Operator's ability at assessing a high-speed (air turbine) handpiece before use: an audit

R. Holliday,*[1] S. Venugopal,[2] A. Howell[3] and W. Keys[4]

RESEARCH

IN BRIEF

- Highlights the importance of air turbine handpiece inspection and demonstrates a general lack of prior training and knowledge in this area.
- The audit results demonstrate an inability to consistently identify faulty and unsafe air turbine handpieces.
- Introduces a simple intervention (educational video) which can improve the ability to detect unsafe handpieces.

Background The 'high-speed' (air turbine) handpiece is used extensively across many dental disciplines and the ability of clinicians to detect faulty handpieces is essential. **Aim** The primary aim of this audit was to determine the proportion of participants who could correctly identify unsafe handpieces. Secondary aims were to determine the proportion that had previous training on the topic and determine whether an educational video could improve scores. **Method** Eighty participants completed the first round of audit. They were asked to inspect seven handpieces, five of which were faulty, with three being classed as unsafe. After the intervention (educational sessions and distribution of a video) a second round of audit was completed on 69 participants. **Results** The ability to detect the three unsafe handpieces increased from 10% to 44% over the two rounds of audit. In the second round the highest score obtained was by those who had received the intervention, 77%. The lowest score, 14%, was by those who had not received the intervention. Nine percent of participants in the first round stated they had previously had training on handpiece inspection and none of these participants identified the three unsafe handpieces. **Conclusion** This audit has highlighted that there is a knowledge deficiency with regards to air turbine handpiece safety and inspection. We have shown that introduction of a simple education video can have an impact on dentists and students abilities to detect unsafe faults. We have already introduced this into the undergraduate curriculum in our school and we aim to also raise awareness within the dental community.

INTRODUCTION

The 'high-speed' (air turbine) handpiece is a great feat of engineering that transformed dentistry and has evolved over many years since its introduction. James Morrison produced the first commercially manufactured foot-treadle dental engine in 1871.[1] In 1959, the 'Borden Alston' air rotor dental unit was introduced in Chicago and was the first unit that used air pressure to turn the bur. The drill could achieve 250,000 rpm and was cooled down by water – not too dissimilar to the principles of the turbines used today. The modern air turbine handpiece now operates between 300,000 rpm and 500,000 rpm and is used on a daily basis across many dental disciplines.

There are several designs and manufacturers of air turbine handpieces and each will have their own intricacies and common faults. Kavo (Kavo Dental, Bismarckring, Germany) has been reported as the most used handpiece in dental practice[2] and this is one of the two main models used within Newcastle Dental Hospital, where this audit was completed.

Modern handpieces are expected to withstand more insults than those of the pre-sterilisation era. Handpieces can go through the sterilisation process several times daily and this will have an impact on the lifetime of the components, although proper cleaning and lubrication can help extend their lifespan. As with any piece of equipment, the treating clinician is responsible for checking the piece of equipment is fit for purpose, undamaged and safe for use.

UK teaching on handpiece inspection is varied and it is the experience of the authors that undergraduate teaching is generally absent or in an informal ad hoc basis. In a secondary care setting, such as those where UK graduates undertake a large proportion of their clinical training, the responsibility of ensuring handpiece safety is often partly taken centrally by an instrument curator. For example, in Newcastle Dental Hospital each handpiece is checked in the curator's laboratory after each sterilisation cycle. A large portion of UK graduates will follow careers in the primary dental services where they are likely to take the lead responsibility for checking these precision instruments without any or very little formal training on the topic.

This audit was undertaken to determine if practicing dentists and undergraduate students had received any training on handpiece inspection, whether they could identify unsafe handpieces and if an educational video could improve safety and awareness.

AIMS AND OBJECTIVES

The primary aim of the first round of audit was to determine the proportion of participants that could correctly identify unsafe handpieces. A secondary aim was to determine the proportion that had previous training on the topic. The aim of the second round of audit was to establish the impact of an educational video on unsafe handpiece detection.

METHODS

Audit criteria

The criteria selected for scrutiny in this project were:

[1]Academic Clinical Fellow/ Speciality Registrar, [2]Core Dental Trainee, in Restorative Dentistry, Newcastle Dental Hospital; [3]General Professional Trainee (Dental), Newcastle Dental Hospital; [4]Speciality Registrar in Restorative Dentistry/Honourary Clinical Teacher, Dundee Dental Hospital
*Correspondence to: Dr Richard Holliday
Email: richard.holliday@nhs.net

Online article number E3
Refereed Paper – accepted 12 November 2014
DOI: 10.1038/sj.bdj.2015.40
©British Dental Journal 2015; 218: E3

- The ability to identify five faulty air turbine handpieces (broken chuck (bur loose), loose spray cap, loose back cap and loose sleeve handle, loose head and collapsed bearings)
- The ability to identify the three 'unsafe' air turbine handpiece faults (broken chuck, loose spray cap and loose back cap).

Standard

There are no published guidelines on this topic. We established a standard by discussion between the authors and the experienced technicians who are responsible for the maintenance of the handpieces in the dental hospital. We felt it appropriate that all participants should be able to identify an 'unsafe' handpieces. We therefore set this audit standard at 100%.

Design

The instrument curator at Newcastle Dental Hospital provided seven handpieces; five of which had faults and two were non-faulty. There were six faults across five handpieces, one handpiece having two faults. All handpieces had faults rendering them unfit for use, with three classified as 'unsafe'. Figure 1 shows these faults.

The audit involved participants (different in each audit) assessing each handpiece in turn and stating if it was safe to use or not. If the handpiece was deemed unsafe then the participant was asked to describe the fault and this was recorded.

RESULTS

A total of 80 participants (40 staff and 40 students) completed the first round of audit and 69 (24 staff, 45 students) completed the second round of audit.

The first round of audit demonstrated that 4% of the participants identified all five faulty handpieces. This increased to 28% in the second round. Figure 2 shows the results for each handpiece individually.

Figure 3 shows the ability of participants to detect the three unsafe handpieces. A subgroup analysis is also shown for staff and students as well as those who had received the intervention (educational video) or not before round two. The ability to detect unsafe handpieces increased from 10% in the first round, to 44% in the second round. In the second round the highest score obtained was by those who had received the intervention, 77%. The lowest score, 14%, was obtained by those who had not received the intervention.

Nine percent of participants in the first round stated they had previously had training on handpiece inspection. None of these participants identified the three unsafe handpieces.

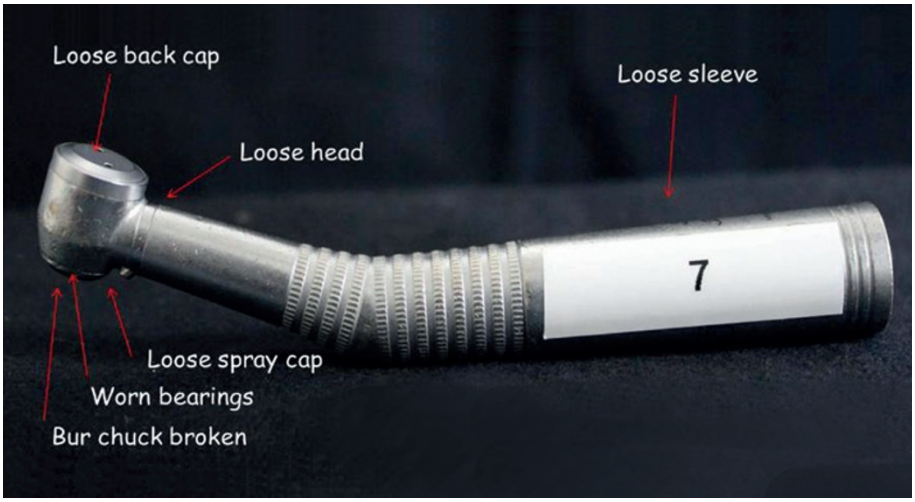

Fig. 1 Six handpiece faults highlighted on an air turbine handpiece

DISCUSSION

The intention of this audit was to highlight the importance of knowledge of handpiece safety within the Newcastle Dental Hospital and to improve this. Little existing literature exists on this topic, however the FDA[3] issued a public health notification in December 2007 following some serious patient injuries, including third degree burns, associated with the use of poorly maintained electric dental handpieces. This was after March 2003, when the FDA received 265 reports of injuries and malfunctions involving over heating of pneumatic and electric powered rotary surgical handpieces.

The results from this audit provide evidence that dental students and qualified dentists did not consistently identify faulty and unsafe air turbine handpieces. It shows that of those sampled very few had received any previous training on this topic. Those who claimed to have undergone previous training did not demonstrate that they could identify unsafe handpieces in practice.

The broken chuck/loose bur scenario was identified by almost 100% of participants whereas the other four faults were only identified by 26–36% of participants. The audit standard was set at 100% of participants being able to identify three grossly unsafe handpieces. The results show that this group was highly deficient in the first round with only 10% of participants identifying the faults.

The audit intervention was an oral presentation of the results at a clinical governance meeting and the development of a short educational video. This video was played at the meeting, distributed to staff and students via email and shown to undergraduate students during their lectures.

The second round of audit showed a general improvement with 44% of participants able to identify the three unsafe faults. Forty-three percent of participants reported that they had watched the educational video. A

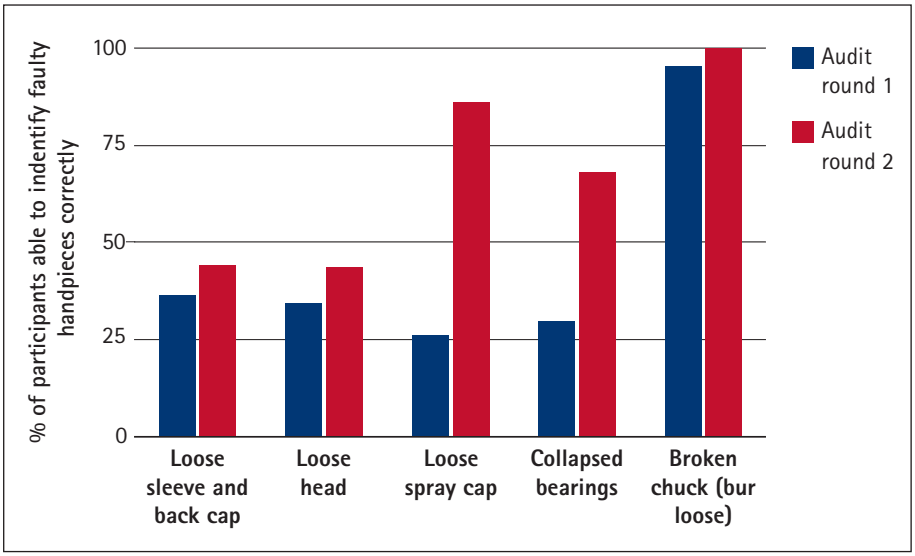

Fig. 2 Ability to identify handpiece faults

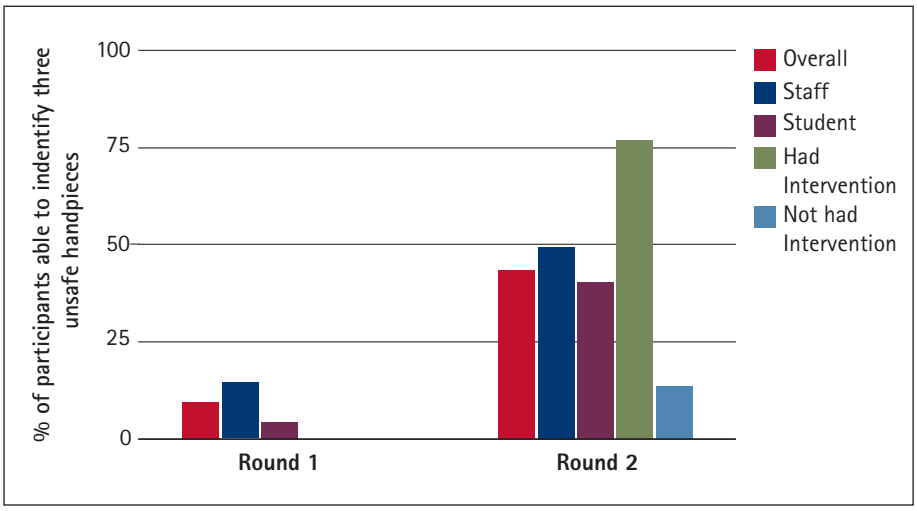

Fig. 3 Ability to detect unsafe handpieces

subgroup analysis showed those who had seen the video were better at identifying the faults with a score of 77%, compared to 14% for those who hadn't seen the video. This latter proportion was not dissimilar to that in the first round. The video was distributed to staff and students on several occasions over a nine month period. We ensured there was at least one month between the last promotion of the video and the second round of audit.

A subgroup analysis was undertaken at both rounds for staff and students. This showed very little difference between the two groups, suggesting this might not be a skill that can be learnt by experience alone and specific training is needed.

When considering the applicability of the results of this audit to the real world it is worth considering the potential influence of the 'Hawthorne effect'. Participants would have been aware of the aims of the audit, and therefore possibly more mindful of analysing the handpieces and conscious of identifying faults. Consequently, the poor unsafe handpiece detection rates in this audit may be even lower in day to day practice.

The educational video lasted for five minutes and detailed common handpiece errors before suggesting a systematic technique for handpiece inspection. The video was made as widely accessible as possible by uploading it to the university virtual learning environment and YouTube (http://youtu.be/VassmwjRSqg). The audit results suggest an impact of the short educational video with an improvement in the performance observed in those who had seen it.

At the School of Dental Sciences at Newcastle University, the teaching of handpiece inspection and use of this educational video has been incorporated into the key clinical skills course of the undergraduate programme. This practical skill may now be assessed during examinations and links with the GDCs learning outcomes on maintenance of equipment, to '*recognise the need for effective recorded maintenance and testing of equipment and requirements for appropriate storage, handling and use of materials*'.[4]

Ideally we would like all of our staff and students to see the video and we will continue to strive towards this. We will continue to circulate the video to staff, particularly targeting junior staff, where there is a high turnover. We are currently developing an e-learning package to add to the mandatory training completed by staff at induction.

The use of checklists in many fields has grown in recent years. The airline industry employ 'crew resource management' techniques to increase situational awareness and this is incorporated into a checklist.[5] The WHO developed a surgical checklist based on this, which has resulted in a reduction of post-operative complications and death rates by 36%.[5,6] A dental checklist tool should include routine handpiece inspection, although such a tool is not yet in regular use.

This audit focused on common generic faults with the air turbine handpiece. As previously mentioned, different designs and manufacturers of handpieces will have their own specific intricacies and common faults. For example, the other main handpiece in use in our hospital is a W&H (W&H, Austria) handpiece. This has a LED light and the chair-side checks for this should include checking the integrity of the glass cover and if the light is functioning. On a similar note the 'slow speed' electric handpieces should be inspected before use in a similar manner to the air turbine handpiece. We acknowledge this audit was conducted in a secondary care environment, on a limited sample size, and differences could potentially exist in primary care where clinicians might be more directly involved in equipment maintenance.

CONCLUSION

This audit has highlighted that there is a knowledge deficiency with regards to air turbine handpiece safety and inspection within the qualified and student dental community in the chosen sample. We have shown that introduction of a simple education video can have an impact on dentists and students' abilities to detect unsafe faults. We have already introduced this into the undergraduate curriculum in our school and we aim to raise awareness within the dental community.

Acknowledgements
The authors would like to thank Alan Brantingham and Steven Colquhoun, instrument curators at Newcastle Dental Hospital for their kind help in the preparation of the faulty handpieces. We would also like to thank Dr McCracken for his kind advice throughout this project and during the production of this manuscript.

1. Stephens R R. The dental handpiece- a history of its development. *Aust Dent J* 1986; **31:** 165–180.
2. Smith G W G, Smith A J, Creanor S *et al.* Survey of the decontamination and maintenance of cental handpieces in general dental practice. *Br Dent J* 2009; **207:** E7.
3. FDA. FDA public health notification: patient burns from electric dental handpieces. 2007. Online information available at: http://www.fda.gov/medicaldevices/safety/alertsandnotices/publichealthnotifications/ucm062018.htm (accessed December 2014).
4. General Dental Council UK. Preparing for practice. Dental team learning outsomes for registration. 2011. Online information available at: http://www.gdc-uk.org/newsandpublications/publications/gdc%20learning%20outcomes.pdf (accessed December 2014).
5. Pinsky H M, Taichman R S, Sarment D P. Adaptation of airline crew resource management principles to dentistry. *J Am Dent Assoc* 2010; **141:** 1010–1018.
6. Haynes A B, Weiser T G, Berry W R *et al.* A surgical safety checklist to reduce morbidity and mortality in a global population. *N Engl J Med* 2009; **360:** 491–499.