Transmission of Infectious Diseases through Mouth-to-Mouth Ventilation: Evidence-Based or Emotion-Based Medicine?

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Cardiopulmonary arrest is the interruption of the heart's mechanical activity confirmed by unconsciousness, apnea, and absence of central pulse [1]. The basic technical knowledge for management of this medical emergency by way of cardiopulmonary resuscitation (CPR) should be part of the training curriculum for health care workers and is highly recommended for the general public. However, concern about the transmission of diseases appears to have created substantial barriers for the use of CPR, both in and out of the hospital setting. The idea that the intention of saving a person's life could result in the death of the rescuer is intimidating and reduces peoples' desire and availability to help cardiopulmonary arrest victims [2-5]. The outcome of reduced use of CPR is reflected in the increase in the morbidity and mortality of the event [6-8]. Studies carried out by Brenner report that about 50% of physicians would refuse to carry out mouth-to-mouth ventilation in strangers and 7-14% would not perform mouth-to-mouth ventilation on victims with AIDS [9-11]. Another study reports that, although 68% of the interviewees would perform chest compressions on an unknown victim of cardiopulmonary arrest, only 15% would perform mouth-to-mouth ventilation [12]. A number of other papers report similar findings [13-17]. In the great majority of cases, the reason for the reluctance to immediately start CPR is the fear of catching transmissible diseases, especially HIV [12,18].

The objective of this article is to review the literature on infectious diseases transmitted through mouth-to-mouth ventilation. The search for available scientific evidence for pre- and post-exposure prophylaxis has been made through searching the *Medline* database of articles published between 1990-1999. In addition to this, all the articles published between 1966-1999 in journals indexed to *Index Medicus* with the key word *mouth to mouth ventilation* or *mouth-to-mouth ventilation*, and *cardiopulmonary resuscitation* were reviewed. Conclusions were also based on a personal collection of articles, posters and relevant notes collected over the last few years.

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Risk of contracting infectious diseases during mouth-to-mouth ventilation – Virtually any disease transmissible by secretions or blood may be acquired during basic CPR. Adding this knowledge to the natural fear caused by mouth-to-mouth contact with other people, mouth-to-mouth ventilation is becoming the object of numerous concerns relative to the safety of the rescuer performing the CPR. In spite of the number of potentially transmissible diseases, only reports of isolated incidents have been published. Since the first medical use of mouth-to-mouth ventilation in 1744 [19], only the transmission of tuberculosis, *Neisseria meningitidis*, *Herpes simplex*, *Helicobacter pylori*, *Shigella sonnei* and *Salmonella infantis* have been documented. No case of hepatitis or HIV transmission has been described over these 254 years, but due to their emotional impact, they will also be discussed here.

Risk of tuberculosis transmission - Tuberculosis is caused almost exclusively by *Mycobacterium tuberculosis* and is transmited from person to person via the respiratory route. Transmission is most likely to occur from infected persons who are not on effective antituberculosis therapy, or from those under adequate treatment for less than 2-3 weeks with no clinical signs of improvement [20]. Infectious particles may be expelled during sneezing, coughing, speaking [21], and expiratory phase of mouth-to-mouth ventilation. Extra pulmonary tuberculosis with open abscesses may also be a rare source of infection [22]. *Mycobacterium* present in fomites are quickly destroyed by heat and sunlight and do not constitute source of infection [20].

Less than 1% of infected persons manifest acute clinical disease. In 5-10% disease only appears after months, years or decades. The remaining 90-95% never develop tuberculosis [22].

The test of choice for the diagnosis of contaminating tuberculosis in the resuscitated victim is the search for acid-fast bacilli on smear of sputum carried out on two consecutive days. The tuberculin skin test (PPD) is the preferred method to identify rescuers infected with *M. tuberculosis* [22]. PPD is not affected or contraindicated during pregnancy [23]. Two to eight weeks are necessary for the tuberculin test to become positive after contamination [24].

Chemoprophylaxis is indicated after mouth-to-mouth ventilation in victims with positive sputum smears or under antituberculosis therapy for less than 2 weeks (table I) [25]. In

Table I - Chemoprophylaxis of tuberculosis after mouth-to-mouth ventilation in positive sputum smear patients or in treatment for less than 2 weeks

Rescuer at the time of exposure	Medication	Daily dosage	Duration
PPD negative	Isoniazid	10mg/kg till 400mg	2-6 months *
PPD positive	Isoniazid	10mg/kg till 400mg	12 months

* See text to differentiate the duration of prophylaxis.

rescuers PPD negative at the time of exposure, induration ≥5mm two to eight weeks after the mouth-to-mouth ventilation is considered a positive test and indicative of contamination during resuscitation [26]. In such cases prophylaxis should be extended for six months. If PPD remains negative after two months of exposure, prophylaxis may be suspended. Chemoprophylaxis in initially PPD positive rescuers should be extended for 12 months [27]. Rescuers previously vaccinated should follow the same regimen described in table I, and the PPD is considered positive if ≥10mm [28,29]. Chemoprophylaxis is not contraindicated during pregnancy. Isoniazid can prevent tuberculosis in 54-88% of cases [30].

The utilization of BCG for postexposure prophylaxis is inferior to the algorithm of PPD plus chemoprophylaxis [31]. Some authors advocate routine vaccination of health care workers, especially in places where the tuberculin test is not used systematically and adherence to the treatment is not adequate [32] . International guidelines do not support the use of BCG in health care workers to prevent tuberculosis infection because of (1) unclear effectiveness and (2) adequate protection provided by PPD plus chemoprophylaxis [33]. In previously vaccinated rescuers, no benefit occurs with revaccination after mouth-to-mouth ventilation [34]. The benefits of BCG in persons with positive tuberculin tests are minimum [35]. Vaccination is not indicated for pregnant women or immunocompromised host [33].

Only one case of tuberculosis transmited during mouth-to-mouth ventilation has been described. It involves a victim of cardiopulmonary arrest with pulmonary tuberculosis that caused primary skin tuberculosis on the left nasolabial fold of the rescuer. No postexposure chemoprophylaxis was administered. Treatment with isoniazid caused remission of the disease and did not leave sequelae in the rescuer [36].

Risk of *Herpes simplex* transmission - About 60% of adolescents [37] and 85% of adults have serological evidence of infection by *Herpes simplex* type I (HSV-1), which is frequently acquired during infancy by contact of herpetic lesions with mucosa or lesioned skin. In addition to this, between 2-10% of adults have HSV-1 in the saliva without clinical signs of disease [38,39]. Transmission via CPR training mannequim is also possible, as the HSV is capable of surviving for 88 hours in dry gauze and for 1.5 hours on a toilet seat [40].

The rescuer infected during the mouth-to-mouth ventilation may remain asymptomatic during the acute phase in 99% of cases. In the remaining, after an incubation period of 3-4 days, gingival stomatitis, fever, or oral vesiculae may appear.

The diagnosis of infection by HSV-1 is essentially clinical and there are no studies to recommend postexposure chemoprophylaxis to prevent HSV transmition. Available therapy only reduce symptoms, especially if initiated in the prodromic phase [41]. Seronegative rescuers or those without history of labial herpes that have been exposed to herpetic lesions during mouth-to-mouth ventilation may use acyclovir soon after contact [42].

Two cases of HSV-1 transmission during mouth-to-mouth ventilation have been described. In both, herpetic lesions were visible in the victim being resuscitated. Both rescuers fully recovered with no sequelae [43,44]. One case of a probable transmission of asymptomatic herpes during CPR training using a mannequim has also been documented and simultaneously published in two journals [45,46].

Risk of *Helicobacter pylori* transmission - Prevalence of infection by *H. pylori* in Brazil is approximately 90% in individuals with digestive symptoms [47] and 60% in asymptomatic blood donors [48-49]. Available data suggest that transmission of the microorganism is by personal contact, but no consensus exists as to whether the oral/fecal or oral/oral route predominates [50-52]. *Helicobacter* has already been isolated in dental plaque, saliva, gastric juice, and stools [53-54].

The majority of the persons acutely infected do not have clinical signs of disease [53]. After an unknown period of latency, a minority develop epigastric pain, nausea, vomiting, hematemesis, and transient hypochlorhydria [55-56]. Most infected persons develop chronic gastritis after contamination [57]. Ten to 20% develop a peptic ulcer during their lifetime and a minority evolve toward either gastric cancer [58-62], primary lymphoma of the stomach, or both [63-65].

The best method for diagnosis is obtaining material through endoscopy for histological analysis and culture. Other noninvasive diagnostic methods are the urea test and detection of antibodies in the serum [66].

No studies are available on the prophylaxis of *H. pylori* transmission after mouth-to-mouth ventilation of contaminated persons, and its utilization should be restricted to experimental protocols. The value of testing for the diagnosis of *H. pylori* infection on the rescuer has not been fully established, but a theoretic benefit does exist eradicating the microorganism in peptic ulcer disease.

Only one case of *H. pylori* transmission during mouth-to-mouth ventilation has been described, which involves the rescue of a victim of respiratory arrest [67].

Risk of *Shigella* transmission – Shigellosis is a bacterial disease caused by ingestion of *Shigella* species.

Asymptomatic carriers are common, which makes the transmission by mouth-to-mouth ventilation possible even in the absence of symptoms.

After one to eight days of incubation dysentery may occur in the acutely infected rescuer, which is generally self–limited to 1-2 weeks even without treatment. Rarely the contamination can evolve with colonic perforation, bacteremia, or other extraintestinal complications [68].

The recommended diagnostic method is coproculture, wich become positive 24 hours after the beginning of the symptoms.

No studies about *Shigella* infection prophylaxis after contact with contaminated persons are available, and such usage should be restricted to experimental protocols.

Only one case of *Shigella* transmission during mouth-to-mouth ventilation has been reported [69]. The physician infected with *Shigella sonnei* recovered soon after the treatment.

Risk of *Salmonella* transmission – Salmonellosis is an infection caused by ingestion of *Salmonella* species bacteria. The nontyphoid form is responsible for 98% of cases, and its transmission is possible in the absence of symptoms.

The most common clinical presentation of acute infection is self-limited gastroenteritis (from two to seven days), which appears after an incubation period of 6-72 hours [70].

The recommended diagnostic method is coproculture.

No studies exist about *Salmonella* transmission or prophylaxis after contact with contaminated material, and its use should be restricted to experimental protocols.

One case of *Salmonella infants 6,7:r* transmited during mouth-to-mouth ventilation that apparently resulted in self-limited gastrointeritis has been reported [71].

Risk of *Neisseria meningitidis* infection- *Neisseria meningitidis* is a commensal organism of the nasopharynx that can cause a wide range of diseases, being meningitis its most common clinical form. Transmittion occurs principally through airbone droplets or close contact.

The colonization of the upper airway tract by menigococci can result in clinical disease after an incubation period from 2-10 days, causing headache, fever, nausea, vomiting, photophobia, and meningismus. In most cases, however, the colonization is asymptomatic and can persist for months. About 2% to 30% of persons are asymptomatic carriers in the nonepidemic setting. If we consider a kiss similar to mouth-to-mouth ventilation, about 33% of rescuers can be colonized by the pathogenic meningococci while performing basic CPR in patients with menigococcal disease [72]. Adults may be immune to *N. meningitidis* due to previous contact with nonpathogenic bacteria that induce cross-reactive antibodies [73].

The diagnosis of meningitis in the resuscitated victim is made by specific laboratory findings. All cases of menigococcal disease in Brazil have to be reported to the authorities in the first 24 hours after their diagnosis [74].

Prophylaxis should be given to the rescuer after mouth-to-mouth ventilation in persons with meningococcal disease. Rifampin is the drug of choice, but ceftriaxone and ciprofloxacin can also reduce the colonization of the pharynx in 90% (table II). Ceftriaxone is the drug of choice in pregnat rescuers. Antimicrobial chemoprophylaxis should be started as soon as possible within 24 hours after the contact.

During epidemics, vaccination of rescuers is also indicated. The quadrivalent vaccine prevents the transmission of serogroups A, C, Y and W-135 when administered as a single 0.5mL subcutaneous injection. The serogroups A and C vaccines have efficacies of 85-100% [77-79]. Vaccination with serogroups Y and W-135 induces bactericidal antibody, but clinical protection has not been documented. Protective levels of antibody are reached from 7 to 10 days following vaccination and last 3 years in adults. Vaccination offers little aditional protection to chemoprophylaxis, but can be used as an adjuvant. The vaccination schedule should not be modified in pregnant women. The protective efficacy and immunogenicity of several vaccines against serogroup B range from 57 to 83% [80-82]. The only one commercially available vaccine against serogroup B has not been used in the majority of countries because conclusive studies are lacking [83].

At least four cases of meningococcal transmission have followed mouth-to-mouth ventilation [84].

Theoretic risk of hepatitis B transmission - The B virus (HBV) is mainly found in blood, but also can be isolated in saliva, tears, digestive juices, semen, vaginal secretions, bile and fomites [85-89], being potentially transmissible during mouth-to-mouth ventilation. HBsAg was found in saliva of 76% of patients with severe hepatitis and in 81% of chronic carriers [90]. However, as saliva has a viral load 1000 to 10000 times lower than plasma, the transmission of HBV by contact of contaminated saliva with the oral cavity, even after the induction of microlesions in receptor mucosa, is still a controversial subject [91-94].

Contact of contaminated blood with the rescuer's oral cavity, open skin lesion, or cornea can result in the transmission of HBV. Percutaneous exposure to blood is the most efficient route of transmission. The risk of HBV contamination is 30% after exposure to HBeAg-positive blood, and 6% after contact with HBeAg-negative blood [94-96]. Although the degree of infectivity is best correlated with HBeAg-positivity, any person positive for HBsAg is potentially infectious. HBsAg can be identified in serum 30 to 60 days after exposure. The incubation period is 45-160 days. Symptoms are generally insidious, and can follow

Table II - Prophylaxis after mouth-to-mouth ventilation in endemic cases of meningococcal disease

Drug	Age	Dosage	Duration and route
Rifampin	Adults	600mg bid	2 days PO
Ciprofloxacin	Adults	500mg	single dose PO
Ceftriaxone	Adults	250mg	single dose IM

three directions: 1) a self-limited course, with destruction of the virus and permanent immunity, which happens in 90 – 95% of cases; 2) chronic infection, which happens in 5-10% of cases and 3) fulminating hepatitis, which happens in less than 1% of cases. Chronic carriers can be identified by persistently positive HBsAg levels. In these individuals a 20% risk of dying of cirrhosis and a 6% lifetime risk of dying of liver cancer exists. The tendency toward chronicity is inversely related to age [97].

If the rescuer is anti-HBs or anti-HBc positive, no risk of acquiring hepatitis B exists after mouth-to-mouth ventilation. Anti-HBc identifies all persons previously infected, both carriers and those who are not carriers. Anti-HBs identifies previously infected persons, except for carries. None of these markers show particular advantages for groups expected to have carrier rates of less than 2%, such as health care workers [98]. The utilization of these tests in rescuers after mouth-to-mouth ventilation should not delay the institution of chemoprophylaxis. Postexposure prophylaxis is indicated after mouth-to-mouth contact with HBsAg positive persons (table III) [33]. The cleansing of the exposed skin site with sodium hypochloride followed by soap and water is recommended [116].

The most efficient measure for preventing HBV infection before occupational exposure is the use of vaccine. The two currently available forms (plasma derived or recombinant) have demonstrated similar immunogenecity and efficacy, and do not interfere with other vaccines concurrently being administered [99]. The vaccine derived from plasma can cause Guillain - Barre syndrome after the first dosage. The magnitude of this association is 1:200,000 vaccinees.

The usual schedule of vaccination comprises three intramuscular doses, with second and third doses given 1 and 6 months, respectively, after the first. Every single dose consists in administrating 20mg in the deltoid muscle [100]. Between 90–100% of persons develop protective levels of antibodies after three doses [101-108], which provides absolute protection against chronic infection or clinical disease for 7-10 years [109-110]. Anti-HBs testing should be done 1-6 months after completion of the vaccine series to provide information on response to the vaccine. Persons who do not respond to the primary vaccine series should complete a second three-dose vaccine series or repeat vaccination until adequate antibody response is obtained [111,112]. The immunogenecity of vaccine is substantially lower if administrated in the butttock [113]. Vaccine series should be initiated within 7 days after exposure of an unvaccined rescuer even if the source of exposure is HBsAg-negative. An alternative schedule of 0, 1, 2 and 12 month have been approved more rapid induction of immunity. No clear evidence exists that this alternative regimen offers greater protection than the standart schedule. Vaccination of individuals previously infected by HBV does not cause significant side effect but is not necessary [114].

The utilization of a specific immunoglobulin for hepatitis B (HBIG) plus vaccine provides protective levels of antibodies for a prolonged period of time. Therefore, HBIG should be given in a dose of 5 ml or 0.06ml/kg as postexposure prophylaxis, even though a study has demonstrated that this regimen is not superior to the use of HBV vaccine alone after exposure to HBsAg-positive blood [115]. The effectiveness of HBIG when administered after 7 days from exposure is unclear. HBIG and vaccine can be administered at the same time but at a different anatomic site, and is not contraindicated in pregnant or postpartum women. A second dose of HBIG should be administrated one month after the first dose if vaccine series are not provided after exposure [33].

No case of HBV transmition during mouth-to-mouth ventilation has been described. During the CPR training with a mannequim also no case of transmission has been reported, not even when the mannequim was not cleaned between use by different people [117]. Grouping all studies that describe accidental contamination of CPR training mannequim by the saliva of asymptomatic carriers, 55 individuals are reported to have been exposed to HBV, but none of these became infected after six months [117-119].

Theoretic risk of hepatitis C transmission - The hepatitis C virus (HCV) is transmitted primarily through blood-to-blood contact. Other forms of contamination are less impor-

Table III - Chemoprophylaxis of hepatitis B after mouth-to-mouth (including ocular exposure to blood)

	Rescuer not vaccinated	Rescuer vaccinated		
		Immune *	Not immune *	Unknown
Source HbsAg positive	One dose of HBIG and begin vaccination	Tranquilization	A dose of HBIG and re-vaccination or 2 doses of HBIG	Test anti-HBs in the rescuer: 1) If adequate tranquilize; 2) If inadequate, 1 dose of HBIG and vaccine
Source HBsAg negative	Begin immunization	Tranquilization	Tranquilization	Tranquilization
Source Unknown	Begin immunization	Tranquilization	If high risk source, treat as HBsAg positive	Test anti-HBs in the rescuer: 1) If adequate tranquilize; 2) If inadequate, begin re-immunization

* Consider immune if anti-HBs ≥ 10mIU/mL.

tant during mouth-to-mouth ventilation, even though 62% of chronic carriers may have HVC-positive saliva [120-122]. Sneezes, cough or fomites do not transmit HCV [123].

The average incubation period of HCV after blood-to-blood contact is from 7 to 10 weeks. The majority of infected individuals are asymptomatic (60-70%), have jaundice (20-30%) or have nonespecific symptoms, such as anorexia and weakness (10-20%). Chronic carriers are also common and contamination is possible in the absence of clinical illness. At least 85% of the chronically infected have a recurrence of the disease, 60% remain with persistently elevated liver enzimes [124], 20% develop cirrhosis [125] and less than 1% develop primary hepatocellular cancer. Factors that negatively influence the progression of HCV infection include alcohol use, age over 40 years, and male gender [126].

Three conditions potentiate the risk of HCV transmission during mouth-to-mouth ventilation: 1) an anti-HCV-positive victim; 2) blood present in the victim's mouth and 3) blood-to-blood contact. Knowing each one of these risk factors makes it possible to estimate the chance of contamination. The prevalence of anti-HCV in the urban population of a Brazilian city is 1.25% [127]. Blood visible in the saliva or vomit is present in 7% of all resuscitations [128]. Microlesions in the oral mucosa can be present in up to 50% of rescuers, making blood-to-blood contact possible [129]. The average risk of seroconversion after blood-to-blood contact is 1.8% (0 to 7%) [124,130-132]. Mitsui et al reported a seroconversion rate of 10% based on detection of HCV RNA by *polymerase chain reaction* (PCR) [133].

A risk calculation of seroconversion due to mouth-to-mouth ventilation is about 1:125,000 (1.25x 7x 50x 1.8). In the absence of microlesions in rescuers' oral-mucosa, the risk of contamination through mucosa-blood contact cannot be estimated, because only two cases describing this route of contamination are reported [134-135]. Follow-up studies have not documented transmission associated with nonintact skin or mucous membrane exposures.

Anti-HCV can be detected in 80% of rescuers within 15 days of exposure, in 90% within 5 months, and in 97% within 6 months [138,139]. Approximately 10% of infections will not be detected unless PCR is used to detect HCV RNA [97-136]. The only tests currently approved by the U.S. *Food and Drug Administration* for the diagnosis of HCV infection are those that measure anti-HCV, such as the *enzyme immunoassay* (EIA) and *recombinant immunoblot assay* (RIBA). The sensitivity of these tests is greater than 97%, but do not distinguish between patients with acute, chronic, or resolved infection. EIA is considered a standart screening test. Aditional testing with a more specific assay, such as RIBA or detection of HCV RNA, reduce the risk of false-positive results in persons who are EIA positive [123].

HCV infection can be diagnosed by detecting either anti-HCV or HCV RNA. Anti-HCV is recommended for routine use in asymptomatic persons, and should include use of both EIA and confirmatory testing with an aditional, more specific assay. Persons who are either EIA anti-HCV negative or EIA anti-HCV positive with negative supplemental test are considered uninfected, unless other evidence exists to indicate HCV infection (eg., abnormal ALT level with no other etiology). Indeterminate supplemental test results have been observed in persons chronically or recently infected. Confirmation or exclusion of HCV infection in these cases should be made on basis of repeating the anti-HCV in 2 months or testing for HCV-RNA and ALT level [137].

For rescuers exposed to anti-HCV-positive material, by blood-to-blood or mucosa-to-blood contact, EIA anti-HCV and ALT tests should be performed at the time of exposure and at six months [136]. The HCV RNA can be performed 4-6 weeks after exposure if an early diagnosis is required. The algorithm for detecting asymptomatic infection after contact with anti-HCV-positive blood is found in figure 1 [137]. Experimental data suggest that HCV infection does not offer immunity against re-infection [140,141].

No vaccine is available to prevent hepatitis C. Animal data are confliting about using immune globulin (IG) in HCV prophylaxis. Some studies show protection [142-144] while other do not [145]. IG is not recommended for postexposure prophylaxis in humans because adequate evidence are lacking [136].

There is no data to support postexposure use of interferon to prevent HCV infetion [136,146-148], though there may be a role for early interferon therapy. At least six health care workers acutely infected received early interferon therapy and cleared HCV [149,150]. Determination of wheter treatment of HCV infection is more benefical in the acute phase than in the early chronic phase will require aditional studies.

In the absence of pre- and postexposure prophylaxis, specific recommendations for the prevention of HCV transmission, and effective therapy for most persons with chronic hepatitis C, the overall public health benefit associated with the identification of HCV infection in rescuers will be limited. On an individual level, medical and legal issues may be important. Anti–HCV-positive rescuers should refrain from donating blood, organs, tissues and semen, and should not share shaving blades and toothbrushes.

No case of contamination by HCV after mouth-to-mouth ventilation has been described. Transmission of HCV using CPR mannequim have not been reported even though 23 persons have been accidentally exposed to contaminated saliva during training [151] .

Theoretic risk of HIV transmission - Mouth-to-mouth ventilation can result in saliva exchange between the victim and the rescuer. This exchange is not implicated in the transmission of HIV, not even when contaminated saliva comes into contact with open wounds [152-155]. Although saliva, sweat and tears do not transmit HIV, blood surely does. Other bodily fluids are also implicated in HIV transmission, but as the contact with these fluids is unlikely during mouth-to-mouth ventilation they will not be discussed here.

The theoretic risk of HIV transmission can be estimated in a similar way as the British population is estimated [156].

Conceptually, three conditions potentially transmit HIV: 1) an HIV-positive victim; 2) visible blood in the victim's oral cavity and 3) blood-to-blood contact. The prevalence of HIV in the adult Brazilian population (between 15 and 49 years old) is 0.6% [157]; in children (<15 years old) and elderly people (>49 years old) it is 0.1% [157,158]. Blood visible in the saliva or vomit is present in 7% of all resuscitations [128]. Microlesions in the oral mucosa can be present in 50% of healthy rescuers, making blood-to-blood contact possible [129]. The average risk of seroconversion after percutaneous exposure to HIV-infected blood is 0.3% [159,160].

A risk calculation of seroconversion through mouth-to-mouth ventilation can be estimated as: (a) 1:1,580,000 in the rescue of an adult in the general population (0.6x7 x 50x0.3); (b) 1:9,500,000 in the rescue of a child or an older person in the general population (0.1x7 x 50x0.3); (c) 1:9,500 in the rescue of a known HIV-positive victim (100x7 x 50x0.3); (d) 1:650 in the rescue of a known HIV-positive victim with visible blood in the oral cavity (100x100 x 50x0.3).

In the absence of microlesions in the oral mucosa of the rescuer, the theoretic risk of transmission is 1:4,600,000 in an adult rescue and 1:28,000,000 in a child rescue, as the rate of seroconversion after mucosa-blood contact can be estimated in 0.1% [161]. In spite of individual reports of HIV transmission by skin-blood contact [162], the risk of seroconversion can not be quantified because this type of contamination has not been reported in prospective studies. Considering that survival rates of atempted CPR outside the hospital setting are 12% [163], one HIV-infected rescuer will develop for every 500,000 adults successfully resuscitated. This risk is greater in deep cut, large quantity of contaminated blood, prolonged exposure to HIV and terminal AIDS victim [154,164]. The utility of viral load measurements from a source victim for assessing transmition risk is unknown. Plasma viral load measurement reflects only the level of cell-free virus in the peripheral blood. This measurement does not reflect cell-associated virus in the peripheral blood or the level of virus in other compartiments.

The above estimates may appear empty if not compared with other situations. The risk of death by anaphylactic shock after penicillin use, for example, is 1:50,000. In addition, no case of HIV transmission through mouth-to-mouth ventilation has been documented while it has been reported that two persons have probably been infected through kissing [165,166].

The very low frequency with which HIV has been transmitted by the oral route is impressive. This is probably due to the risk of infection may depend on the size of innoculum, which is frequently very small by oral-to-oral route. The findings of inhibitory substances in saliva may further reduce the risk of infection and cannot be considered in our numerical estimatives. Complete inactivation of HIV by saliva may require 30 minutes of exposure [167], which makes the role of these substances unclear.

About 95% of health care workers who seroconvert do so within 6 months after exposure. The consensual recommendation is to perform HIV-antibody testing right after the exposure, at 6 weeks, 12 weeks, and 6 months. If the HIV serostatus of the source patient is unknown consent should be obtained and the person tested for serological evidence of HIV infection.

Wounds and skin sites that have been in contact with body fluids should be washed with soap and water [164]; mucous membranes should be flushed with water or sterile solution [164,169,170]. There is no evidence to support the use of antiseptics, caustic agents or desinfectants as a postexposure prophylaxis. Squeezing the site of contact will not reduce the risk of HIV transmission.

Animal data demonstrated the importance of starting chemoprophylaxis as son as possible [171,172], and even its

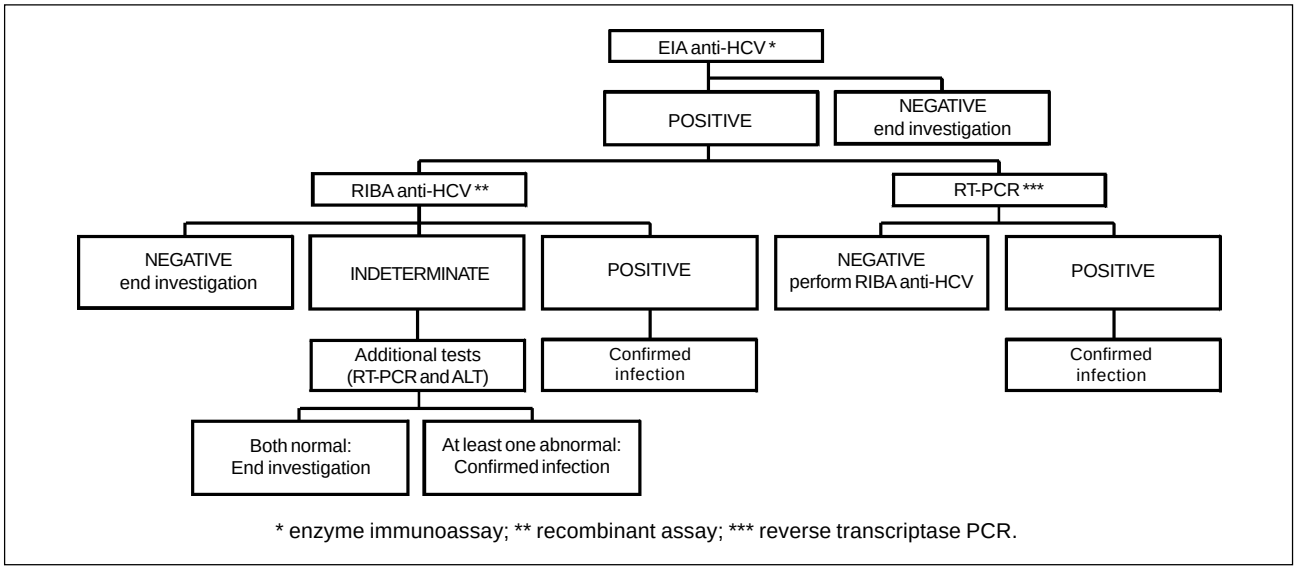


Fig. 1 - HCV infection testing algorithm for asymptomatic persons, to be performed right after exposure and at 6 months.

ineffectiveness when started later than 24-36h postexposure [173-175]. The regimen indicated for use after contact with HIV-positive blood during mouth-to-mouth ventilation is in fig 2. If the victim is HIV-negative and does not have clinical evidence of AIDS or symptoms of HIV infection, the investigation can be terminated. The follow-up of HIV-negative source at the time of CPR, but who engaged within the last 6 months in behaviours that pose a risk of infection is of unproven benefit.

There is insufficient evidence to recomend a highly effective regimen for all exposures, and two are povided: a "basic" that should be used in most cases, and an "expanded" that should be reserved for exposures that pose an increased risk of transmission (table IV) [164].

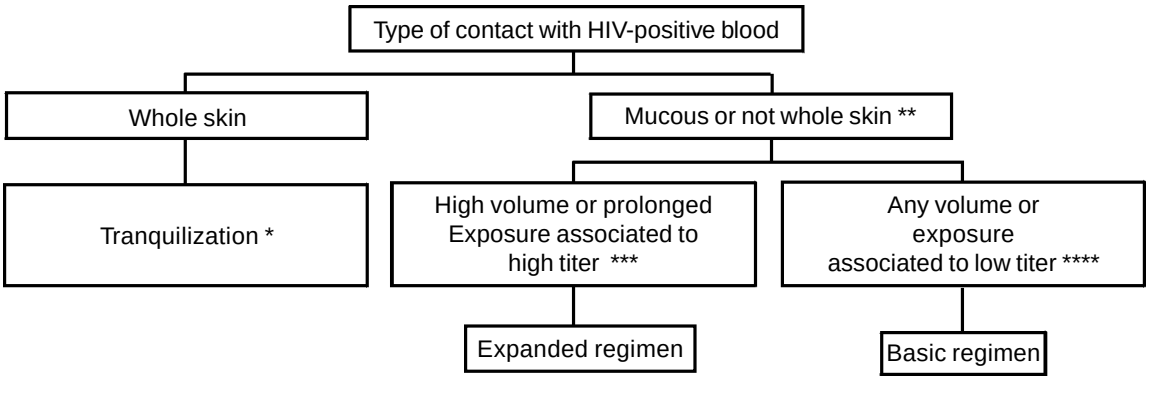
From all antiviral agents, only zidovudine (ZDV), has been shown to prevent HIV transmission in humans [176,177], reducing the risk of infection by 81% [178]. No data address wheter adding other drugs provides additional benefit. However, combination therapy have proved superior to monotherapy in reducing HIV titers in infected patients [179,180]. Based on theoretical grounds, a combination of drugs with activity at different stages in viral cycle could offer an additive effect in chemoprophylaxis, particularly for high risk exposures. ZDV is not contraindicated during pregnancy [181-183]. The long-term safety of lamivudine (3TC) is not known in pregnant women [184,185]. No studies have been conducted to determine the effects of the protease inhibitors (IDV) during pregnancy.

An important consideration is that ZDV at doses of 1000 – 1200mg per day cause side effects that result in 30% to discontinue drug. Common symptoms include nausea, vomiting, and headache. All side effects reverse when ZDV is discontinued [186-188]. Multiple drug regimen also cause 30% to discontinue chemotherapy [189-192]. Side effects can be managed reducing dosage, treating symptoms, or discontinuing drug [164].

Discussion

The importance of ventilation during cardiopulmonary resuscitation has been accepted over the centuries. The prophet Elisha may have performed the first mouth-to-mouth ventilation as described in the Bible [192]. The first medical report of successful CPR was the rescue of a miner in 1744 [19]. From that time on, several forms of assisted ventilation have been tested until the midtwentieth century when Safar et al. demonstrated that mouth-to-mouth ventilation was superior to the manual methods used until that time [193-195]. Based on these studies, mouth-to-mouth ventilation has become the therapy of choice for out-of-hospital respiratory arrest by 1960s.

In more recent years, concerns about the transmission of diseases have created significant barriers for the use of mouth-to-mouth ventilation either inside or outside of the hospital setting, decreasing the willingness of persons to help victims of cardiopulmonary arrest. These facts have brought into question the real necessity for this type of ventilation, in view of the fact that 10 out of 16 cases of transmission of diseases during CPR occurred during mouth-to-mouth. As a justification for such questioning, two additional sources of oxygen for the victim of cardiopulmonary arrest have been cited: *gasping* and compression-induced ventilation. Animal data show that adequate ventilation can be achieved by chest compression alone, suggesting that mouth-to-mouth may not be critical during CPR. However, the thoraxes of pigs and dogs are more compliant than the human thorax, and the result of these studies should be interpreted with caution. Studies in humans do not report adequate fluxes in the airway during chest compression [195,196]. In addition, sternal thoracic compression provokes progressive pulmonary disinsulfflation and increases hypoxemia in the absence of *gasping* or mouth-to-mouth ventilation in prolonged CPR. Active compression/decompression generates adequate ventila-



* Consider basic regimen if the circunstance suggests a higher volume exposure and prolonged contact; **Include dermatitis, abrasion, open scar, or fissures; *** Examples: terminal AIDS, primary HIV infection, high or increasing viral load, or low CD4 count; **** Examples: asymptomatic patient, and high CD4 count.

Fig. 2 - Choice of chemoprophylaxis for the transmission of HIV after mouth-to-mouth.

Table IV - Basic and expanded postexposure prophylaxis regimens after exposure to HIV during mouth-to-mouth ventilation.

Regimen category	Medication
Basic	4 weeks of **zidovudine** 600mg per day (300mg bid or 200mg tid or 100mg every 4 hours) plus **lamivudine** 150mg bid
Expanded	Basic regimen plus **indinavir** 800mg tid* or **nelfinavir** 750mg tid**

*__Indinavir__ should be taken on an empty stomach and with increased fluid intake; ** **Nelfinavir** should be taken during meals.

tion in the absence of intubation or mouth-to-mouth ventilation[197], but new studies are necessary to evaluate the clinical applicability of these findings.

In spite of these physiological considerations, the major impact is the mortality of cardiopulmonary arrest victims who receive only thoracic compressions, compared with victims who receive compression plus mouth-to-mouth. In this regard, numerous are the articles with animal models, but rare are the studies in humans. In an observational study, long term survival of those treated with chest compression plus mouth-to-mouth ventilation and those treated with chest compression alone was comparable (16% and 15%, respectively) [198,199]. Notwithstanding the praiseworthy initiative of the authors, the study does not have a definitive design, and it is subjected to criticism. While awaiting new studies in humans, the use of mouth-to-mouth ventilation remains a standart part in the management of cardiopulmonary arrest.

Transmission of infectious diseases during CPR are generally focused on the rescuer, but the victim's risk deserves consideration too. Only one report was found describing this type of contamination, which involved HSV transmission during ventilation through an endotracheal tube [200]. Rescuers that carry potentially contagious diseases should not perform mouth-to-mouth, if mechanical ventilation devises or other trained persons are available. Otherwise, the benefits from CPR overcomes the theoretic risk of disease transmission from the rescuer to the victim, and vice-versa [201]. The utilization of gloves and protective glasses reduces contact with contaminating material, and their use should be part of routine emergency management. The utilization of barrier methods does not provide full protection as is evidenced by the transmission of *Streptococcus pyogenes* to a fireman in 1991 during ventilation using a bag-valve-mask apparatus [202].

In summary, the person who witnesses a cardiopulmonary arrest should to be guided by ethics and morality in the rescue. The fact that the rescuer does not wish to perform mouth-to-mouth ventilation when blood is visible does not remove the responsibility to call for help, open the airway [205], and perform chest compression. Provision of sternal compressions without mouth-to-mouth ventilation is far better than not perform resuscitation at all [198] . In the event that the rescuer decides to follow international guidelines and carry out mouth-to-mouth ventilation [1,203,204], it is necessary to accompany the victim after initiation of advanced life support to check out the presence of contagious diseases that require postexposure prophylaxis. Drug prophylaxis should be precociously started, and the exposure to contaminated blood or saliva during mouth-to-mouth should be treated as a medical emergency. An overall view of the diseases transmited during mouth-to-mouth ventilation is provided in table V.

The approach to risk of transmission of diseases involves several key issues before and after exposure. A careful preexposure plan should include teaching of basic CPR, knowledgement of the actual risks of infection, preexposure prophylaxis, and utilization of universal precautions to avoid contact with infected material. The postexposure care should include diagnostic tests, prophylaxis, follow-up, and counseling for helping the rescuer to deal with the tremendous anxiety associated with the risk of transmission of infectious diseases. A complete understanding comprising all of these measures should result in an

Table V - Overall view of diseases transmited during mouth-to-mouth ventilation

Cause	Latency	Symptoms	Preexposure prophylaxis	Postexposure prophylaxis
Mycobacterium tuberculosis	variable	Variable. Majority asymptomatic	BCG not proved	isoniazid
Herpes simplex	3-4 days	Gingival stomatitis and fever. Asymptomatic in 99%	unknown	acyclovir to decrease symptoms
Helicobacter pilory	unknown	Nausea, vomiting, epigastric pain and hematemesis. Majority asymptomatic	unknown	unknown
Shigella sonnei	1-8 days	Self-limited dysentery	unknown	unknown
Salmonella infantis 6,7:r	6-72 hours	Self-limited dysentery	unknown	unknown
Neisseria meningitidis	2-10 days	Headache, fever, and meningismus. Majority asymptomatic	vaccine during outbreaks	rifampin

increased willingness of laypersons and physicians to perform mouth-to-mouth ventilation on victims of cardiac arrest and, eventually, in a higher rate of successful resuscitations.

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