allele of the CKR5 structural gene", Science, 1996, 273, 1856–1862.
9. Feng Y., Broder C., Kennedy P., and Berger E., "HIV-1 entry cofactor: functional cDNA cloning of a seven transmembrane, G protein-coupled receptor", Science, 1996, 272, 872–877
10. Kwong P., Wyatt R., Robinson J., Sweet R., Sodroski J., and Handrikson W., "Structure of an HIV gp120 envelope glycoprotein in complex with CD4 receptor and a neutralizing human antibody", Nature, 1998, 393, 648-659
11. Melikyan G., "Common principles and intermediates of viral protein-mediated fusion: The HIV-1 paradigm", Retrovirology, 2008, 5, 111

12. Stein B., Gowda S., Lifson J., Penhallow R., Bensch K., and Engleman E., "pH-independent HIV entry into CD4-positive T cells via virus envelope fusion to the plasma membrane", Cell,1987, 49: 659–668
13. Archin N., Sung J., Garrido C., Soriano-Sarabia N., and Margolis D., "Eradicating HIV infection: seeking to clear a persistent pathogen", Nat Rev Microbiol, 2014, 12, 750-764
14. Wilen C., Tilton J., and Doms R., "HIV: Cell Binding and Entry", Cold Spring Harb Perspect Med, 2012, 2: a006866.
15. Craigie R., and Bushman F., HIV DNA Integration, Cold Spring Harb Perspect Med 2012, 2: a006890.
16. Zeng M., Southern P., Reilly C., Beilman G., Chipman J., Schacker T., et al., "Lymphoid tissue damage in HIV-1 infection depletes naïve T cells and limits T cell reconstitution after antiretroviral therapy", PLoS Patholog, 2012, 8:e1002437
17. Perelson A., Neumann A., Markowitz M., Leonard J., and Ho D., "HIV-1 dynamics in vivo: virion clearance rate, infected cell life-span, and viral generation time", Science, 1996, 271,1582–1586.
18. Levy J., "Virus–host interactions in HIV pathogenesis: directions for therapy", Adv Dent Res, 2011, 23, 13–18
19. Brankston G., Gitterman L., Hirji Z., Lemieux C., and Gardam M., "Transmission of influenza A in human beings", The Lancet Infectious Disease, 2007, 7, 257-265.
20. Pica F., and Volpi A., "Transmission of Human Herpes virus 8: an update", Current Opinion in Infectious Diseases, 2007, 20,152-6
21. Manavi K., "A review on infection with human immunodeficiency virus Best Practice & Research", Clinical Obstetrics & Gynaecology, 2006, 20, 923-940.
22. American Medical Society for Sports Medicine., "Human immunodeficiency virus (HIV) and other blood-borne pathogens in sports", Available at: https://journals.sagepub.com/doi/abs/10.1177/03635465 9502300424?journalCode=ajsb Accessed 5/5/2020
23. Shao J., Chen J., Shen Y., Wang J., Zhang R., Zheng Y., et al., "Identification of human immunodeficiency virus-1 (HIV-1) transmission from a 29-yearold daughter to her mother in Shanghai, China", Arch Virol, 2013, 158,11–17.
24. Centers for Disease control and prevention., "HIV Surveillance Report, 2018 (Preliminary)", 2019, 30,Available at: www.cdc.gov/hiv/library/reports/hiv-survelliance.htm; Accessed: 05/05/2020
25. Cohen M., "Preventing Sexual Transmission of HIV", Clinical Infectious Diseases, 2007, 45, S287-S292
26. Guertle L., "Virus safety of human blood, plasma, and derived products", Thrombosis Research, 2002, 107, Supplement 1, S39-S45
27. Collier L., and Oxford J., Human Virology. Oxford: Oxford University Press; 2003
28. Aitken C., and Jefferies D., "Nosocomial spread of viral disease", Clinical Microbiology Reviews, 2001, 14, 528–546.
29. Bridges C., Kuehnert M., and Hall C., " Transmission of influenza: implications for control in health care settings", Clinical Infectious Diseases, 2003, 37, 1094-101
30. Hayden F., Gubareva L., Monto A., Klein T., Elliot M., Hammond J., et al., "Zanamivir Family Study Group. Inhaled zanamivir for the prevention of influenza in families Zanamivir Family Study Group", The New England Journal of Medicine, 2000, 343,1282–9.
31. Kaiser L., Henry D., Flack N., Keene O., and Hayden F., " Short-term treatment with zanamivir to prevent influenza: results of a placebo-controlled study", Clinical Infectious Diseases, 2000, 30,587–9.
32. Tellier R., "Review of Aerosol Transmission of Influenza A Virus", Emerging Infectious Diseases, 2006, 12, 1657-62
33. Knight V., "Viruses as agents of airborne contagion", Annals of the New York Academy of Sciences, 1980, 353, 147–56
34. Nicas M., Nazaroff W., and Hubbard A., "Toward understanding the risk of secondary airborne infection: emission of respirable pathogens," Journal of Occupational and Environmental Hygiene, 2005, 2, 143–54
35. Yu IT., Li Y., Wong T., Tam W., Chan A., Lee H., et al., "Evidence of airborne transmission of the severe acute respiratory syndrome virus", N Engl J Med, 2004, 350, 1731-1739
36. Mckinney K., Gong Y., and Lewis T., "Environmental transmission of SARS AT amoy Garden", J Environ Health, 2006, 68, 26-30 quiz 51-22
37. Chen C., Zhao B., Yang X., and Li Y., "Role of two way air flow owing to temperature difference in severe acute respiratory syndrome transmission: revisiting the largest nosocomial severe acute respiratory syndrome outbreak in Hong Kong", J R Soc Interface, 2011, 8, 699-710
38. Bean B., Moore B., Sterner B., Peterson L., Gerding D., and Balfour H., " Survival of influenza viruses on environmental surfaces", The Journal of infectious diseases, 1982, 146, 47–51
39. Mandelbrot L., " Vertical transmission of viral infections", Current Opinion in Obstetrics and Gynecology, 1998, 10, 123-128
40. Department of Health and Social care, UK., "Public Information campaign focuses on Handwashing", 2020, Available at: https://www.gov.uk/government/news/public-information-campaign-focuses-on-handwashing Accessed 05/05/2020.
41. Public health agency of Canada., "Guidance Infection Prevention & control Measures for Health care workers in Acute Care and Long-Term care settings: Seasonal Influenza", 2010. Available at: http://www.phac- aspc.gc.ca/nois-sinp/guide/pdf/ac-sa-eng.pdf Accessed 05/05/2020
42. Hortan R., "Handwashing: the fundamental infection control principle", British Journal of Nursing, 1995, 4, 926-32.
43. Reybrouck G., "Role of hands in the spread of nosocomial infections", The Journal of hospital infection, 1983 4, 103-10
44. Maier., et al., (eds), Coronaviruses: Methods and Protocols, Methods in Molecular Biology In Fehr A., and Perlman S., Coronaviruses: An overview of their Replication and Pathogenesis, Ch 1. New York: Springer Science + Business Media; 2015
45. Lau S., Woo P., Li K., et al "Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats", Proc Natl Acad Sci U S A, 2005,102,14040–14045
46. Li W., Shi Z., Yu M., et al., "Bats are natural reservoirs

of SARS-like coronaviruses", Science, 2005, 310, 676–679
47. Peiris J., Yuen K., Osterhaus A., et al., "The severe acute respiratory syndrome", N Engl J Med, 2003, 349, 2431–2441
48. Guan Y., Zheng B., He Y. et al., "Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China", Science, 2003, 302, 276–278.
49. Disantolo, A. (2020) 'Wet markets horror exposed by Downton Abbey star amid China coronavirus probe [online]'. Express. 26 April. Available at: https://www.express.co.uk/news/uk/1273952/china-news-wet-markets-coronavirus-peter-egan-downton-abbey-covid-19-latest Accessed 05/05/2020.
50. 'Coronavirus: Australia urges G20 action on wildlife wet markets [online]', BBC 23 April. Available at: https://www.bbc.co.uk/news/amp/world-australia-52391783 Accessed 05/05/2020
51. Briggs H.,(2020) 'Coronavirus: WHO developing guidance on wet markets [online]', BBC. Science and Environment. 21 April. Available at: https://www.bbc.co.uk/news/amp/science-environment-52369878 Accessed 05/05/2020
52. Department of Health UK., Immunisation Against Infectious Disease -The Green Book' London. The Stationery Office. 2006. Available at: https://www.gov.uk/government/collections/immunisation-against-infectious-disease-the-green-book Accessed 05/05/2020
53. WHO Immunization Profile - United Kingdom of Great Britain and Northern Ireland (the). (2012) Available at: http://apps.who.int/immunization_monitoring/en/globalsummary/countryprofileresult.cfm Accessed 05/05/2020
54. Fiore A., Shay D., Haber P., Iskander J., Uyeki T., Mootrey G., et al., "Advisory Committee on Immunization Practices (ACIP), Centers for Disease. Prevention and control of influenza. Recommendations of the Advisory Committee on Immunization Practices (ACIP), MMWR. Recommendations and reports, 2007, 56, 1-54. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5606a1.htm Accessed 05/05/2020
55. World Health Organization., "Weekly epidemiological record", 2011, 86, 509-520. Available at: http://who.int/wer/2011/wer8646.pdf Accessed 05/05/2020
56. The U.S. Food and Drug Administration., "FDA Approves expanded use of Gardasil 9 to include individuals 27 through 45 years old", 2018. Available at: https://www.fda.gov/news-events/press-announcements/fda-approves-expanded-use-gardasil-9-include-individuals-27-through-45-years-old Accessed at : 05/05/2020
57. Bronowicki J., Venard V., Botte C., Monhoven N., Gastin I., Chone L., et al., "Patient- to-patient transmission of hepatitis C virus during colonoscopy", The New England Journal of Medicine, 1997, 337, 237-40
58. Chanzy B., Duc-Bin D., Rousset B., Morand P., Morel-Baccard C., Marchetti B., et al., "Effectiveness of a manual disinfection procedure in eliminating hepatitis C virus from experimentally contaminated endoscopes", Gastrointestinal Endoscopy, 1999, 50, 147-51
59. Johnson I., "Hepatitis B outbreak investigation team. An outbreak of hepatitis B associated with EEGs", Canadian Medical Association Journal, 2000, 162, 1127-31
60. Sartor C., Charrel R., de Lamballerie X., Sambuc R., De Micco P., and Boubli L., "Evaluation of a disinfection procedure for hysteroscopes contaminated by hepatitis C virus", Infection Control and Hospital Epidemiology,1999, 20, 434-6
61. Khuroo M., "Viral Hepatitis in international travelers: risks and prevention", International Journal of Antimicrobial Agents, 2003, 21, 143-152.
62. Shapshak P., McCoy C., Shah S., Page J., Rivers J., Weatherby N., et al., "Preliminary laboratory studies of inactivation of HIV-1 in needles and syringes containing infected blood using undiluted bleach", Journal of Acquired Immune Deficiency Syndrome, 1994, 7, 754-9
63. [63] Center for disease Control., "National Respiratory & Enteric virus Surveillance system" Available at: cdc.gov Accessed 05/05/2020
64. Center for Disease control and Prevention., "Transmission: Respiratory Syncytial virus Infection", Available at: https://www.cdc.gov/rsv/about/transmission.html Accessed 05/05/2020
65. Kulkarni H., Smith C., Hirst R., Baker N., Easton A., and O' Callagan., "Airborne transmission of Respiratory Syncytial virus (RSV) Infection" European Respiratory Journal, 2011, 38, 1722
66. Griffiths C., Drews S., & Marchant D., "Respiratory Syncytial Virus: Infection, Detection & New options for prevention and treatment" Clin Microbiol Rev, 2016, 30, 277-319
67. Easl international consensus conference on hepatitis C, Paris 26-27 February 1999. Consensus statement, Journal of Hepatology, 1999, 31, 3-8.
68. Centers for Disease Control and Prevention., "Recommendations for prevention and control of hepatitis C virus infection and HCV-related chronic disease. MMWR. Recommendations and reports", 1998, 47, 1-39. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/00055154.htm Accessed 24/11/2012
69. Pinkerton S., and Abram P., "Effectiveness of condoms in preventing HIV transmission", Social Science & Medicine, 1997, 44, 1303-1312.
70. Manhart L, and Koutsky L., "Do Condoms Prevent Genital HPV Infection, External Genital Warts, or Cervical Neoplasia ? : A Meta-Analysis," Sexually Transmitted Diseases, 2002, 29, 725-735
71. de Walque D., "How does the impact of an HIV/AIDS information campaign vary with educational attainment? Evidence from rural Uganda," Journal of Development Economics, 2007, 84, 686- 714
72. Hogan D., Baltussen R., Hayashi C., Lauer J., Joshua A., and Salomon J., "Achieving the millennium development goals for health Cost effectiveness analysis of strategies to combat HIV/AIDS in developing countries", BMJ, 2005, 331, 1431-1437
73. American Academy of Pediatrics, Committee of Pediatric AIDS and Committee on Adolescence., "Adolescents and human immunodeficiency virus infection: the role of the pediatrician in prevention and intervention", Pediatrics. 2001; 107: 188-190.

74. Cowgill B., Bogart L., Corona R., Ryan G., Schuster M., "Fears about HIV transmission in Families with an HIV-Infected Parent: A qualitative Analysis", Pediatrics, 2008, 122, e950-e958
75. Krauss B., Godfrey C., O'Day J., Freidin E, "Hugging by uncle: the impact of a parent training on childrens' comfort interacting with persons living with HIV", J Pediatr Psychol, 2006, 31, 891-904.
76. Connor E., Sperling R., Gelber R., *et al*,. "Reduction of maternal– infant transmission of human immunodeficiency virus type 1 with zidovudine treatment", The New England Journal of Medicine, 1994, 331, 1173–1180
77. Cooper E., Charurat M., Mofenson L., Hanson I., Pitt J., Diaz C., et al., "Women and Infants' Transmission Study Group. (2002) Combination antiretroviral strategies for the treatment of pregnant HIV-1-infected women and prevention of perinatal HIV-1 transmission", Journal of Acquired Immune Deficiency Syndrome, 2002, 29, 484-494
78. Dorenbaum A., Cunningham C., Gelber R., Culnane M., Mofenson L., Britto P., Rekacewicz C, Newell M, Delfraissy J, Cunningham-Schrader B, Mirochnick M, Sullivan., International PACTG 316 Team., "Two-dose intrapartum/newborn nevirapine and standard antiretroviral therapy to reduce perinatal HIV transmission: a randomized trial", Journal of American Medical Association, 2002, 288, 189-198
79. Leroy V., Karon J., Alioum A., Ekpini E., Meda N., Greenberg A., et al., "Twenty- four month efficacy of a maternal short course zidovudine regimen to prevent mother-to-child transmission of HIV-1in West Africa", AIDS, 2002, 16, 631-641. doi:10.1097/00002030-200203080-00016
80. Petra Study Team., "Efficacy of three short-course regimens of zidovudine and lamivudine in preventing early and late transmission of HIV-1 from mother to child in Tanzania, South Africa, and Uganda (Petra study): a randomised, double-blind, placebo-controlled trial", Lancet, 2002, 359, 1178-1186
81. Thorne C., and Newell M., "HIV", Seminars in Fetal and Neonatal Medicine, 2007, 12, 174-181
82. Health Protection Agency., "Testing Times – HIV and other sexually transmitted infections in the United Kingdom", 2007
83. Gutierrez J., Johns B., Adam T., Bertozzi S., Edejer T., Greener R., et al., "Achieving the WHO/UNAIDS antiretroviral treatment 3 by 5 goal: what will it cost?", Lancet, 2004, 364, 63-4.
84. A report of a meeting organized by Viral Hepatitis Prevention board and European Liver Patients Association. "The Role and Impact of patient Advocacy groups", 2008
85. Department of Health, London., "Guidelines on Post-Exposure Prophylaxis for Health care workers Occupationally Exposed to HIV", 1997
86. Duff S., Wong C., and May R., "Surgeons' and occupational health departments' awareness of guidelines on post-exposure prophylaxis for staff exposed to HIV: a telephone survey", BMJ, 1999, 319,162-3.
87. Tait A., and Tuttle D., "Prevention of occupational transmission of human immunodeficiency virus and hepatitis B virus among anesthesiologists: a survey of anesthesiology practice", Anesth Analg,1994, 79, 623-8
88. Diprose P., Deakin C., and Smedley J., "Ignorance of post-exposure prophylaxis guidelines following HIV needlestick injury may increase the risk of seroconversion", British Journal of Anaesthesia, 2000, 84, 767-70
89. Jeffries D., "HIV and Hepatitis -some way to go", Anaesthesia, 1992, 47, 921-2
90. Centers for Disease control., "Hepatitis A information" Available at: https://www.cdc.gov/hepatitis/hav/index.htm Accessed 05/05/2020.

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