A Protocol of Guidance for Sterilization and Infection Control in Dental Settings

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Contents of the Protocol:

Preface

Infection control is considered the first phase issue in dentistry and other health fields. So, to develop a device or any medication, it has to pass different phases of studies to evaluate that device or medication from different views. Safety evaluation of these technologies starts first in phase I followed by evaluation of the efficacy of these technologies in Phase II studies. The final phase for evaluation of efficiency is phase III to get approval for market use. In dentistry, focus on infection control is a number one priority before setting any treatment scenarios. To assess a student for his work, a mark ranging from zero to ten may be given. This however is not so in the case of infection control assessment where either a zero or ten is given because there are many major issues connected in the form of a chain and any break in these connections will jeopardize infection control of work conducted, and this will leave us, patients and community under inevitable risk. Emphasis on this pivotal topic was the direction of the Dean of College in our institute, Dr Rayan Salim Hamed and for preparing organized lectures in infection control to our dental students. This was followed by negotiations with the dean to prepare a protocol based on evidence based practice in dentistry and medicine which is the source of education and training for our students and others who work in dental and other health fields. This protocol can be considered as a major lane for organization and control in a smooth flow that will be parallel with treatments delivered. In 23rd February 2020, the College of Dentistry founded the higher committee for sterilization and infection control to hold responsibility of infection control duties in the dental teaching hospital. The protocol was completed following two months writing starting at the 10th of February 2020.This work will be updated annually or in need particularly after the recent challenges with the pandemic disease Covid19. The photo on the right shows the two major arms of dentistry and the second photo at the bottom explains the function of street lanes in facilitating flow of the cars where we can match this with the function of the protocols in organizing and protection of our daily work.

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Chapter 1: Introduction

Infection control in dental settings is necessary to prevent transmission of infections to dental care staff, patients and public. This protocol provides the rules for sterilization and infection control at the University College Dental Hospital, College of Dentistry/ University of Mosul / Iraq. The writing of this protocol based on published international guidelines and articles particularly the one published by the centers for disease control and prevention (CDC) and the protocol for infection control in dental service which published by the Hong Kong department of health in 2019. The writing of the current protocol focused on the international standards and the simplicity in formatting the contents of this work taking in our mind the applicability of this work in our department at University of Mosul. The current protocol focused on basic principles for infection control in dentistry and how to control on cross of contamination in this field. Also it discussed how to deal with disposals in this field. This protocol will consider as a guidance to our college dental hospital which will be updated annually in coincide with the future amendments and developments in this field and also it will consider as an educational and training program for individuals who study and work in dental services. Multidisciplinary team for infection control in dental practice is necessary to discuss the plans of working in a scientific way. This team is consist from professional academic and clinical dentists in different specialties, qualified dental assistants, microbiologists and Engineers of dental units.

Chapter 2: Basic principles of infection control

2.1 General recommendation

All guidelines for different subjects to control the occupational hazards should be well written and studied inform of protocols under supervision of specialized committees. Updating the information of these protocols should be achieved annually in coincide with recent development. Health service workers should be well educated and trained about these guidelines and policies. Compliance of knowledge of trained workers should be assessed to ensure sufficient protections for staff, patients and public.

2.2 Education and training

Preparing lectures for infection control based on audience (Dental professionals including dental students 4th and 5th grade, Dental Hygienists, Dental assistants, Dental technicians, Dental service cleaners). These lectures and training programs should be educated and assessed annually.

It is very important to follow the competency of trained people in different ways as reported in well-designed published articles. A committee of multidisciplinary team is necessary to assess efficiency and compliance of the work. .

2.3 Immunization (Vaccination)

Dental health workers are in direct contact with infectious diagnosed or undiagnosed / symptomatic or asymptomatic diseases for this reason their immunization is necessary in preventing transmission of diseases. This should be organized with health services to provide their vaccination programs to medical institutes. The vaccines required for dental health professionals are Hepatitis B, Measles, Mumps, Rubella, Varicella, Influenza, Diphtheria, Pertussis, Tetanus, Tuberculosis and Polio. All records about vaccination should be reported in a specific log book and also Individuals who will refuse taking the vaccines their information should be updated in a separated log book. All dental professionals, dental assistants and dental technicians should be registered with Dental Health organizations or/and Dental Colleges or/and Iraq Dental Association. Vaccination certificate should be submitted with other documents for their registration and license approval.

2.4 Exposure prevention and post-exposure management

2.4.1 Disease transmission (Figure 1)

General routes of disease transmission in dental fields:

A. Transmission by direct contact through infected lesions, infected body fluids (blood and saliva, etc.), including incidental injuries like needle stick injuries which is very common between dental workers (which could consider risk for hepatitis B and HIV and other blood born microbes). Also spread of blood and saliva into exposed wounds and unprotected eyes could be a cause of this type of serious diseases. MRSA methicillin resistant staphylococcus aureus can be transferred by air and direct contact through intact skin and mucosa. It is depend on the duration of contact so it is not consider a problematic in dental practice compared with people who admit in hospitals for long period however this microbe is possible to grow in dental office if the surface is not sufficiently cleaned and disinfected. MRSA nasal swabs is a method for diagnosis of this type of microbes and it is consider one of the requirements for arrangement to hospital admission in most of the developed countries.

B. Transmission by Indirect contact via contaminated dental instrument, equipments and materials.

C. Transmission by dental unit waterlines and aerosols

Dental unit water could be considered as a source for infection for both dental health professionals and patients if these units are not well cleaned and disinfected. A proper microbiological monitoring of these pipelines is very important to control on risk of infections.

Aerosols are small liquid droplets (or solid particles) which float in air. These floating objects carry microorganisms and float in the air dental clinics through normal activities such as talking, coughing and sneezing and also it spread by using dental instruments which generated by air where theses can cause certain diseases such as influenza and

tuberculosis for this reason vaccines and use protective measures can prevent the transmission of these diseases.

It is worrying that the published studies showed that the knowledge of the dental health care professionals about the transmission of the disease, cross infection and how to prevent them is insufficient. This should be kept in mind for planning to educational programs of dental health care professionals in all their levels.

Rout of transmission	Viruses	Bacteria
1- Transmission via direct contact.	Herpes simplex virus type 1 and 2, Norovirus, Corona virus and Coxsackie-virus	Staphylococcus aureus Escherichia coli
2- Transmission via blood-blood contact (direct and/or indirect contact).	Hepatitis viruses (HBV, HCV, HDV) and Human immunodeficiency virus (HIV)	Neisseria gonorrhoeae Treponema palladium
3- Transmission via water of dental units and aerosols.	Cytomegalovirus Measles virus Mumps virus Respiratory viruses (influenza, coronavirus, rhinovirus, adenovirus) Rubella virus	Streptococcus pyogenes Mycobacterium tuberculosis Legionella pneumophilia Pseudomonas aeruginosa

Figure 1: Microorganisms detected dental fields which spread where they sorted by their routes of transmission. (Soet J and Volgenant, 2018)

2.4.2 Cross infection

Awareness and necessary precautions play a major duty in preventing the existing of cross infection. Dental teams should work in professionality to close the chance on spread of diseases. To avoid the cross of infection there should be monitoring and control on certain variables such as dental care individuals, patients, dental office environment and equipment's. There is a possibility of contact in two directions between all these objects which can raise the risk of cross infection if these situations are not handled in a proper way.

2.5 Medical Conditions, Work-Related Illness, and Work Restrictions

A clear policy should be available for dental health workers regarding to their risk, prevention of getting the disease, treating of the disease and follow up of the person in a professional and a confidential way under supervision of specialists in the field.

2.6 Records Maintenance, Data Management, and Confidentiality

Patients and departmental medical records should be kept in paper and electronic forms. Confidentiality about these records should be considered and should be very restricted.

Chapter 3: Sterilization and infection control in dentistry

3.1 Medical history

Always obtain a thorough medical history. Include specific questions about medications, current and past illnesses. Medical consultation or specific precautions might be considered when history of an active infection of a disease is elicited. Archived recodes is consider very useful in controlling of disease transmission from patient to patient or from patient to dental staff.

3.2 Hand hygiene

Hands consider a pad for microbial growth particularly for those who work in health fields for this reason frequent washing and drying of the hands or applying of alcohol gel is

required after each use or touch to reduce the risk of infection. Compliance and accuracy of hands washing in dental service is not within the required standard. Long nails should be trimmed and no artificial nails be used. Jewelries and rings should be removed but a plain wedding ring can be kept. Short sleeves is recommended. Cuts, wounds and other skin damages should be covered by dressing to protect the body against bacterial invasion.

For routine dental procedure hand washing with liquid soap is adequate. Also an alcohol based hand rub is adequate for its rapid action and accessibility. Tip of the fingers, nails, palms of the hands and between fingers should be well washed. This procedure should repeated after each dental treatment for at least 20 seconds. Proper drying of the hands after washing and before wearing of the gloves is recommended as humidity under gloves can help in growth of microorganism. For surgical procedure, 4% Chlorhexidine and 3% parachlorometaxylenol (PCMX) are antiseptics recommended for surgical hand antisepsis. Both chlorhexidine gluconate 4% and PCMX 3% have similar bactericidal efficacy. Skin allergy can be developed from frequent use of Chlorhexidine gluconate so in this case iodophors can be used as an alternative. Surgical procedure scrubbing is recommended for at least 2-6 minutes with proper detergents and the hands should be washed until elbow.

A study was conducted to assess used bar soaps from 18 different dental clinics. The results showed microbial load of the "in-use" bar soap constituted a mixed flora of gram positive, gram negative, aerobes, anaerobes, and fungi. The researchers concluded that bar soaps under "in-use" condition is consider as a reservoir of microorganisms and handwashing with such a soap may lead to spread of infection.

3.3 Personal protective equipments (PPE)

3.3.1 Gloving

Wearing protective gloves is mandatory for all staff who are in contact with patients, dental environments and equipments. Different types of gloves are available based on

their use and their materials. Non latex / powder free gloves is indicated for people with contact dermatitis to these materials. A proper handling of sterile gloves during their wearing is required to keep their sterilization.

Different types of gloves are available: Non-sterile clean gloves for routine operative dental procedure and even dental extraction, the sterile type of gloves which should be used in open surgery procedures. There is no difference in use of the sterile and nonsterile gloves regarding the infection and healing of the socket of the extracted tooth. Don't touch any unsterilized object if you are wearing sterile gloves and closing of hands or crossing of arms (if you wearing a sterile gown) is recommended. Utility gloves use for handling of instruments during cleaning and disinfection procedures.

3.3.2 Face masks

Face masks in medical use is applied to protect nasal and mouth inlets from iterance of any foreign object and sometimes eye plastic shields are connected to them for eye protections. Face masks are clean but not sterilized for this reason avoid touch of the mask with sterile gloves when a septic procedure required. The mask should be changed following each patient and should be changed when the material gets wet or damaged. A proper securing and adapting of mask peripheries is required to achieve a proper filtration and flow of clean hygienic air through mask materials without improper flow of air from edges of the mask.

Aerosols are invisible droplets (10 µm in diameter or less) float in the air while splatters are visible droplets (100 µm in diameter or more) float in the air particularly in areas when dealing with certain procedures such as in dental clinics. These particles carrying microorganisms which could jeopardize the health system for the staff and patients. A proper ventilation and disinfection of clinics is the key to control on these droplets.

Two basic types of facemasks are mainly in use in dental services. The first one is the surgical face masks which is indicated for routine and surgical dental procedures while the second type is a special type called N95 face mask (respirators) which is indicated when a

high secured filtration (up to 1 micron filtration) is required when treating or dealing with patients carrying certain infectious respiratory diseases such tuberculosis and sever acute respiratory syndrome (SARS). There is another type of face masks which is a paper based and this type of facial masks are not recommended to be used in dental / surgical practice. A certified personal respirator (e.g. N 95) can be more effective than high-quality surgical masks in dental settings.

3.3.3 Dental goggles

Dental clinics can be considered as a source of eye injuries if scientific precautions have not been applied. A protective eyewear (dental goggles and dental face shields) should be used in dental practice to avoid injuries, Dentists, dental assistants and patients should be protected from unexpected trauma. The risk of eye injury in dentistry is mostly related to the risk of high speed handpieces and ultrasonic devices. Porter et al investigated the occupational injuries which investigated in dental hospitals over 9 years. The authors found that eye injuries constituted about 10% of the incidents. In 1991 the use of dental googles became compulsory in United States to avoid the risk of blood borne pathogens in addition to other occupational hazards which could risk the eyes safety.

Mechanical, microbial, chemical and electromagnetic are the possible occupational hazards for eye injuries in dental field. Mechanical injuries associated with contamination is the major problem in mechanical injuries with hard particles during unprotected dental procedures with these foreign particles such as tooth corpuscles, calculus, bone derbies, parts of metal, amalgam particles and other hard objects. Microbial injuries occur due to exposure to contaminated objects such as aerosols, calculus, plaque, saliva, blood, tissue residues and others which could result in bacterial and viral infections such as bacterial conjunctivitis, bacterial keratitis, viral conjunctivitis, hepatitis B, hepatitis C and HIV infection. Herpes simples wounds around the mouth should be covered before starting the dental procedure and patient face should protected with facial shields. Precautions should also be taken to avoid injuries with chemicals and electromagnetic radiations such as invisible infrared which can be used for treatment with laser. Aiming beam should be

tested before using this type of lasers under cover of specific goggles to avoid unexpected injuries to eyes and other body organs if the aiming beam on the targeted spot is not coincide with the invisible infrared radiation.

3.3.4 Protective clothing

In 2006, UK NHS banned the use of white coats in medical settings that go below the elbow due to the increased risk of cross patient infection based published clinical evidences.

Uniforms, white coats (half sleeve is recommended) and disposable gowns can be considered the best protective clothing to protect dental staff from infections. Disposable gowns should be used to protect clothing, surgical scrubs and skin during patient care and sterilization procedures to prevent contamination with blood and other body fluids. These protective disposable gowns should be well secured cuffed long sleeve, closed neckline and should be removed before leaving work places.

All the reused clothes should not be taken outside the health care buildings and should be washed/sterilized inside these places.

3.3.5 Footwear

Dental practitioner and clinical support staff should wear enclosed footwear that protects them from injury or contact with sharp objects such as accidentally dropped sharps and chemicals. Footwear should have the features to be cleaned easily.

3.4 Respiratory Hygiene

All dental health care staff should follow certain rules when they get certain cough, nasal congestion, sneezing and other respiratory tract infection symptoms. People with respiratory infections should cover their mouth and nose during coughing and sneezing with tissue papers and discard them in lidded trash bins after use. They should wash their hands with antimicrobial detergents. Hands should be dried and cleaned with alcohol

based sanitizer. Those people should cover their nose and mouth with surgical masks to prevent transmission of infection. In mild and sever causes with certain condition discontinuity and taking break from work is recommended. Currently in 2020 pandemic infection of respiratory tract with Corona virus is in progress and gets very risky. Take this point in our future and early diagnosis of any flue like infection is mandatory to prevent spread of infection from / to patients.

3.5 Patient triage (Priorities in treatment)

Certain precautions should be taken when facing respiratory tract infections in endemic or pandemic level such as incase of tuberculosis and viral infection with Corona virus. Early identification and isolation of the case is required by professional staff. In dentistry, the treatment should focus to the public in this area for emergency only to relief pain until the control on the disease announced by the health organizations in the area. Protective face masks with efficient filters N95 respirator is useful for protection. Prevent symptomatic patients to get their treatments and refer them to specialized medical hospitals to receive their medical and dental treatments in these areas under supervision of professionals in these fields and to prevent cross of infection. Other etiquettes should be applied as mentioned above for respiratory hygiene.

3.6 Surface asepsis

It is a set of procedures that involve aseptic isolation to avoid cross infection and cleaning of the dirty site with disinfectants or use of isolation surfaces. Surface asepsis involves two basic steps:

1- Limit contamination by scientific zoning of dental care units, use aseptic techniques during dental procedures, use of certain disposable barriers and others.
2- Disinfection of the contaminated surface. Using of barriers reduce the need for this procedure.

3.6.1 Limit of contamination

3.6.1.1 Zoning

Basically the dental unites divided into treatment (working) zone, dirty zone and clean zone. The treatment or working zone is where you treat the patients then transfer the used instruments to the dirty zone for washing and disinfection followed by packing them and finally transfer the packed instruments to the clean zone for sterilization and store them. It is a unidirectional flow which means that instruments and others can't pass from the dirty zone to the clean zone without cleaning and disinfection while it is possible to return the instruments from the clean zone to the dirty zone when there is a suspicious or not enough cleaning to these items. Personal protective equipments (PPE) should be used in a separation at each zone. It is better to prepare the packing and sealing of instruments in a separated zone away from washing and disinfection which is also consider as a dirty zone. Handling of instruments for using should be provided from the clean zone. Foods and drinks should be kept away from these zones. The design of a typical zoning is as follow in Figure 2:

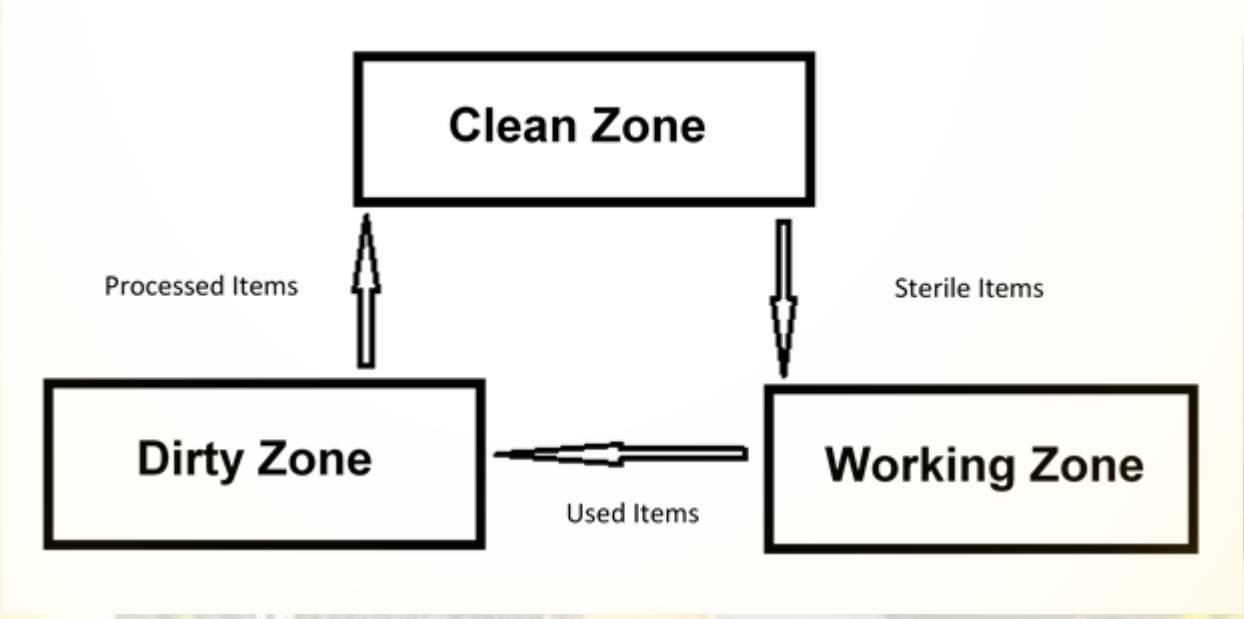

Figure 2: Zoning of Dental Care Units to avoid Cross Contamination, A Unidirectional Flow of Instruments. (Cheung, Law and Yeung, 2019)

3.6.1.2 Use of barriers

Using of disposable plastic barriers is very efficient to control on cross contamination and cross infection with least cleaning by disinfectants after use. Different sizes of disposable dental barriers are available based on their use such as the one for covering dental chair handles, head and back support of dental chair, handles of the dental light, saliva ejectors, 3 in 1 dental syringe (triple syringe), dental trays, the cone of x-ray machine and x-ray films, door handles and others.

Over gloving plastic examination gloves can be used as barriers when need to achieve certain duties to avoid cross contaminations.

3.6.1.3 Control on aerosols and splatters

Preoperative rinse with mouthwash (chlorhexidine 0.2%) is very useful to reduce the number of microorganism in oral cavity which can spread in air during dental procedure particularly during using of high speed handpieces and scalers. Using saliva ejectors and suction devices is very helpful to control on spread of these microorganisms. Also using rubber dam in dental procedure is very helpful to prevent contamination, cross infection and other possible injuries.

3.6.1.4 Treatment planning

An efficient work plan for dental treatments is necessary to reduce the zones crossing which reduces the chance of cross contamination. Applying more than one treatment in one visit is better than many schedules for efficient therapy without harry and efficient sterilization without the risk of cross contamination and infection.

3.6.2 Surface disinfection

Follow the manufactural instructions for the correct use of cleaning and other hospitals registered disinfectants. Don't use high level disinfectants for disinfection of the environmental surfaces (clinical contact surfaces or housekeeping surfaces). Clinical

surfaces include bench tops, drawer surfaces and dental units which have high risk of disease transmission while housekeeping surfaces include floor, wall and sink which have limited risk of disease transmission. Use PPE is necessary when cleaning and disinfecting environmental surfaces.

3.6.2.1 Clinical contact surfaces

Use surface barriers to protect clinical contact surfaces particularly for those are difficult to clean and change them after each patient. Use double gloving when it is required. Clean and disinfect clinical contact surfaces that are not protected by surface barriers. Use low level (HIV and HBV label claim) or intermediate disinfectants (tuberculocidal claim). Use the intermediate disinfectant when you want to disinfect a blood spot or spots on environmental surfaces. Low level and intermediate level disinfectants are those registered with the US environmental protection agency (EPA) as hospital disinfectants with tuberculocidal activity. Intermediate level disinfectants are such as phenolics, iodophors and chlorine containing compounds. Low disinfectants are such as alcohol and quaternary ammonium compounds.

3.6.2.2 Housekeeping surfaces

Clean housekeeping surfaces (e.g. floors, walls and sinks) with detergent and water or with a registered hospital disinfectant / detergent on routine basis. Use intermediate level disinfectant when you want to clean blood on these surfaces.

Surface disinfection is a two steps procedure: the first one is the surface should be cleaned first referred as a pre-cleaning step to remove organic materials for direct contact and effect of disinfectants. The second step is the application of the disinfectant to take its germicidal action for 10 minutes as recommended by the manufactural instructions followed by wiping the area with a clean gauze or paper towels to remove its residues.

Sodium hypochlorite can be used as an intermediate level disinfectants with concentration 5-6 % with dilution 1:10 and need to be applied for 10 minutes then the

area should be wiped or washed with water to remove its remaining ingredients. Main side effects are it is consider as carcinogenic, it cause metal corrosion and also it bleaches other materials on daily use.

Alcohol is not consider as an intermediate level disinfectant because it vaporize very quickly so it doesn't have enough time of contact with surfaces to kill certain microorganism such as incase of tuberculosis. It considers as an intermediate disinfectant if the dirty items immersed for 10 minutes inside a container with alcohol with a locked lid.

3.7 Dental radiographs

Precautions should be taken during taking dental radiographs to avoid cross infection due to the possibility of contamination with saliva and/or blood. All machine parts (Cone and film cassette) which susceptible to infection should be covered with surface barriers. Radiographic films should be also covered with this transparent disposable barriers to reach into a clean procedure. The exposed film should be dropped on a clean surface and the used gloves should be changed (or over gloving) to take the film for processing (development).

3.8 Disinfection of impressions, prostheses and appliances

There should be communication between dental care units and lab technicians regarding the procedure of disinfection for impression, prosthesis and others to avoid the cross of infection or duplication of the procedure. Type of disinfectant and time of exposure should be applied and reported according to the manufactural instructions to achieve an efficient disinfection with dimensional stability of the materials.

Impression, prosthesis and appliances with non-metallic structures should be washed first with water then immerse it in a container with sodium hypochlorite 1:10 for 10 minutes or dip then keep them in a closed container for 10 minutes followed by rinsing them with

water then dryness. Alcohol might cause dryness for some of impression material after use which could effect on their physical properties.

Ceramic and metal prosthesis disinfection starts first by rinsing them with water followed by immersing them in 70% alcohol for 10 minutes which will act as an intermediate level disinfectant then finally rinse the prosthesis with water then dryness. Sodium hypochlorite might damage the color and the metal of these prosthesis.

All these disinfected impressions and prosthesis should be kept in a locked containers and referred to the laboratories. Equipments inside the labs should be well disinfected and/or sterilized. Also the prepared prosthesis should be disinfected before insert them inside patient mouth as mentioned in the above reported procedures with sodium hypochlorite or alcohol.

3.9 Instrument sterilization and disinfection

Dental / Surgical instruments and clinical items are classified into three main categories based on their use in relation to tissue contacts and penetrations:

1- Critical items

These items penetrate the tissues during their use and get in contact with blood and other body fluids. Examples for these items are surgical instruments and scalers. The possibility to get infection from these instruments is very high for this reason instruments cleaning, disinfection, rinsing, dryness, packing and sterilization in a suitable autoclave is necessary.

2- Semi-critical items

These instruments are get in contact with mucosa but it doesn't penetrate soft tissues or get in contact with bone. Infection transmission from these instruments is intermediate but dealings with them follows the same protocol as applied for the critical items. Examples of these instruments are dental mirrors and other hand instruments in use in operative dentistry which are in contact with mucosa. Note, matrix bands are nor sterilizable and should be disposed after use.

3- Non-critical items

These type of instruments are get in contact with intact skin only. The possibility for infection transmission is very low. Wiping of these items with intermediate level disinfectant is recommended. Surface barriers can reduce the need for cleaning of these items after use.

3.9.1 Sterilization room

Personal protection equipments, PPE (sterile disposable gloves, examination disposable gloves, utility thick washable gloves, disposable gown, waterproof apron, safety glasses, face masks and scrub caps should be always available in sterilization rooms to avoid cross contamination and cross infection. The following sections are required achieve a proper sterilization and to avoid cross contamination.

- Collection, cleaning and disinfection area
- Filling pouches and sealing area
- Sterilization area
- Storage and distribution area

3.9.2 Sterilization sequence

3.9.2.1 Collection, cleaning and disinfection

Collection of dirty instruments should be carried out in dirty zone. Used Instruments should be cleaned in dirty zone as soon as possible to avoid dryness of blood and other materials which can be considered as a layer to protect certain microorganism from efficient disinfection or sterilization. If the cleaning of instruments delayed then soaking of these instrument in disinfectant for few minutes is necessary to dissolve the dried particles and to disinfect the surface of these instruments before transferring them to other steps which are washing them with water, dryness, packing then sterilizing them. Ultrasonic cleaners or washer disinfector is recommended to be used dirty zone for pre-sterilization disinfection to avoid the risk with instrumental injuries during cleaning of sharp instruments. Disinfected instruments should be rinsed under water to remove all

chemicals and other particles from these instruments and they should be checked well to ensure their freeness from residual particles or other stains. Dryness of instruments is necessary before packing. Heavy utility gloves should be used in this procedure to avoid unpredicted injuries with sharp objects. Other PPEs should be worn as we mentioned before for protection.

3.9.2.2 Packing of instruments with sterilization pouches

Packing of instruments should be done in dirty zones. There are either the ready-made or machine cut sterilization pouches which can be used in dental setting with different sizes. Sterilization pouch roles which connected to cutting and sealing machine for packing of the cleaned/dried instruments before dispatching them to autoclave. Date, autoclave number and even the name of the operator should be printed on the pouches for any future recall or checking for these instruments. These pouches should be hold inside the autoclave on their side or flat with their paper side down and the plastic side facing the top.

3.9.2.3 Sterilization with autoclaves

Different types of autoclaves are available depend on their mechanism of actions and use. These are: N class, S class and B class. B class autoclaves is the best and the most efficient type which used for sterilization of different dental and other surgical instruments. Misuse of these machines will jeopardize the sterilization of instruments.

Basically sterilization of instruments can be achieved with dry heat or moist heat. Dry heat can be used with semi-critical and other instruments which are sensitive (get blunt or rusted) to moist heat such as scissors and other sharp instruments. Sterilization by dry heat is achieved with 160C° temperature and exposure time 60 minutes (Total working cycle time 120 minutes). Generally, moist heat is the most effective way among other procedures of sterilization. This technology of sterilization is efficient, reliable and rapid where instruments heated to 121 C° temperature under 15 Ibs pressure for 15 minutes.

Sterilization with dry heat doesn't cover the job for sterilization by moist heat using autoclaves particularly with the current risk of infectious diseases.

The well sterilized pouched critical instruments can be stored up to three months while the semi-critical which are mainly used in operative dentistry can be stored for up to 2 years. For unwrapped operative instruments which kept inside perforated stainless steel trays and stored in a well disinfected locked storage cabinet where these instrument should be re-sterilized at least every three months.

Spore tests using specific spore strips is necessary every week or when there is a suspicious break down in sterilization these tests should be repeated for three times in ideal sterilization cycles. Every test should be reported inside a log book specified for this purpose.

3.9.2.4 Sterilization monitoring

As mentioned before in this protocol the sterilized instrument and the sterilizer should be checked in three ways: physical, chemical and biological tests. The physical test checked by the temperature, pressure and time of the sterilization cycle, the chemical test confirmed by certain indicator inform of strips or cards attached to pouched which change their colours when expose to certain temperature. Spore test with nonpathogenic (nonharmful microorganisms) is the best and the most reliable method to test the efficiency of sterilizers (autoclaves) to ensure killing of all spores which are the most resistant to heat compared with other infectious microorganisms. Sterilization log book is required to record all details of these procedures at least in weekly basis.

3.10 Waterlines and suction asepsis

The source of water to dental units should be tested regularly (twice annually) and when there is certain noticed problems. All the pipelines of the dental units and all the water passing through them should be well tested by microbiologists. Chemical cleaning of these pipelines with 0.2% chlorhexidine was found to be useful in reducing the microbial counts

(bacteria and fungi) in these water supply of these units which pass through handpieces and triple syringes but chlorine based disinfectants results in corrosion of dental unit pipelines so alternative an ideal treatment shock is available currently with A-Dec ICX or Citrisil disinfectants.

Suctions / ejectors should be cleaned immediately after each use suction of the water during using of the suckers is recommended to avoid clotting of the blood. Avoid closing of the mouth during the suction procedure to avoid the negative pressure which return the fluid in the opposite direction to the mouth. Suction of the water at the end of the procedure followed with suction of a disinfectant which match with the materials of the system as mentioned in the manufactural instructions. A disposable suction tips should be used and discarded immediately after use.

In 2003,the centers for disease control and prevention (CDC) published '' Guidelines for infection control in dental health care setting'' and highlighted that oral streptococcus species, human pathogens such as Pseudomonas aeruginosa and Legionella species and non-tuberculosis Mycobacterium species had all been isolated from dental water system. Although many of the bacterial species such as legionella and pseudomonas have been shown to be harmless for the immunocompetent patients but many of these are consider pathogenic for immunocompromised patients and also have resulted in one documented fatality. The American Dental Association (ADA) in 1995 have set a limit for water quality control with <200 colony forming unit (CFU)/ml but this has been amended to be in consistent with the recommendation of the CDC in 2004 to be <500 CFU/ml. Dental handpieces supported with anti-retraction valves, so far all studies have reported contamination despite being provided with these technologies.

The following guidelines should be taken to control on the infection of the water units of the dental chair pipelines:

1- Removal of the biofilms accumulated in the dental unit water lines by chemical treatment (A-Dec ICX or Citrisil disinfectants).

2- Water supplied from these unit in different sources (Mouth wash water, triple syringes water, handpieces (turbines water) should be examined periodically. American public health association and American water works association have all set limits for heterotrophic bacteria of < 500 CFU/ ml of water and this should be applied on our dental work examination in assessing the hyogienisity of dental unit water lines. Don't' forget to check the source of water.

3- If the test approved that there is a significant amount of bacterial colonies in the dental water which might jeopardize the health of the patients particularly immunocompromised patients (diabetics, HIV patients, smokers and drinkers particularly old ages, cancer patients and other people with debilitating diseases) then in this the water unit should be shocked with disinfectants. There are many studies worked on different disinfectant but the most approved antiseptics recently with least side effects on both human and the manufactural supplies of these machines are the use of certain manufactured tablets of disinfectants of A-Dec ICX or Citrisil disinfectants. There is no significant different between the action of the two disinfectants but a significant difference reported when use these tablets compared with non-tablets one.

Although sodium hypochlorite was found to be efficient for infection control in the waterlines of dental units but the hazards from this disinfectant is serious as it consider as a carcinogenic in addition to it is highly corrosive and the taste and smell of this disinfectant are unacceptable.

Hydrogen peroxide agents such as Sterilex Ultra have reported to increase the possibility of blockage and possible exposure to disinfectant residues.

4- Flush the lines for 2 to 3 minutes at the start of each working day.

5- Flush the water lines for 20 to 30 seconds between each patient.

3.11 Vaccination (Immunization)

Read section 2.3 page 2.

3.12 Safe injection practice and sharps handling

Safe administration of local anesthesia in dentistry is required. Incidental injection with contaminated needles in dental practice is a common problem. A proper reflection, palpation of the tissue and recapping of the needle should be achieved using specific instruments or holders. One handed scoop technique can be used also to avoid any unexpected injuries. Burs of handpieces should be removed at the end of the work before separation of the handpiece from the dental unit.

All sharps should disposed in labeled biohazards boxes and these boxes should be disposed when it reached its labeled limit line (70%-80%). All biohazards boxes should be kept locked and dispatched in specific colored double biohazard bags (usually red in color).

3.13 Waste management

Examples of regulated medical or medical wastes in dental-practice settings are solid waste soaked or saturated with blood or saliva (e.g., gauze saturated with blood after surgery), extracted teeth, surgically removed hard and soft tissues, and contaminated sharp items (e.g., needles, scalpel blades, and wires) all sharps must be kept in their locked biohazard boxes. All biohazards boxes of sharps should not be stored longer than three months. All these material should be disposed in double red plastic bags written on them biohazards in Arabic and English. All bags should be tightened in a form of swan neck method of sealing when they reach to their 70-80% of maximum volume.

All trash other than the regulated clinical waste could be disposed as a domestic waste in black plastic bags such as clean used PPE, clean used gauze and other clean used non-sharp disposable items but it is preferable to be kept in yellow bags and be treated as medical wastes.

Suctioned blood, fluids and other liquid waste (chemicals) should be poured carefully into a drain connected to a sanitary sewer system.

3.14 Occupational exposure to infectious materials

Occupational exposure defined as contact of the intact skin, eye, and mucous membrane or parentally with blood or other potentially infectious materials. After occupational injury starts with first aid then referral to hospital. First aid for the skin wound is direct squeezing, washing the area with soap and water then dryness and application of 70% alcohol and dress the wound if necessary. First aid injuries of the mucous membrane is to flush the area with water. Referral of the person should be arranged and a specific referral form for occupational injuries should be available in the department. (Figure 3)

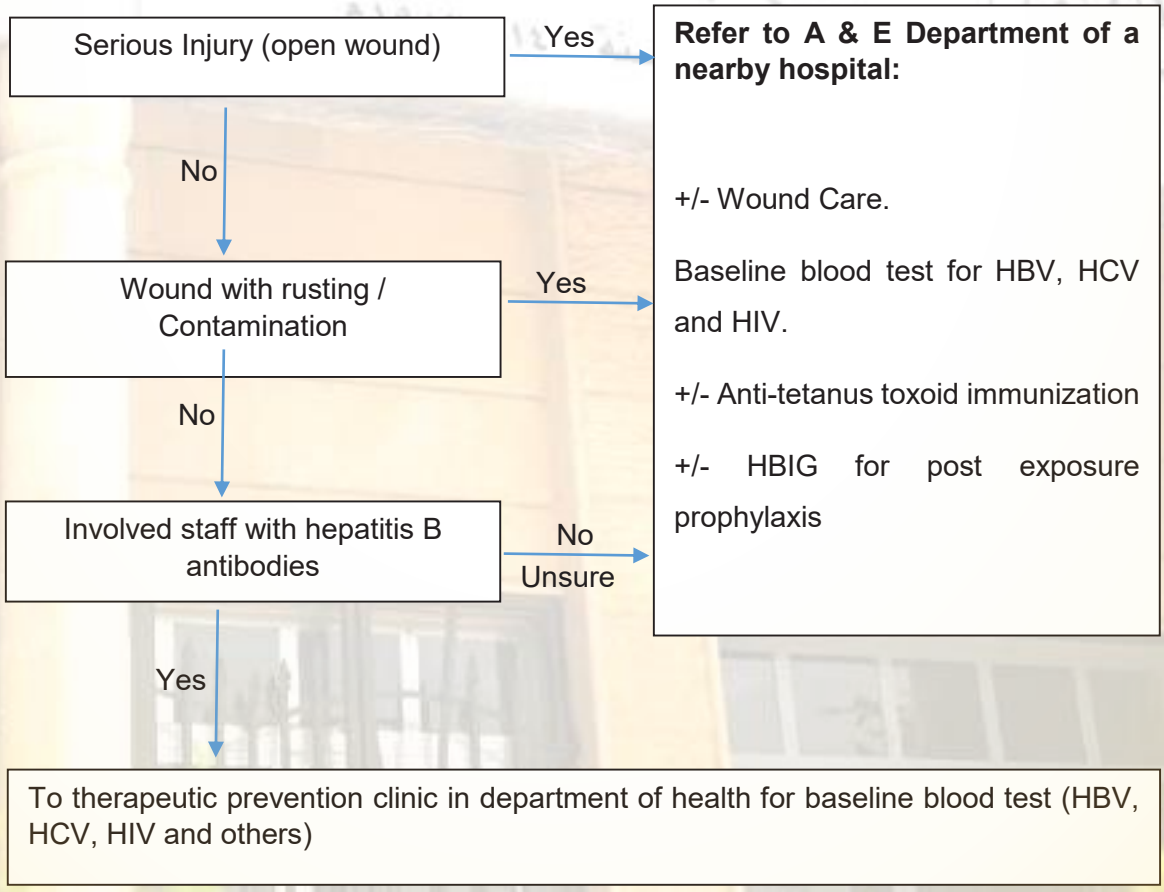

Figure 3: of therapies for staff exposed to dental occupational injuries. (Cheung, Law and Yeung, 2019)

3.15 Handling of linen

Appropriate PPE should be worn during handing of soiled / dirty linen. All used linen should be contained in designated bins or laundry bags. Washing machines with disinfectant detergents should be used inside the dental health care unit to avoid spread of infections to the public.

3.16 Oral Surgical Procedures

Oral surgery procedure should be operated in aseptic condition. Wash your hands for 2-6 minutes with antimicrobial soap (a single use soap bar or detergent) and water follow by dryness then use alcohol based hand scrub with persistent activity until hands get dried. Use sterile surgical gloves and Use sterile saline for irrigation.

3.17 Handling of biopsy

Place biopsy specimens inside a formalin filled container with secured lid written on it biohazard. The surface of the container should be disinfected if contaminated with blood or saliva. The closed container of specimens should be placed in a sealed bag. Gloves should be worn when handling the specimen container. Don't forget to label the container and write patient's details. Details about specimens should be written on a referral letter stamped on the sealed bag. Refrigerator used for specimen storage when this required.

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Appendix

Terminology in infection control

Selected definitions: (Kohn et al, CDC. gov. USA, 2003)

"**Alcohol-based hand rub**: An alcohol-containing preparation designed for reducing the number of viable microorganisms on the hands.

Antimicrobial soap: A detergent containing an antiseptic agent.

Antiseptic: A germicide used on skin or living tissue for the purpose of inhibiting or destroying microorganisms (e.g., alcohols, chlorhexidine and iodine).

Colony-forming unit (CFU): The minimum number (i.e., tens of millions) of separable cells on the surface of or in semisolid agar medium that give rise to a visible colony of progeny. CFUs can consist of pairs, chains, clusters, or as single cells and are often expressed as colony-forming units per milliliter (CFUs/mL).

Decontamination: Use of physical or chemical means to remove, inactivate, or destroy pathogens on a surface or item so that they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal.

Dental treatment water: Nonsterile water used during dental treatment, including irrigation of nonsurgical operative sites and cooling of high-speed rotary and ultrasonic instruments.

Disinfectant: A chemical agent used on inanimate objects (e.g., floors, walls, or sinks) to destroy virtually all recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial endospores). The U.S. Environmental Protection Agency (EPA) groups disinfectants on the basis of whether the product label claims limited, general, or hospital disinfectant capabilities.

Disinfection: Destruction of pathogenic and other kinds of microorganisms by physical or chemical means. Disinfection is less lethal than sterilization, because it destroys the majority of recognized pathogenic microorganisms, but not necessarily all microbial forms (e.g., bacterial spores). Disinfection does not ensure the degree of safety associated with sterilization processes.

Droplet nuclei: Particles ≤5 µm in diameter formed by dehydration of airborne droplets containing microorganisms that can remain suspended in the air for long periods of time.

Droplets: Small particles of moisture (e.g., spatter) generated when a person coughs or sneezes, or when water is converted to a fine mist by an aerator or shower head. These particles, intermediate in size between drops and droplet nuclei, can contain infectious microorganisms and tend to quickly settle from the air such that risk of disease transmission is usually limited to persons in close proximity to the droplet source.

Germicide: An agent that destroys microorganisms, especially pathogenic organisms. Terms with the same suffix (e.g., virucide, fungicide, bactericide, tuberculocide, and sporicide) indicate agents that destroy the specific microorganism identified by the prefix. Germicides can be used to inactivate microorganisms in or on living tissue (i.e., antiseptics) or on environmental surfaces (i.e., disinfectants).

Hand hygiene: General term that applies to handwashing, antiseptic handwash, antiseptic hand rub, or surgical hand antisepsis.

Health-care--associated infection: Any infection associated with a medical or surgical intervention. The term health-care--associated replaces nosocomial, which is limited to adverse infectious outcomes occurring in hospitals.

Hepatitis B immune globulin (HBIG): Product used for prophylaxis against HBV infection. HBIG is prepared from plasma containing high titers of hepatitis B surface antibody (anti-HBs) and provides protection for 3--6 months.

Hepatitis B surface antigen (HBsAg): Serologic marker on the surface of HBV detected in high levels during acute or chronic hepatitis. The body normally produces antibodies to surface antigen as a normal immune response to infection.

Hepatitis B e antigen (HBeAg): Secreted product of the nucleocapsid gene of HBV found in serum during acute and chronic HBV infection. Its presence indicates that the virus is replicating and serves as a marker of increased infectivity.

Hepatitis B surface antibody (anti-HBs): Protective antibody against HBsAg. Presence in the blood can indicate past infection with, and immunity to, HBV, or immune response from hepatitis B vaccine.

High-level disinfection: Disinfection process that inactivates vegetative bacteria, mycobacteria, fungi, and viruses but not necessarily high numbers of bacterial spores. FDA further defines a high-level disinfectant as a sterilant used for a shorter contact time.

Hospital disinfectant: Germicide registered by EPA for use on inanimate objects in hospitals, clinics, dental offices, and other medical-related facilities. Efficacy is demonstrated against Salmonella choleraesuis, Staphylococcus aureus, and Pseudomonas aeruginosa.

Iatrogenic: Induced inadvertently by health care professionals, medical (including dental) treatment, or diagnostic procedures. Used particularly in reference to an infectious disease or other complication of treatment.

Immunization: Process by which a person becomes immune, or protected against a disease. Vaccination is defined as the process of administering a killed or weakened infectious organism or a toxoid; however, vaccination does not always result in immunity.

Intermediate-level disinfection: Disinfection process that inactivates vegetative bacteria, the majority of fungi, mycobacteria, and the majority of viruses (particularly enveloped viruses) but not bacterial spores.

Intermediate-level disinfectant: Liquid chemical germicide registered with EPA as a hospital disinfectant and with a label claim of potency as tuberculocidal.

Latex: Milky white fluid extracted from the rubber tree Hevea brasiliensis that contains the rubber material cis-1, 4 polyisoprene.

Low-level disinfection: Process that inactivates the majority of vegetative bacteria, certain fungi, and certain viruses, but cannot be relied on to inactivate resistant microorganisms (e.g., mycobacteria or bacterial spores).

Low-level disinfectant: Liquid chemical germicide registered with Environmental Protection Agency as a hospital disinfectant. Occupational Safety and Health Administration requires low-level hospital disinfectants also to have a label claim for potency against HIV and HBV if used for disinfecting clinical contact surfaces.

Microfilter: Membrane filter used to trap microorganisms suspended in water. Filters are usually installed on dental unit waterlines as a retrofit device. Microfiltration commonly occurs at a filter pore size of 0.03--10 µm. Sediment filters commonly found in dental unit water regulators have pore sizes of 20--90 µm and do not function as microbiological filters.

Nosocomial: Infection acquired in a hospital as a result of medical care.

Occupational exposure: Reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials (OPIM) that can result from the performance of an employee's duties.

OPIM: Other potentially infectious materials. OPIM is an OSHA term that refers to 1) body fluids including semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures; any body fluid visibly contaminated with blood; and all body fluids in situations where differentiating between body fluids is difficult or impossible; 2) any unfixed tissue or organ (other than

intact skin) from a human (living or dead); and 3) HIV-containing cell or tissue cultures, organ cultures; HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral: Means of piercing mucous membranes or skin barrier through such events as needle sticks, human bites, cuts, and abrasions.

Prion: Protein particle lacking nucleic acid that has been implicated as the cause of certain neurodegenerative diseases (e.g., scrapie, CJD, and bovine spongiform encephalopathy [BSE]).

Retraction: Entry of oral fluids and microorganisms into waterlines through negative water pressure.

Sterile: Free from all living microorganisms; usually described as a probability (e.g., the probability of a surviving microorganism being 1 in 1 million).

Sterilization: Use of a physical or chemical procedure to destroy all microorganisms including substantial numbers of resistant bacterial spores.

Ultrasonic cleaner: Device that removes debris by a process called cavitation, in which waves of acoustic energy are propagated in aqueous solutions to disrupt the bonds that hold particulate matter to surfaces.

Vaccine: Product that induces immunity, therefore protecting the body from the disease. Vaccines are administered through needle injections, by mouth, and by aerosol.

Washer-disinfector: Automatic unit that cleans and thermally disinfects instruments, by using a high-temperature cycle rather than a chemical bath''.