

Title

**The evaluation of advice given by health care professionals
to pregnant patients regarding dental radiography**

Authors

C Kaher Department of Oral and Maxillofacial Surgery

A Pinto Department of Oral and Maxillofacial Surgery

P Gupta Department of Paediatric Medicine*

Oral and Maxillofacial Radiology

Queen Mary University of London

The Royal London Hospital

New Road, Whitechapel, London, E1 1BB, UK

Tel: +44 20 73777050

Fax: +44 20 73777121

ckaher@gmail.com

*Queen Elizabeth Hospital, Gayton Road, Kings Lynn, PE30

4ET

Abstract

Pregnancy can be associated with an increased incidence of dental disease. Dental radiographs may be necessary for the correct diagnosis and treatment planning of patients who may be/are pregnant. Recommendations on dental radiography in pregnancy by different healthcare professionals can be conflicting and confusing. This in turn can lead to unnecessary anxiety and stress for pregnant patients. Current guidelines suggest that dental radiography in pregnancy delivers such a small dose to the foetus that the associated risks can be regarded as negligible. Pregnant patients misinformed as to the risks to the foetus after dental radiography can undergo significant psychological distress, this has its own risks to the unborn child. This study surveyed current advice given about the safety of dental radiography during pregnancy by different groups of healthcare professionals. These included general medical practitioners, general dental practitioners and midwives. Substandard knowledge and misinformation on dental radiography in

pregnancy and its risks were common amongst all healthcare professional groups.

Aim

The purpose of this study is to investigate the knowledge amongst health care professionals of current Health Protection Agency (HPA), (previously known as the National Radiological Protection Board (NRPB)) guidelines regarding dental radiography in pregnant females and determine if further information needs to be targeted to healthcare professionals involved in pregnant patient care.

Introduction

The study was initiated as a result of concern elicited amongst some of the Authors' pregnant patients who had been misinformed by their healthcare professionals with regard to dental radiography and its harmful effects to the foetus. This in turn caused the pregnant patients much stress and anxiety, due to the concern raised about the possible effects to the unborn child

The current Guidance Notes for Dental Practitioners on the Safe Use of X-Ray Equipment state, "A dental radiograph delivers such a small dose to the foetus that the associated risk can be regarded as negligible." ¹. A survey of 372 dentists in the Birmingham and Manchester areas regarding factors influencing their prescription of bitewing radiographs, found 95.6% of them were influenced or strongly influenced not to take them in patients that were pregnant². A further survey of 2,257 dentists in the USA, found 63.1% would not take a radiograph in a pregnant patient with toothache, in the first

trimester. ³. A comparable result has also been found amongst Australian dentists ⁴.

In an extreme case; following three periapical radiographs in a female patient undergoing endodontic treatment, who later learned she was pregnant at the time, was advised by her GMP to have a termination, due to the potential hazardous effects of the radiation, as she was not wearing a lead apron⁵.

Recommendations on dental radiography in pregnancy by different healthcare professionals can be conflicting and confusing. This in turn can lead to anxiety and stress for pregnant patients.

Methodology

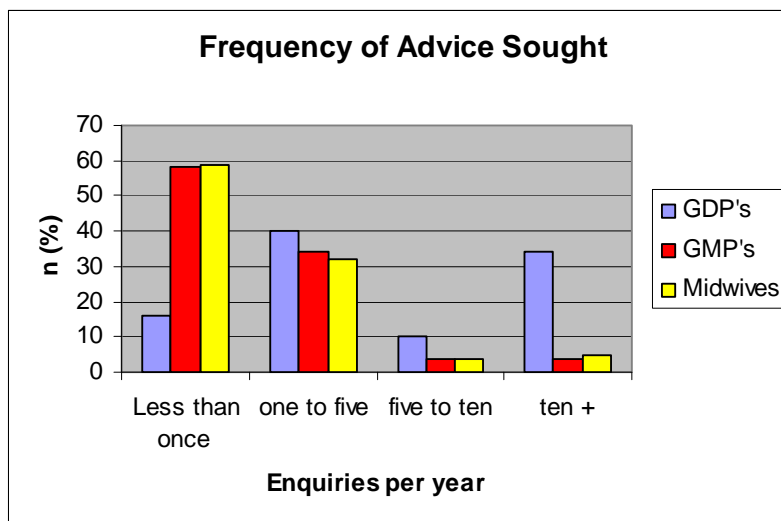
The study took the form of a survey, which was answered by general medical practitioners (GMP's), general dental practitioners (GDP's) and midwives. A total of 441 questionnaires were sent out. 141 to GDP's and 150 to both GMP's and midwives. Each of the 3 healthcare professional groups completed 100 questionnaires. A response rate of 71%, 67% and 67% respectively) The survey was in the form of a closed ended questionnaire. Questionnaires were sent to local surgeries (dental and medical) and midwife offices as well as local post-graduate courses. There were six sections. The first part of the questionnaire assessed the frequency of advice sought from pregnant patients with regards to dental radiography. The second part assessed the healthcare professionals' beliefs with regard to the justification of dental radiography in pregnant patients with dental pain. The third part assessed their perception of the harmful effects of dental radiography to the unborn child. The fourth attained information on the current advice respondents recommended regarding dental radiography in pregnancy.

The fifth asked whether the respondents were aware of IR(ME)R 2000. The sixth asked what respondents thought the dosage of a small intra-oral radiograph was equivalent to in terms of hours on an airplane.

Results

The majority (84%) of GDP's were asked about dental radiography by pregnant patients more than once a year. GMP's and Midwives were asked less often about them. Although just over 40% of both groups reported being asked about them more than once a year. Figure 1 shows the frequency of advice sought from pregnant patients regarding dental radiographs

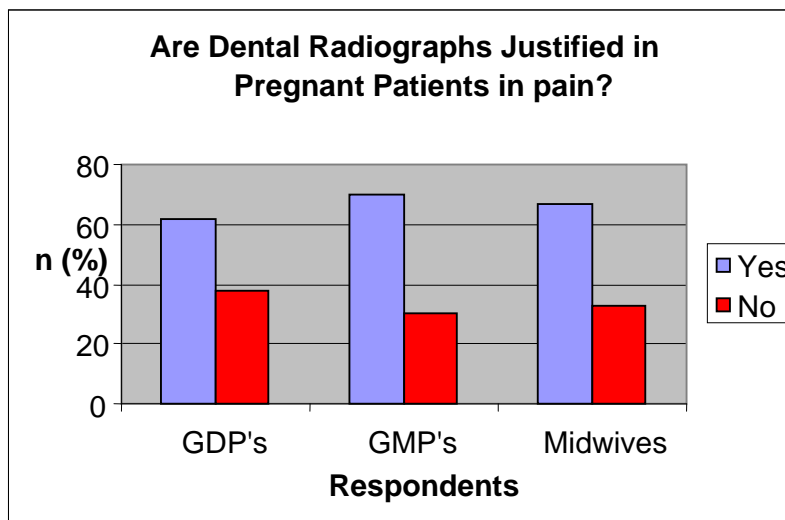
Fig. 1



The majority of all groups (62-70%) agreed dental radiographs in pregnant patients suffering from dental pain were justified. Surprisingly, a higher proportion of GDPs (38%)

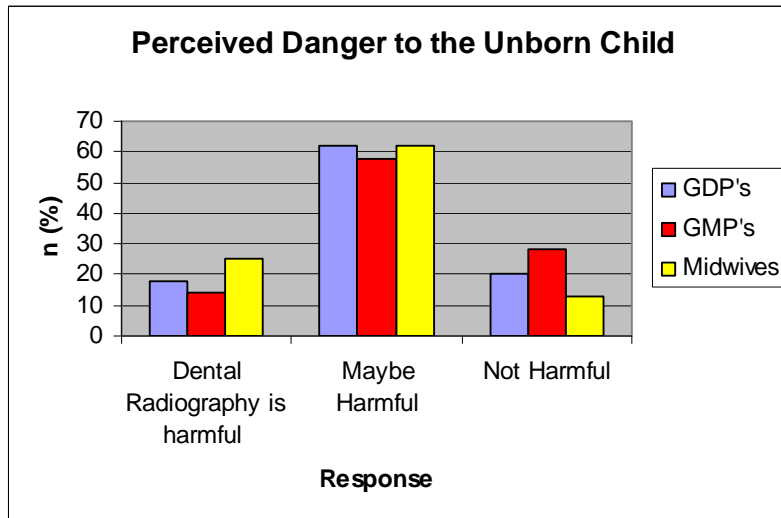
than the other groups thought they were not justified. Figure 2 shows current beliefs in regards to whether dental radiography in pregnant patients with dental pathology causing pain is justified.

Fig. 2



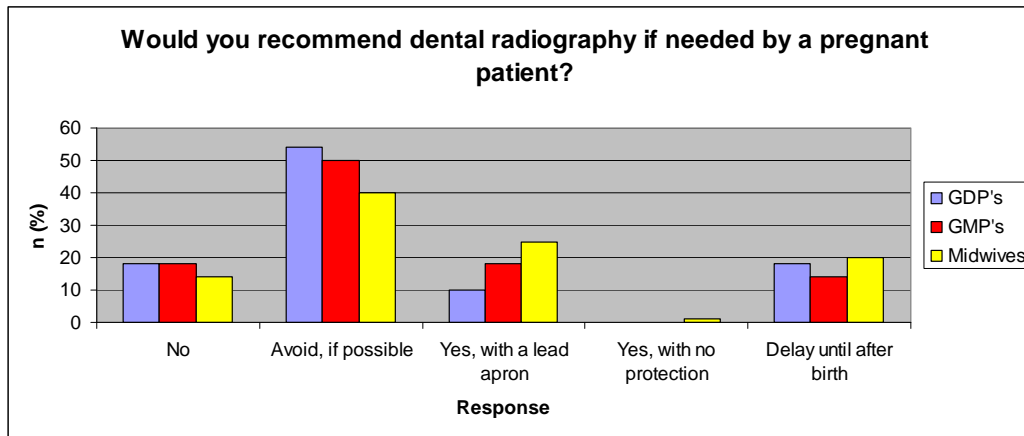
The majority of all professionals (80-87%) believed dental radiography maybe or was harmful to the unborn child. Figure 3 shows the perceived danger of dental radiographs to an unborn child.

Fig. 3



The majority of responses in all groups indicated that they advise dental radiography be avoided if possible. 14-18% would not recommend dental radiography, even if needed. With 14-20% of respondents recommending the radiograph be delayed until after birth. Figure 4 shows current advice given in regards to dental radiography and pregnant patients by health care professionals. Interestingly, 10-25% of respondents would recommend them with the patient wearing a lead apron. No GDP's or GMP's and only 1% of midwives would recommend dental radiography with no protection even if needed.

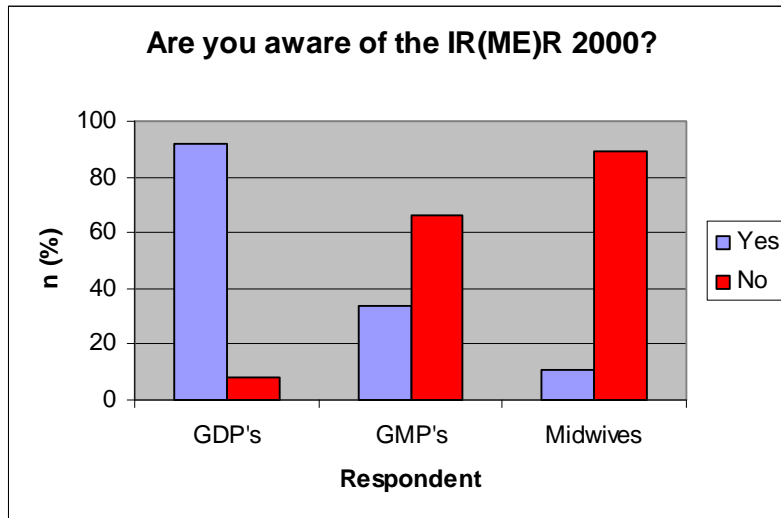
Fig. 4



The fifth question ascertained current knowledge of IR(ME)R 2000. Encouragingly, the vast majority of GDP's (92%) were aware of them.

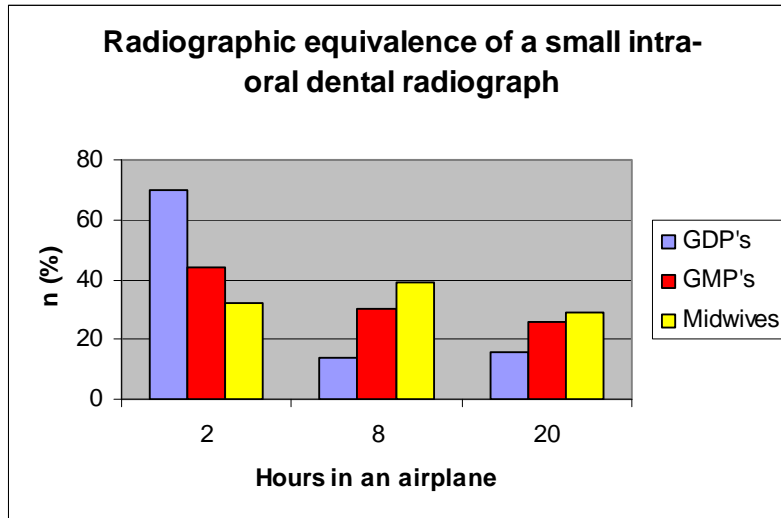
Figure 5 shows awareness of the current Ionising Radiation (Medical Exposure) Regulations 2000.

Fig. 5



The final question ascertained beliefs on the radiographic equivalence of a small intra-oral radiograph. The majority of GDP's (70%) gave the correct equivalence of about 2 hours on an airplane. The majority of GMP's and midwives overestimated the dosage, comparing it to an 8 or 20 hour flight. Figure 6 shows the perceived radiographic equivalence from a small intra-oral dental radiograph

Fig. 6



Discussion

Pregnant Females and Oral Disease

Gingivitis, pyogenic granuloma, caries and erosion have all been associated with pregnancy^{6,7,8}. Several studies have shown an increase in gingivitis in pregnant patients compared to post delivery or non-pregnant females^{9,10}. Pregnant patients are known to have increased levels of sex hormones. Receptors for these hormones have been found in the gingival tissues, which are thought to make these

tissues more reactive to plaque¹¹. These sex hormones are also metabolised by gingival bacteria, *Prevotella* species and possibly *P. intermedia*^{6,12}. The ratio of sub-gingival anaerobic to aerobic bacteria has been shown to increase during pregnancy¹³. Whether or not plaque increases during pregnancy is controversial with studies showing both outcomes⁶. It is currently thought there is an increased gingival vascular response to pre-existing plaque during pregnancy, leading to a higher incidence of gingivitis and pyogenic granulomas. The latter is thought to affect up to 5% of pregnant patients⁶.

Evidence suggests an increase in the number of salivary cariogenic micro-organisms in pregnancy¹⁴, concurrent with a decrease in salivary pH and buffer effect¹⁵. The effect of pregnancy on the initiation and progression of caries is unclear⁶. It is also difficult to estimate, as caries can take years to initiate and develop. DMF was found to be higher in women with children compared to those without¹⁶.

Erosion of the teeth may occur due to hyperemesis gravidarum (morning sickness). This is most often seen on palatal surfaces of maxillary incisors.

Stress and Pregnancy

The term stress describes a state of threatened "homeostasis." The disturbing forces may be described as "stressors." These include psychological (i.e. anxiety), physiological (i.e. mal-nutrition), physical, or biochemical factors. Stress during pregnancy may lead to fetal distress, miscarriage, pre-eclampsia, pre-term delivery (PTD), low birth weight (LBW) and other delivery complications as well as increasing the risk of the child to develop diseases in the subsequent periods of life^{17,18,19}. The effects are thought to be brought about by the two components of the stress response system; corticotropin-releasing hormone (CRH) and the hypothalamic-pituitary-adrenal axis system along with the autonomic nervous system (locus ceruleus-norepinephrine system (LC/NE)). CRH has been shown to prepare the foetus

for parturition. Elevated levels, found in stress are linked to pre-term parturition. These pathways alter the neuro-endocrine systems of mother and foetus and are thought to bring about the noted complications^{17,18,19,20}.

It is reasonable to assume a pregnant patient who has been told, subsequent to a dental radiograph, that the x-ray was harmful to the foetus, will elicit a prolonged stress response, until informed otherwise or delivery. The authors have found this situation in their personal experiences. Putatively, the stress caused by the misinformation given by some healthcare professionals may cause more harm to the foetus, from psychological distress than any dental radiographic exposure.

Further studies are needed to determine the effect this stress has, if any, on the foetus, and if the risk to the foetus from stress is higher than the risk from ionising radiation.

Radiography in Pregnancy

Regulation 6(1)(e) of the Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) 2000²¹ prohibits the carrying out of a medical exposure of a female of child bearing age without an enquiry as to whether she is pregnant if the primary x-ray beam is likely to irradiate the pelvic area. This is not normally relevant in dental radiography. However, dental radiography is often avoided in pregnant patients, essentially for psychological reasons. An acceptable course of action would be to explain to the patient that a dental radiograph delivers such a small dose to the foetus that the associated risk can be regarded as negligible. However, because of the emotive nature of radiography during the pregnancy, the patient could be given the option of delaying the radiography. Lead aprons are not recommended and only indicated in the rarely used vertex occlusal radiograph where pregnancy cannot be ruled out in the patient¹.

According to the HPA, normal selection criteria for dental radiography do not need to be influenced by the possibility of a female patient being at any stage of a pregnancy²².

In order to allow meaningful comparisons between various sources of radiation, the Background Equivalent Radiation Time (BERT) unit has been established. BERT is the number of hours, days, weeks, months or years of exposure to natural background radiation that would equate to an adult receiving the same 'effective dose' from generated ionising radiation sources such as a dental X-ray machine. Some examples of radiation doses expressed as BERT are listed in table 14.

Table 1 shows examples of common investigations and their dose equivalent of Background Equivalent Radiation Times (BERT).

Event	BERT	Effective dose (μSv)
One transatlantic flight	5 days	37.5
One flight to Australia	15 days	112.5
Chest radiograph	4 days	30.0
Dental panoramic film	28 hours	7.0-14.0
Intra oral Periapicals		1.0-8.0
	16 hours	4.0
- Rectangular collimator	8 hours	2.0

*Adapted from 4,23,24.

Table 2 shows typical effective doses for a range of dental and conventional medical examinations.

Table 2(adapted from 23)

Examination (and conditions)	Effective dose (μSv)
Two dental bitewings (70kV, 200 mm fsd, rectangular collimation, E-speed film)	2
Two dental bitewings (70kV, 200mm fsd, round collimation, E-speed film)	4
Two dental bitewings (50-60kV, 100mm fsd, round collimation, E-speed film)	8
Two dental bitewings (50-60kV, 100mm fsd, round collimation, D-speed film)	16

Dental panoramic (rare earth 7 intensifying screen)	
Dental panoramic (calcium tungstate intensifying screen)	14
Skull	1000
CT: Head	2000
Chest	40
CT: Chest	8000
Barium meal	5000

The risk of any teratogenic effect related to a 1cGy (10000 μ Sv)[‡] exposure (which is more than 1000 full mouth intra oral radiographs, with E-Speed films and rectangular collimation) is given as 0.1% or less. This is at least 1000 times less than the anticipated risk of spontaneous abortion, malformation or genetic disease. The gonadal dose to women from a full mouth radiographs, is less than 0.01 μ Sv, which is at least 1000-fold below the threshold shown to cause congenital damage to newborns²⁵. Animal and human studies support the conclusion that no increase in

gross congenital anomalies or intrauterine growth retardation occurs as a result of exposures during pregnancy totalling less than 5-10 cGy (50000-100000 μ Sv)²⁶.

One report has estimated the risk of a first generation fetal defect from a dental radiographic examination to be 9 in 1 billion. The risk is even lower with faster films and digital radiography ²⁷.

To put these figures into perspective, the gonadal/fetal dose of 2 periapical dental films is 700 times less than 1 day of average exposure to natural background radiation in the United States²⁶.

Fetal radiation exposure risk is minimised by the use of routine, safe dental radiographic procedures. These include high-speed films (F-speed), rectangular collimation, filtration, panoramic rare earth screens, high voltage (60-70kV+), DC potential, focus to skin distance (fsd) of 200mm and a quality assurance program²³. Table 2 demonstrates reduction of the effective dose using dose limiting techniques.

Despite the negligible risks of dental radiography, the dentist should not be cavalier regarding its use during pregnancy. Radiographs should be used selectively and only when necessary and appropriate to aid in diagnosis and treatment (justification) ²⁶.

‡1cGy(0.01 Gy)= 1 rad (roentgen, R) = 0.01 sievert (Sv)=
10mSv

The survey showed current knowledge amongst healthcare professionals regarding dental radiography in pregnancy is inadequate, with 80-87% of respondents believing dental radiographs maybe or are harmful to the unborn child. Indeed, a higher proportion of dentists (38%) than other healthcare professionals thought dental radiography in pregnant patients with dental pathology causing pain, was not justified. Perhaps, more concerning is the misinformation frequently distributed to patients from all healthcare groups.

According to the HPA guidelines¹ and the vast majority of research around the subject, it is safe to take dental radiographs in pregnant patients, providing the primary beam is not directed at the foetus. It is therefore interesting that no GDPs, GMPs and only 1% of midwives in this survey would recommend dental radiography if a pregnant patient sought their advice.

The authors acknowledge the fourth question on the survey was poorly constructed. Would you recommend dental radiography if needed by a pregnant patient? The question was subjective and some respondents may have taken it to mean screening radiographs.

The vast majority of dentists were aware of the IR(ME)R 2000, however the vast majority were not aware of its advice in regard to dental radiography in pregnancy. The survey would suggest more needs to be done to teach current guidelines to the various healthcare professionals involved in pregnant patient care. Further work is required to ascertain

the best way of imparting knowledge regarding dental radiography and pregnancy.

“Justification, Optimisation, Limitation” are the principals governing the practice of radiography¹. Thus the justification should be reviewed to ensure that only radiographs that are absolutely necessary are taken, e.g. delay routine periodic checks. The patient should be reassured that a minimal dose is being employed and the patient given the option of delaying the radiograph. Foetuses are more radio-sensitive than adults²⁸. Thus, it may be prudent to use a protective lead apron when taking the infrequently used vertex occlusal radiograph¹. The correct positioning of the patient and use of a thyroid collar, can prevent the x-ray beam from the upper standard occlusal (USO) radiograph from placing the foetus into the primary beam²⁸.

Dentists have professional obligations not only to limit the use of radiographs to potentially beneficial situations but also to take good quality diagnostic radiographs, to limit the dose,

to use good radiation safety measures and to use modern equipment to achieve best possible films. Radiographs must then be properly developed and viewed under appropriate conditions to gain the maximum diagnostic information from each exposure. Quality assurance programs to ensure this, including radiographic audit are now legally incumbent on dentists to perform. The aim is to ensure consistency in the quality of radiographs, while keeping any radiation exposure to a minimum in both patients and staff^{23, 29, 30}.

According to the General Dental Council, All UK dentists are required to complete 250 hours of Continued Professional Development (CPD) every five years. It is recommended dentists should attend at least 5 hours of courses containing “core of knowledge” (dental radiography and radiology) every 5 years³¹. This knowledge is also important for obtaining informed consent prior to taking radiographs.

Reducing Dosage

Encouragingly, between 1964 and 1993 the radiation exposure of intra-oral radiographs has been shown to have fallen to 1/6 of its original value back in 1964³². One of the main reasons for radiation exposure decreases has been the advent of faster films over time. The dose advantage gained from using an E-Speed film compared to a single emulsion film used in the 1920's, represents approximately 50-fold reduction in patient exposure³³. Indeed, converting from D-Speed films to E-Speed films cuts radiation exposure by 50%³³, with a similar reduction when converting to F Speed. Digital imaging decreases exposure levels significantly up to 75%²⁹ and with the decreasing costs of this technology, this will become an increasingly attractive option when purchasing dental radiographic equipment. This trend of decreasing exposure levels should continue into the future with the advent of new technologies and techniques

The value of lead aprons during radiography in pregnancy has come into question. It is thought that the apron may potentate the effect of scatter radiation that gets under the apron since the scatter beams become trapped between the apron and the body and are then reflected back toward the tissues they are supposed to protect⁴. Since the risk of malignancy from scatter radiation (without an apron) is perhaps in the order of one in 100 million, and since only a small percentage of the primary beam is scattered with modern machines, the value of lead aprons is therefore questionable and is discouraged. However, lead aprons do provide some psychological security for patients and they have been recommended for essentially this reason⁴.

Pregnant dentist/nurse and exposure.

The National Commission of Radiation Protection and Measurements (USA) reports that production of congenital defects is negligible from fetal exposures of $50000\mu\text{Sv}$. This amount is unlikely to ever to be reached in dental practice. To further protect pregnant workers, the pregnant operator should wear an x-ray detection film badge and stand more than 6ft from the tube head and position herself between 90 and 130 degrees of the beam, preferably behind a protective wall ²⁷.

Conclusion

The results of this survey suggest current knowledge on dental radiography and pregnancy amongst healthcare professionals is poor. The majority of whom believe the associated risks are much greater than they actually are, with most healthcare professionals misinforming patients compared to current guidelines. The misinformation given

can cause much unnecessary psychological distress to the mother to be. Targeted information regarding dental radiography and pregnancy needs to be disseminated to healthcare professionals involved with pregnant patient care.

Acknowledgments

I would like to thank Dr Jimmy Makdissi, Dr Eric Whaites and Dr Colin Cook, for all their help and advice.

References

1. Guidance notes for Dental Professionals on the Safe Use of X-Ray Equipment. National Radiological Protection Board. Pub: Department of Health. June 2001. 2.38-2.40, p 14.
2. Rushton V.E., Horner, K., Worthington, H.V. Factors influencing the frequency of bitewing radiography in general dental practice. *Commun Dent Oral Epidemiol.* 1996 24:272=6
3. Kaugars, G.E., Broga, D.W., Collett, W.K. Dental radiologic survey of Virginia and Florida. *Oral Surg Oral Med Oral Pathol.* 1985 60:225-229
4. Abbott, P. Are dental radiographs safe? *Australian Dental Journal.* 2000 45:(3):208-213.
5. Smith, N.J.D. Dental Radiography during Pregnancy. *Br Dent J.* 1982 May 18; 152:346.
6. Laine, M.A. Effect of pregnancy on periodontal and dental health. *Acta Odontol Scand.* 200260:257-264.
7. Livingston, H.M., Dellinger, T.M., Holder, R. Considerations in the management of the pregnant patient. *Special Care in Dentistry.* 1998 18(5):183-188.

8. Loe, H. Periodontal changes in pregnancy. *J Periodontol.* 1965 36:209-17
9. Loe, H, Silness, J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand.* 1963 21: 533-551.
10. Hassaon, E. Pregnancy gingivitis. *Harefuah* 1960 58:224-226
11. Parker, M.H., Newman, H.N., Olsen, I. Polymerase chain reaction analysis of oestrogen and androgen receptor analysis in human gingival and periodontal tissue. *Arch Oral Biol.* 1996 41:979-83
12. Kornman, K.S., Loesche, W.J. Effects of estradiol and progesterone on *Bacteriodes melaninogenicus* and *Bacteriodes gingivalis*. *Infect Immun.* 1982 35: 256-263.
13. Kornman, K.S., Loesche, W.J. The subgingival microbial flora during pregnancy. *J Periodont Res.* 1997 12:500-509.
14. Laine, M., Tenovuo, J., Lehtonen, O.P. Pregnancy related increase in salivary *Streptococcus mutans*, lactobacilli and IgA. In Cimasoni, G., Lehner, T., (Eds). *Borderland between*

caries and periodontal disease III Edition Medicine et Hygiene, Geneva; 1986. p193-200.

15. Laine, M., Tenovuo, J., Lehtonen, O.P., Ojanotko-Harri, A., Vilja, P., Tuohimaa, P. Pregnancy related changes in human whole saliva. Arch Oral Biology. 1988 12:913-917.

16. Banoczy, J., Orosz, M., Gabris, K., Nyarasy, I., Rigo, O., Schuder, L. Untersuchungen über den Zusammenhang zwischen Schwangerschaft, Karies und Gingivitis. Zahn-, Mund-, Kieferheilkd Zentralbl. 1978 66:573-81.

17. Hobel, C.J. Stress and Preterm Birth. Clin Obstet Gynecol. 2004 Dec; 47(4):856-80.

18. Halbreich, U. The association between pregnancy processes, preterm delivery, low birth weight, and postpartum depressions - the need for interdisciplinary integration. Am J Obstet Gynecol. 2005 Oct;193(4):1312-22.

19. Knackstedt, M.K., Hamelmann, E., Arck P.C. Mothers in stress: consequences for the offspring. Am J Reprod Immunol. 2005 Aug; 54(2):63-9.

20. Field, T., Diego, M., Hernandez-Reif, M., Schanberg, S., Kuhn, C., Yando, R., Bendell, D. Pregnancy anxiety and comorbid depression and anger: effects on the fetus and neonate. *Depress Anxiety*. 2003; 17(3):140-51.
21. Ionising Radiation Medical Exposure Regulations 2000 No 1059 Health & Safety. ISBN 0 11 099131 1. Pub: The Stationary Office. 2000.
22. National Radiological Protection Board (NRPB). Board Statement on diagnostic medical exposures to ionising radiation during pregnancy. Documents of the NRPB, Vol. 4, no. 4:1-3. Oxford: HMSO; 1993.
23. National Radiological Protection Board (NRPB). Guidelines on Radiology Standards for Primary Dental Care. Report by the Royal College of Radiologists and the NRPB. Documents of the NRPB, Vol. 5, no.3. Oxford: HMSO;1994.
24. Macdonald, R. Have you met BERT? *ADA(SA) Newsletter*. 1997 10 (9): 8-9.
25. White, S.C. Assessment of radiation risk from dental radiography. *Dentomaxillofac Radiol*. 1992 21:118-126.

26. Little, J.W., Falace, D.A. Pregnancy and breast feeding. In: Dental Management of the medically compromised patient. 6th ed. St. Louis: C.V. Mosby Co., pp306-313, 2002.
27. Danforth, R. A., Gibbs, S.I. Diagnostic dental radiation. What's the risk. J Calif Dent Assoc.1980 28:28-35.
28. Serman, N.J., Singer, S. Exposure of the pregnant patient to Ionizing Radiation. Ann Dent. 1994 53(2):13-15.
29. FGDP (UK) Good Practice Guidelines. Selection Criteria for Dental Radiography. Faculty of General Dental Practitioners (UK), The Royal College of Surgeons of England. London. 2nd Ed, 2004.
30. Whaites, E. Essentials of Dental Radiography and Radiology. 3rd Ed. Churchill Livingstone, 2002.
31. Continuing Professional Development (CPD) for Dentists. Pub General Dental Council Nov 2006.
32. Suleiman, O.H., Spelic, D.C., Conway, B., Hart, J.C., Boyce, P.R., Antonsen, R.G. Radiographic Trends of Dental Offices and Dental Schools. Journal of the American Dental Association. 1999 130:1104-1110.

33. Preston-Martin, S., White, S.C.. Brain and salivary gland tumors related to prior dental radiography: implications for current practice. Journal of the American Dental Association. 1990 120:151-158.