ADA CE Program ARTICLE 3

A method of determining the presence of blood in and on a dental needle after the administration of local anesthetic

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ABSTRACT

Background. In the study reported in this article, the authors aimed to demonstrate the presence of blood on the surface and in the lumen of two gauges of dental needles after administration of local anesthetic (LA) by using three LA-administering techniques normally used for the extraction of teeth.

Methods. The authors obtained standardized photographs of 200 urine dipsticks after moistening the dipstick's chemical pads for blood with the first drop of liquid discharged from the needle lumen after LA administration. Using the histogram function of a software program, the authors analyzed differences in gray-scale values of the different blood parameters for the presence of blood. They used luminol spray to expose small quantities of blood on the surface of the needle after LA administration.

Results. Blood was identified at 39 percent in the lumen and at 16 percent on the surface of the needles when analyzed after LA administration.

Conclusions. With the method used, it was possible to demonstrate and quantify the percentage of blood present in the lumen of needles (39 percent) after the administration of dental LA. Furthermore, the technique was adequately sensitive for demonstrating the quantity of blood in two needles of different diameters.

Practical Implications. By demonstrating the presence, as well as quantifying the percentage, of blood on two dental needles of different gauges after the administration of LA, dental health care workers can be motivated to report needlestick injuries and to follow the approved protocols recommended by their institutions.

Key Words. Anesthesia; dental bloodborne pathogens; disease transmission; patient-to-professional transmission; occupational exposure; photography; dental students.

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Needlestick injuries (NSIs) pose a great risk of transmission of bloodborne infection to dental health care workers (HCWs) in the oral health setting. Hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) infections have been recognized as occupational hazards, with the risk of transmission from patient to health care personnel being 3 percent for HCV, 30 percent for HBV and 0.3 percent for HIV.[1-4] After experiencing an NSI, a person usually goes through psychological trauma. The awareness of the extent of blood and body fluid usually found in the lumen and on the surface of a needle after LA, and the probable risk thereof, can assist in the counseling of a person with NSI.

Percutaneous exposures result from injuries by any sharp object used in dentistry and surgery—such as contaminated needles, burs, scalpels, broken glass, exposed ends of dental wires or other sharps that penetrate or break skin. These injuries can occur at any time during dental treatment, especially when personnel dispose of needles. Any viral transmission risk is influenced by the type and number of microorganisms present in the blood, the presence of blood in and on the needle, the depth of the injury and the size and type of needle used.[5]

Authors of several articles have examined occupational injuries in dental health care settings[1,2,6] as well as NSIs among dental students.[7-10] Underreporting of sharps and mucocutaneous exposures among HCWs is common and remains problematic. Results of a survey showed that 22.6 percent of HCWs reported having experienced a sharps exposure during their career, but 33.0 percent of these exposures had not been reported.[11] Twenty-three percent of HCWs reported having experienced a mucocutaneous exposure, but 82.9 percent of these exposures had not been reported.[11] Thirty-eight percent of dental professionals reported having experi-

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enced sharps exposures, 23.7 percent of which were unreported. Of 13 mucocutaneous exposures, 69.2 percent of the exposures were not reported.[11] A tendency among dental care workers to underreport exposures was 25 percent for sharps exposures and 69 percent for mucocutaneous injuries.[11]

This problem affects dental students as well as health care professionals. In a study among dental students who had NSIs, 23 percent had reported the incident and 74 percent had not.[9] In a survey, underreporting among dental students in different years was between 20 and 40 percent.[12] In a survey of 29 studies, 17 to 97 percent of HCWs tended to underreport.[11] The most common reason for not reporting was the belief that the exposure was not clinically significant, followed by the combination of believing the exposure was not clinically significant and being too busy.[11] Dental students are regarded as being at high risk of experiencing NSIs.[7,13,14] This perception derives from their lack of experience in handling needles during and after administering local anesthetic (LA). The knowledge and awareness of NSIs among dental students in an Indian dental college was generally satisfactory.[15]

The literature focuses mostly on the prevalence of NSIs and not on the presence of blood in the lumen or on the surface of a needle. One might assume that it is difficult to demonstrate the minute quantity of blood in these areas of a needle. In this article, we describe a study we conducted in which we used a commercially available urine test strip, a well-documented forensic method and digital photography to detect the presence of blood in the lumen and on the external surface of two needles of different diameters after administration of three LA techniques normally used for the extraction of teeth.

BACKGROUND

Testing for the presence of blood. The dipstick test for blood is based on the peroxidaselike activity of hemoglobin. Red blood cells are lysed on contact with the chemical pad for blood on the test strip, allowing free hemoglobin to catalyze the liberation of oxygen from organic peroxide. Tetramethylbenzidine is oxidized, producing a color change from orange to blue-green. If intact red blood cells do not lyse, they produce speckles on the chemical pad for blood. The sensitivity for blood is rated at 5 to 10 erythrocytes per microliter when tested in urine[16] and 5 or fewer erthrocytes per μL of cerebrospinal fluid,[17] which corresponds to approximately 0.015 milligrams of hemoglobin per deciliter in urine and 0.007 mg of hemoglobin per dL in cerebrospinal fluid. This level of sensitivity was acceptable for our purposes in this study. The dipstick test for blood is used widely as a screening method to detect blood in urine.[18-20] In a previous study, investigators found a correlation between a negative result on the urine test strip and the presence of fewer than 5 red blood cells per high-power field and a spectrophotometric absorbance of less than 0.02 percent at 415 nanometers in a cerebrospinal fluid sample.[17]

Chemical methods used to detect small quantities of blood in forensic investigations usually are divided into crystal, catalytic and direct instrumental tests. The luminol (5-amino-2,3-dihydrophthalazine-1,4-dione) catalytic test is easy and inexpensive and is the most frequently used test in forensic investigations.[21] When an aqueous medium is being used, an oxidation system and an oxidative catalyst are required, in addition to alkaline conditions. Transition metal cations, either free or complexed to organic or inorganic ligands, catalyze the luminol chemiluminescence oxidation. Through this method, heme-containing proteins and hemoglobin are able to catalyze the chemiluminescence of luminol in the presence of an oxidant and to produce light with a blue-green color that is visible in the dark.[21] Luminol has been shown to be effective in detecting blood on various surfaces even after exposure to precipitation, water flow and cleaning with various chemical cleaning agents.[22] It is estimated that the sensitivity of luminol to blood is approximately 1:1,000,000 parts.[23] A test with luminol for the presence of blood was still effective eight years after deposition of blood in soil.[24]

Photographic technology. Electronic or digital photography technology has progressed substantially in the past few years. Digital cameras rapidly are becoming a standard photographic tool in dentistry. An electronic sensor, made up of photosensitive diodes, records the light. When light strikes the sensor, electron charges are generated. The charges are recorded as digital information on the camera's memory card and then can be converted into an image.[25] The digital image is composed of a set of cells aligned in rows and columns to form a table. Each cell is characterized by three numbers: the x-coordinate, the y-coordinate and the gray-scale value. The gray-scale value is a number that corresponds to the intensity at the specific location during the exposure of the sensor. The individual cells are known as "picture elements" or "pixels."[26] Each pixel in a digital image is represented by a number corresponding to its gray-scale level (shade of gray). Therefore, each number corresponds to one small area of the image, and the number indicates the level of darkness or brightness of a particular pixel. The dynamic range of shades of gray generally is 256; the darkest gray (black) is assigned a value of zero and the lightest gray (white) is assigned a value of 256.[27] These gray-scale values can be used to calculate the difference in density between two photographs obtained with a standardized method.[28] The same principle is used in subtraction radiography.[29]

ABBREVIATION KEY. **HBV:** Hepatitis B virus. **HCV:** Hepatitis C virus. **HCW:** Health care worker. **HIV:** Human immunodeficiency virus. **LA:** Local anesthetic. **NSI:** Needlestick injury.