Original Article

Cross-contamination in dentistry: A comprehensive overview

Abstract

Introduction: Cross-contamination and cross-infection can occur by direct contact with micro-organisms, indirect contact with contaminated objects, droplet transmission, and inhalation of airborne pathogens. In dentistry, operatory surfaces can routinely become contaminated with patient saliva, blood, and other fluids during treatment. **Aims and Objectives:** This review is aimed to identify cross-contamination and spread of infection by various means and the appropriate preventive measures to be implemented. This review will also highlight the various aspects that are neglected in various dental schools/dental practice or any dental set up that potentiate cross-contamination ultimately affecting the dentist, dental team and the patients. **Materials and Methods:** A review of the dental literature concerning cross-contamination was performed. Material appearing in the literature before 1996 was reviewed as exhaustively as possible and materials after 1996 were reviewed electronically. In Medline, key words like cross-contamination, sterilization, asepsis, infection, infection control, prevention were used in various combinations to obtain a potential reference for review. A total of 2245 English Language titles were found, many were repeated due to recurring searches. The headings were shortlisted and reviewed for detailed examination. **Results:** A comprehensive review to evaluate the methods of preventing cross-contamination in dentistry involving various aspects and challenges encountered in a dental set up was constructed which was missing in the references of the review. **Conclusions:** Awareness and the necessary precautions play a pivotal role in preventing the occurrence of cross-contamination. It is the responsibility of the entire dental team to work in unison to prevent the menace of cross-contamination and spread of infection.

Key words:
Cross-contamination, infection, prevention, sterilization

Introduction

The oral cavity is an environment in itself which providing a nutritive medium for bacterial growth.[1] Dental plaque, both supragingival and in the periodontal pocket, is a major source of these organisms. The mouth harbors bacteria and viruses from the nose, throat and respiratory tract. Any dental procedure that has the potential to aerosolize saliva will cause airborne contamination with organisms from some or all of these sources.

Materials and Methods

A review of the dental literature concerning cross-contamination was performed. Material appearing in the literature before 1996 was reviewed as exhaustively as possible and materials after 1996 were reviewed electronically. In Medline, key words like cross-contamination, sterilization, asepsis, infection, infection control, prevention were used in various combinations to obtain a potential reference for review. A total of 2245 English Language titles were found, many were repeated due to recurring searches. The headings were shortlisted and reviewed for detailed examination. Manual hand searching of the MEDLINE reference list was performed to identify any articles missed in the original search. Thirty-eight articles were identified and three were excluded. Two relevant titles were then searched and retrieved as full papers. Additional searches also included DARE, CRD, Cochrane oral health group.

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Aims and Objectives

This review is aimed to identify cross-contamination and spread of infection by various means and the appropriate preventive measures to be implemented. This review will also highlight the various aspects that are neglected in various dental schools/dental practice or any dental setup that potentiate cross-contamination ultimately affecting the dentist, dental team and the patients.

Results

A comprehensive review to evaluate the methods of preventing cross contamination involving various aspects and challenges encountered in a dental set up was constructed.

Background of infection control

Infection control is a major issue in each dental practice because this is an area where blood or saliva contamination can easily occur. This is well understood by the dental staff; however, it is not quite understood by the patients. Dental patients, because they usually are peripatetic, cannot easily understand that they undergo small operations that very often involve blood.[1] Various guidelines and policies in most of the world regarding infection control focuses primarily on education of the dental staff and not on patient education.

Disease possibilities

As the dental profession involves the use of small, sharp instruments contaminated with blood or other fluids, there is ample opportunity for inadvertent skin wounds to the operator and staff. Such accidents include the possibility of transmission of hepatitis B, hepatitis C and human immunodeficiency virus (HIV).

Threat exposure in dentistry

Dentistry potentially exposes much of the population to blood-to-blood contact with infected patients. Unless adequately disinfected, a wide variety of dental equipment may pose unacceptable risks of cross-infection. Handpieces and their attachments, including prophyangles attached to slow-speed motors for cleaning and polishing teeth, and high-speed motors and their burs used for drilling are particularly prone to patient contamination.[2]

Aerosol and splatter

The terms "aerosol" and "splatter" in the dental environment were used by Micik and colleagues in their pioneering work on aerobiology. In these articles, aerosols were defined as particles less than 50 μm in diameter. Particles of this size are small enough to stay airborne for an extended period before they settle on environmental surfaces or enter respiratory tract. The smaller particles of an aerosol (0.5-10 μm in diameter) have the potential to penetrate and lodge in the smaller passages of the lungs and are thought to carry the greatest potential for transmitting infections. Splatter was defined by Micik and colleagues as airborne particles larger than 50 μm in diameter.[3-7]

An aerosol clout of particulate matter and fluid is clearly visible during dental procedures like tooth preparation using a rotary instrument or air abrasion, during the use of air-water syringe, during the use of ultrasonic scaler and during air polishing. This aerosolized cloud is a combination of materials originating from the treatment site and from the dental unit waterlines. The potential routes for the spread of infections in a dental office are direct contact with the body fluids of an infected patient, contact with environmental surfaces or instruments that have been contaminated by patients and contact with infectious particles from the patients that have become air-borne.

Since aerosols are particles less than 50 μm in diameter. Particles of this size are small enough to stay airborne for an extended period of time before they settle on environmental surfaces or enter the respiratory tract and are thought to carry the greatest potential for transmitting infections given the volume and spatter and aerosols produced during dental treatment.[8-9]

Handpieces

Several studies have recommended heat sterilization of high speed handpieces because of the potential for internal contamination during use.[10-16] The justification for the heat sterilization of the low-speed handpiece system is less clear. Pressurized air is needed to operate the air-driven low-speed handpiece. This air must escape or be reduced to eliminate excessive heat buildup. All disposable and reusable types of prophy angles have a vent or opening to reduce or eliminate excessive buildup. This vent may allow internal contamination of a low-speed handpiece system because it is not a sealed system. This could lead to a subsequent cross-contamination unless the handpiece is heat sterilized between uses.

Concern about handpieces

The equipment contains lumens and crevices, which collect infective patient materials and are difficult to properly clean and disinfect. Moreover, internal handpiece components are more prone to malfunction after frequent sterilization at high temperatures. Spores inside high-speed handpieces may survive autoclaving unless the equipment is also internally treated with chemical disinfectants. Much of the concern about the potential for dental handpieces to transmit infections has focused on pathogenic bacteria that may proliferate in waterlines. As is the case with all habitable surfaces on prolonged contact with contaminated water, waterlines in and leading to high speed dental handpieces provide an environment that is highly conducive to biofilm formation. Such attached

microorganisms are unlikely to be readily flushed out and may entrap and periodically shed pathogens during high-speed handpiece operation. Viruses, on the other hand, do not reproduce outside of their hosts and therefore cannot proliferate in waterlines. Consequently, viral transmission is more likely to be of concern when significant amounts of patient materials remain in the lumens and crevices of handpieces and of their attachments, as well as on internal mechanisms. Because many of these sites are isolated from waterlines, flushing should not be expected to rid them of contamination.[17-21]

Saliva ejector

Backflow from saliva ejector tubing into dental patients' mouths may serve as a source of cross-contamination. It could expose the oral mucosa or nonintact tissues of a patient to previously suctioned fluids such as saliva or blood components from another person. Backflow in low-volume suction lines can occur when patients close their lips around a saliva ejector tip to form a seal. Precautions against bacteriological contamination of water in dental units include installing special protective valves in handpieces to prevent patients' saliva penetrate the unit tubing.

Casts and its relevance to spread of contamination

Casts poured from impressions can also harbor infectious microorganisms that can be distributed throughout the laboratory when the casts or dies are trimmed eliminating microbial contamination from an impression poses a special problem. The disinfection process should be adequate but should not adversely affect the dimensional accuracy or surface detail of the impression. Several variables can affect impression materials, including the composition and concentration of the disinfectant, the exposure time and the compatibility of various disinfectants with specific impression materials.[22-25]

Simple precautions

Fingernails should be short and clean. Rings, watches and arm jewellery should not be worn. Hands should be washed using surgical soap and/or an antiseptic hand-wash and dried with a single use disposable paper towel. This reduces the numbers of resident and transient micro-organisms which are capable of transmitting disease. Hand washing should occur before and after every patient contact. Any cuts or open skin lesions should be covered with a waterproof dressing. Protective clothing such as uniforms should be clean, or replaced promptly if soiled. Food and drink must not be consumed in the clinical and sterilizing areas. Protective eyewear is worn to protect eyes and mucous membranes from damage from macroscopic particles, chemical injury, and microbial infection. Patients should be requested to wear protective eyewear during their treatment. For clinical practice, protective clothing should be worn when undertaking procedures that involve the likelihood of body fluid contamination. Where surgical procedures are being undertaken, the sterility of instruments should be further maintained by use of packaged sterile gloves, use of disposable sterile surgical drapes on bracket tops, maintaining a no-touch technique, a new sterile disposable needle in addition to a fresh, new cartridge that must be used for each patient requiring local anesthetic. Particular care should be taken to avoid needle-stick injuries and cuts from sharp items. Needle-stick injuries offer the greatest potential for serious cross-infection

Implementation methods in dental clinics

Noncompliance with infection control specifically, inadequate surface disinfection and failure to use or change barrier between patients- will result in increased number of micro-organisms on the surface. Incorporating many features like reducing the number of surface areas in the operatories, replacing stationary counter-tops with mobile units for placing instruments and other materials used during patient treatment, constructing a new staffed central sterilization facility, replacing nonautoclavable handpieces with autoclavable ones, replacing sink handles and chair control switches with foot pedal controls, making the wearing of gloves, masks and eye protection, as well as using light handle covers and draping countertops on which contaminated instruments would be placed as part of routine procedure for treating patients.

The use of a 0.01% chlorhexidine or essential oil-containing mouthwash for a duration of 60seconds immediately before the commencement of a dental procedure has shown a tremendous reduction of the bacterial count.[26-27]

Sterilization

Sterilization of instruments ensures that they are free of all microbial life including microbial spores which are the most difficult of micro-organisms to kill. Resterilization is the repeated application of a process designed to remove or destroy all viable forms of microbial life, including bacterial spores, to an acceptable sterility assurance level. Resterilization of instruments used on one patient for reuse on another has been common practice in dentistry and oral and maxillofacial surgery such as bone drills and saws, Modern dental and medical equipment can be intricate and contain small lumens, as in endoscopic equipment, and therefore requires more rigorous procedures to ensure sterilization. Some instruments cannot be consistently and reliably sterilized; because of the risk of cross-contamination with these instruments, disposable devices became established in the health care industry.

Precautions during tooth preparation

In tooth preparation with an air-turbine handpiece, there can be minimal airborne contamination if rubber dam is used. Use of a high vacuum evacuator reduces the contamination arising from the operative site. Preprocedural rinse with

antiseptic mouth washes such as chlorhexidine reduces the bacterial count in the mouth, saliva and air and is relatively inexpensive on per-patient basis.

Infection control protocols with respect to handpieces

Better infection-control measures than chemical treatment alone are currently available for handpieces and their attachments to provide a greater assurance that they do not contribute to the spread of diseases. These measures include either autoclaving or dry heat treatment in conjunction with cleaning and chemical disinfection. However, achieving adequate levels of disinfection is complicated by a number of factors associated with the handpiece design.

Flushing for 2 minutes in the morning and for 20–30 seconds between patients should be considered the norm for dental surgery procedures, and longer flushing is suggested after weekends. In the case of using storage tanks, they should be frequently washed and disinfected, filled with distilled sterile water. The appropriate care for the sterility of the dental handpieces and the application of personal protection measures is necessary.

Structured and Detailed Infection Control Policy can be Summarized as Follows.[28-35]

1. Protective dressing, masks, gloves and glasses are to be worn by the dentist and his/her nurse (universal barriers)
2. Proper washing of the hands before donning gloves is necessary. Damaged gloves should be changed immediately
3. Proper cleaning of reusable instruments before sterilization by a nurse with appropriate protective clothing and proper education is necessary
4. Safe storage of sterilized instruments in covered trays or pouches is to be done
5. Minimization of dirty working areas and proper cleaning and disinfection of working areas after each patient's visit are obligatory
6. All sharp items that may be contaminated with blood/saliva are to be disposed off in the sharp boxes, which should be disposed off when two thirds full
7. All clinical waste should be thrown in a designated bag; when the bag is two-thirds full, it should be securely fastened and disposed off in a designated area
8. Proper rinsing and disinfection of all impressions and technical work that are to be sent back to the dental laboratory are obligatory
9. In case of inoculation injury, the wound must be pressed to bleed, washed under running water, and covered with waterproof dressing. Risk assessment is necessary if further action is required. Postexposure prophylaxis is sometimes advisable
10. Encapsulated amalgam should be used to avoid possible spillages with mercury
11. Reaction/ allergy to chemicals must result in immediate disposal of corresponding substance
12. Reaction/allergy to latex should be addressed with the use of nonlatex gloves
13. Total confidentiality of information relating to practice's patient is obligatory
14. Disposable barriers like gowns and drapes should meet adequate barrier protection levels
15. For surface disinfection, less expensive materials like food wrap or plastic cling wrap can be used. They can be disposed between patients and hence changed accordingly. One can also use autoclavable aluminium foils for surgical procedures
16. Air/water syringes, saliva ejectors, high vacuum evacuators can all have single use disposable barriers over them to prevent cross contamination.

Biomedical waste disposal

Biomedical waste is a broader term applied to waste generated during diagnosis, treatment or immunization of human beings or in research activities.[36]

Puttiah and Kohli[37] described that the regulated waste can be classified into:

- Biological waste: Can be gauze, cotton rolls, soft tissues like biopsy specimens and hard tissues like teeth
- Disposable sharps: Scalpel blades, needles, carpules, orthodontic wires, disposable matrix bands, single-use disposable burs, contaminated broken glass, failed implants
- Environmentally hazardous chemicals and metals: Mercury, amalgam, glutaraldehyde

  Nonregulated waste can be unsaturated cotton rolls, paper towels, gauze, nonsharp single disposable devices, disposable syringes
- It is seen that majority of the medical waste undergoes incineration which raises issues pertaining to the environment as these incinerators give out toxic ash residues that are chief contributors of digoxins found in the environment.[38] When these are sent for disposals to the landfills, they have a risk of percolating into the underground water. Therefore, care should be taken to avoid usage of chlorinated plastic bags in the incinerator. Red bag [Table 1] must not be incinerated as red contains cadmium, which causes toxic emissions.

The Biomedical Waste Management Rules 2000 recommends that all forms of disposables, sharps and microbiological wastes should be autoclaved.

Biomedical waste (management and handling) rule 1998, prescribed by the ministry of environment and forests, government of India, came into force on 28th July 1998. This rule applies to those who generate, collect, receive store, dispose, treat or handle biomedical waste in any manner [Table 2].

Table 1: Color coding and type of container for disposal of biomedical wastes[39]

Color coding	Type of container	Waste category	Treatment option
Yellow	Plastic bag	Cat 1,Cat 2, cat 3, cat 6	Incineration/deep burial
Red	Disinfected container/plastic bag	Cat 3, cat 6, cat 7	Autoclaving/microwaving/ chemical treatment
Blue/white translucent	Plastic bag/puncture proof container	Cat 4, cat 7	Autoclaving/microwaving/ chemical treatment and destruction/shredding
Black	Plastic bag	Cat 5, cat 9, cat 10	Disposal in secure landfill

Table 2: So treatment and disposal of various categories of wastes are summarized as

Option	Waste category	Treatment and disposal
Category 1	Human anatomical waste (Human tissues, organs, body parts)	Incineration/deep burial
Category 2	Animal waste (Animal tissues, organs, body parts, carcasses, bleeding parts, fluids)	Incineration/deep burial
Category 3	Microbiology and biotechnology waste (Waste from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines)	Local autoclaving/microwaving/incineration
Category 4	Waste sharps (Needles, syringes, scalpels, blades, glass, etc that may cause puncture and cuts)	Disinfection (chemical treatment/autoclaving/ microwaving and mutilation/ shredding)
Category 5	Discarded medicines and cytotoxic drugs (Waste comprising of outdated, contaminated and discarded medicines)	Incineration/drug disposal in secured landfills
Category 6	Solid waste (Items contaminated with blood, fluids including cotton, dressing, soiled plaster casts, linens, beddings,	Incineration/autoclaving/microwaving
Category 7	Solid waste (Waste generated from disposable items other than the waste sharps such as tubings, catheters, intra venous sets etc)	Disinfection by chemical treatment/ autoclaving/microwaving/mutilation/shredding
Category 8	Liquid waste (Waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities)	Disinfection by chemical treatment/discharge into drains
Category 9	Incineration ash (Ash from incineration of any biomedical waste)	Disposal in municipal landfill
Category 10	Chemicals used in production of biological, chemicals used in disinfection, as insecticides etc	Chemical treatment/discharge into drains for liquids and secure landfills for solids

OSHA Guidelines (as given by the United States Department of Labor)

Some basic requirements for the OSHA blood-borne pathogen standard include:

- Written exposure control plan
- Use of universal precautions
- Consideration, implementation and use of safer, engineering needles and sharps
- Hepatitis B vaccine provided to the exposed employees at no cost
- Medical follow-up in case of "exposure incident"
- Use of labels/color coding for items such as sharp disposal boxes and containers for regulated waste, contaminated laundry
- Employee training
- Proper containment of all regulated waste.

Aerosol transmissible diseases exposure control plan (New Cal OSHA regulation)

(1) The employer shall establish, implement, and maintain an effective, written ATD Exposure Control Plan (Plan) which is specific to the work place or operation(s), and which contains all of the elements in subsection (d)(2). Exception to subsection (d)(1): Employers with laboratory operations in which employees do not have direct patient contact may establish, implement and maintain an effective, written Biosafety Plan meeting the requirements of subsection (f) in lieu of an Exposure Control Plan for those operations.

(2) The Plan shall contain all of the following elements:

(A) The name(s) or title(s) of the person(s) responsible for administering the Plan. This person shall be knowledgeable in infection control principles and practices as they apply to the facility, service or operation.

(B) A list of all job classifications in which employees have occupational exposure.

(C) A list of all high hazard procedures performed in the facility, service or operation, and the job classifications and operations in which employees are exposed to those procedures.

(D) A list of all assignments or tasks requiring personal or respiratory protection.

(E) The methods of implementation of subsections (e), (g), (h), (i) and (j) as they apply to that facility, service or work operation. Specific control measures shall be listed for each operation or work area in which occupational exposure occurs. These measures shall include applicable engineering and work practice controls, cleaning and decontamination procedures, and personal protective equipment and respiratory protection. In establishments where the Plan pertains to laboratory operations, it also shall contain the methods of implementation

for subsection (f), unless those operations are included in a Biosafety Plan.

(F) A description of the source control measures to be implemented in the facility, service or operation, and the method of informing people entering the work setting of the source control measures.

(G) The procedures the employer will use to identify, temporarily isolate, and refer or transfer AirID cases or suspected cases to AII rooms, areas or facilities. These procedures shall include the methods the employer will use to limit employee exposure to these persons during periods when they are not in airborne infection isolation rooms or areas. These procedures shall also include the methods the employer will use to document medical decisions not to transfer patients in need of AII in accordance with subsection (e)(5)(B).

(H) The procedures the employer will use to provide medical services, including recommended vaccinations and follow-up, as required in subsection (h). This shall include the procedures the employer will use to document the lack of availability of a recommended vaccine.

(I) The procedures for employees and supervisors to follow in the event of an exposure incident, including how the employer will determine which employees had a significant exposure, in accordance with subsections (h)(6) through (h)(9).

(J) The procedures the employer will use to evaluate each exposure incident, to determine the cause, and to revise existing procedures to prevent future incidents.

(K) The procedures the employer will use to communicate with its employees and other employers regarding the suspected or confirmed infectious disease status of persons to whom employees are exposed in the course of their duties, in accordance with subsection (h).

(L) The procedures the employer will use to communicate with other employers regarding exposure incidents, including procedures for providing or receiving notification to and from health care providers about the disease status of referred or transferred patients, in accordance with subsection (h).

(M) The procedures the employer will use to ensure that there is an adequate supply of personal protective equipment and other equipment necessary to minimize employee exposure to ATPs, in normal operations and in foreseeable emergencies.

(N) The procedures the employer will use to provide initial and annual training in accordance with subsection (i) to employees in job categories identified in subsection (d)(2)(B).

(O) The procedures the employer will use for recordkeeping, in accordance with subsection (j).

(P) An effective procedure for obtaining the active involvement of employees in reviewing and updating the exposure control plan with respect to the procedures performed in their respective work areas or departments in accordance with subsection (d)(3).

(Q) Surge procedures. Employers of employees who are designated to provide services in surge conditions, and employers of employees who are designated to provide services to persons who have been contaminated as the result of a release of a biological agent as described in subsection (a)(1)(B), shall include procedures for these activities in the plan. The plan shall include work practices, decontamination facilities, and appropriate personal protective equipment and respiratory protection for such events. The procedures shall include how respiratory and personal protective equipment will be stockpiled, accessed or procured, and how the facility or operation will interact with the local and regional emergency plan.

(3) The ATD Plan shall be reviewed at least annually by the program administrator, and by employees regarding the effectiveness of the program in their respective work areas. Deficiencies found shall be corrected. The review(s) shall be documented in writing, in accordance with subsection (j)(3)(A).

The Indian scenario

Sqn Ldr T Prasanth *et al.* (2010)[40] in their study showed that usage of high vacuum suction simultaneously to using airotor handpiece or ultrasonic scaler resulted in decrease in the production of aerosols. They also stated that flushing 0.5% sodium hypochlorite in the dental waterline tubings helps in the reduction of biofilm formation. PP Hegde[41] in their study stated that the bar soap under the "in use" condition is a reservoir of micro-organisms and handwashing with such a soap may lead to spread of infection. KM Shivakumar[42] showed increased risk of transmission of infectious agents to the dentists working in mobile dental units. Balendra Pratap Singh[43] stated that the dentists should undergo continuing education programs on biomedical waste management and infection control guidelines in India.

Infection control and occupational safety recommendations for oral health professionals in India was drafted in 2007 and giving an overview of the dental infection safety and control in India, it stated that the level of infection control in India is still in the early infant stage and way behind the United States and European countries. It also stated that formal training for students, practitioners and institution-based practitioners is a must.

Immunization in dentistry

All health care professionals should be immunized against Hepatitis A, Hepatitis B, Varicella, MMR, DPT, Rubeola, Meningitis, Polio, Influenza, Tetanus, Diptheria, Rubella.

Discussion

The motivation of staff and patients at the same time toward a more responsible attitude, which is actually a matter of education and of personal ethos, can be proved particularly beneficial. All the areas in the practice should be cleaned with disinfectants at least once a day, even those that are considered clean, because many actions of the patients are unpredictable and possibly polluting.

Conclusions

Thus cross-contamination can place the dentist at serious risk of contracting serious illness. However, as they say, necessity is the mother of invention, it is imperative for dentists to realize that the solution to this risk lies within us. Prevention and taking the necessary precautions is the basic requirement that can help keep the menace of cross-contamination and cross-infection away.

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FORM IV

Statement about ownership and other particulars about newspaper ***(Chronicles of Young Scientists)*** *to be published in the first issue every year after the last day of February as per Rule 8*

1.	Place of publication	:	Mumbai
2.	Periodicity of its publication	:	Semiannually (January and July)
3.	Printer's Name	:	Hemant Manjrekar
	Nationality	:	Indian
	(a) Whether a citizen of India?	:	Yes
	(b) If a foreigner, the country of origin	:	N.A.
	Address	:	B5-12, Kanara Business Center, Off Link Rd, Ghatkopar (E), Mumbai - 400075, India
4.	Publisher's Name	:	Hemant Manjrekar
	Nationality	:	Indian
	(a) Whether a citizen of India?	:	Yes
	(b) If a foreigner, the country of origin	:	N.A.
	Address	:	B5-12, Kanara Business Center, Off Link Rd, Ghatkopar (E), Mumbai - 400075, India Phone: 91-22-6649 1818/1816,
5.	Editor's Name	:	Dr. Roop K. Khar
	Nationality	:	Indian
	(a) Whether a citizen of India?	:	Yes
	(b) If a foreigner, the country of origin	:	N.A.
	Address	:	Jamia Hamdard, India
6.	Names and addresses of individuals who own the newspaper and partners or shareholders holding More than one per cent of the total capital.	:	Organization of Pharmaceutical Unity with BioAllied Sciences

I, Dr. Roop K. Khar hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date: 1st March 2013 **Hemant Manjrekar** **Dr. Roop K. Khar**