

## **BACKGROUND**

Over the last 30 years, there has been a growing concern that the smoke plume formed during surgical procedures using electrocautery or laser destruction of tissue could be a health hazard for operators, assistants, and patients. There is recognition that the chemicals found in the plume are potentially damaging to health, and that the aerosolisation of viruses during procedures could permit disease transmission. These concerns have been highlighted during the COVID-19 pandemic when the realisation of possible spread of a virus with a significant mortality has led to the general adoption of personal protective equipment (PPE) to help protect the surgical team.<sup>1</sup>

Human papillomavirus (HPV) and Merkel cell polyomavirus (MCPV) are present in skin and mucosal lesions which are treated surgically by dermatologists. Surgery involves the use of cauterising devices which generate a surgical smoke plume consisting of vaporised and burnt tissue. HPV and MCPV are relatively resistant to heat due to their external capsid proteins<sup>2,3</sup> and viable infectious viral particles have been detected in surgical plumes<sup>4</sup> with the viral DNA being detectable in the plume,<sup>5</sup> and on the face of surgeons after operations.<sup>6</sup>

HPV infection has been shown to be a necessary event in the development of all cervical cancers,<sup>7</sup> a proportion of other genital cancers, and also head and neck squamous cell carcinomas (HNSCCs), especially oropharyngeal, tonsillar and laryngopharyngeal cancers.<sup>8</sup> MCPV is a factor in the development of Merkel cell carcinoma, a relatively rare skin cancer which is increasing in incidence in Europe and Australia.<sup>9,10,11,12</sup>

The risk of developing cancer in the uterine cervix is strongly associated with the persistence of high-risk HPV infection and HPV16 viral copy number is associated with severity of disease.<sup>13,14</sup> There are also data that higher HPV viral copy numbers may also be associated with HNSCC, especially tonsillar SCCs.<sup>15,16</sup> This suggests that larger, infecting doses of high-risk HPV may increase risk of the persistence of HPV, and thus, risk of cancer at the site of infection. The time between exposure to the virus, and development of a pre-malignant or malignant condition at these sites, is often prolonged and may be years or decades. There are case reports of head and neck infection, including cancer in doctors exposed to high-risk surgical plumes,<sup>17,18,19,20</sup> for example in ENT surgery, gynaecology and more recently in dermatologists specialising in genital disease.

The recent data regarding risks to surgeons from infectious agents and toxic and carcinogenic chemicals in the plume has been reviewed,<sup>21,22,23,24,25</sup> and also assessed by CDC<sup>26</sup> and HSE.<sup>27</sup> The numbers of healthcare professionals recorded as having developed HPV-associated disease in the respiratory tract are relatively small.<sup>28</sup> However, this may be an under-reporting, and it should be remembered that in naturally-acquired genital HPV disease, the majority of individuals clear the infection naturally, a small proportion develop persistent infection, and only a minority progress to malignant disease.

Although the use of PPE for dermatologic surgeons has increased and improved over the years, the amount of surgery done in dermatology has increased, with some dermatologists now spending a large proportion of the week in the operating room.

Risk of surgical plume to patients, assistants and surgeons can be reduced if the plume is removed by means of a smoke extractor used during surgery. These are relatively low-cost portable devices that can be used when surgeons consider that there may be risk.

#### **THE BAD CALLS FOR:**

- (1) Smoke extractors to be available in all settings where dermatology surgery takes place so that surgeons can use these devices when they consider it appropriate.
- (2) Further occupational health research into the risks of virus in surgical plume.

There should be education for doctors and nurses undertaking surgical procedures so that they are aware of the types of lesions (e.g. genital and oral lesions, warts in transplant patients, Merkel cell carcinoma) and procedures (e.g. bipolar cautery rather than unipolar; lower power setting) most likely to generate surgical plumes containing potentially harmful virus particles.<sup>29</sup>

These measures should be in addition to the use of PPE of a level to prevent virus inhalation, as outlined in a previous BAD policy statement.<sup>30,31</sup>

*Prepared on behalf of Officers of the BAD by Nick Levell, Peter Goon and Jane Sterling*

#### **REFERENCES**

1. Pavan N, Crestani A, Abrate A et al. Risk of Virus Contamination Through Surgical Smoke During Minimally Invasive Surgery: A Systematic Review of the Literature on a Neglected Issue Revived in the COVID-19 Pandemic Era. *Eur Urol Focus* 6. 2020: 1058-69.
2. Bonnef, W., Rose, R. C., Borkhuis, C., Da Rin, C., and Reichman, R. C. (1994). *J Clin Microbiol* **32**, 1575-7.
3. Roden, R. B. S., Lowy, D. R., and Schiller, J. T. (1997). *The Journal of Infectious Diseases* **176**, 1076-1079.
4. Garden JM, O'Banion K, Bakus AD, Olson C. Viral disease transmitted by laser-generated plume (aerosol). *Arch Dermatol* 2002; 138(10): 1303-7.
5. Kashima HK, Kessis T, Mounts P, Shah K. Polymerase Chain Reaction Identification of Human Papillomavirus DNA in CO2 Laser Plume from Recurrent Respiratory Papillomatosis. *Otolaryngol Head Neck Surg* 1991;104(2): 191-5. [doi.org/10.1177/019459989110400206](https://doi.org/10.1177/019459989110400206).
6. Bergbrant I M, Samuelsson L, Olofsson S et al. Polymerase chain reaction for monitoring human papillomavirus contamination of medical personnel during treatment of genital warts with CO2 laser and electrocoagulation 1994, *Act Derm Venereol* **74**, 393-5.
7. Walboomers, J. M., Jacobs, M. V., Manos, M. M., Bosch, F. X., Kummer, J. A., Shah, K. V., Snijders, P. J., Peto, J., Meijer, C. J., and Munoz, N. (1999). *J Pathol* **189**, 12-9.
8. Goon, P. K., Stanley, M. A., Ebmeyer, J., Steinstrasser, L., Upile, T., Jerjes, W., Bernal-Sprekelsen, M., Gerner, M., and Sudhoff, H. H. (2009). *Head Neck Oncol* **1**, 36.
9. Fondain, M., Dereure, O., Uhry, Z., Guizard, A. V., Woronoff, A. S., Colonna, M., Molinie, F., Bara, S., Velten, M., Marrer, E., Grosclaude, P., Lapotre-Ledoux, B., Tretarre, B., and Guillot, B. (2018). *J Eur Acad Dermatol Venereol* **32**, 1292-1296.

10. Goon, P. K., Greenberg, D. C., Igali, L., and Levell, N. J. (2016). *J Eur Acad Dermatol Venereol* **30**, 2052-2055.
11. Mills, L. A., Durrani, A. J., and Watson, J. D. (2006). *Surgeon* **4**, 133-8.
12. Youlden, D. R., Soyer, H. P., Youl, P. H., Fritschi, L., and Baade, P. D. (2014). *JAMA Dermatol* **150**, 864-72.
13. Swan, D. C., Tucker, R. A., Tortolero-Luna, G., Mitchell, M. F., Wideroff, L., Unger, E. R., Nisenbaum, R. A., Reeves, W. C., and Icenogle, J. P. (1999). *J Clin Microbiol* **37**, 1030-4.
14. Zerbini, M., Venturoli, S., Cricca, M., Gallinella, G., De Simone, P., Costa, S., Santini, D., and Musiani, M. (2001). *J Clin Pathol* **54**, 377-80.
15. Deng, Z., Hasegawa, M., Kiyuna, A., Matayoshi, S., Uehara, T., Agena, S., Yamashita, Y., Ogawa, K., Maeda, H., and Suzuki, M. (2013). *Head Neck* **35**, 800-8.
16. Koskinen, W. J., Chen, R. W., Leivo, I., Makitie, A., Back, L., Kontio, R., Suuronen, R., Lindqvist, C., Auvinen, E., Molijn, A., Quint, W. G., Vaheri, A., and Aaltonen, L. M. (2003). *Int J Cancer* **107**, 401-6.
17. Hallmo P, Naess O, Laryngeal papillomatosis with human papillomavirus contracted by laser surgery. *Eur Arch Otorhinolaryngol* 1991 248(7):425-7.
18. Calero L, Bruis T. [Laryngeal papillomatosis - first recognition in Germany as an occupational disease in an operating room nurse]. *Laryngorhinootologie* 2003; 82: 790-3.
19. Hu X, Zhou Q, Yu J, Wang J, Tu Q, Zhu X. Prevalence of HPV infections in surgical smoke exposed gynecologists. *Int Arch Occup Environ Health* 2020 [doi.org/10.1007/s00420-020-01568-9](https://doi.org/10.1007/s00420-020-01568-9).
20. Rioux, Margo; Garland, Andrea; Webster, Duncan; Reardon, Edward. HPV positive tonsillar cancer in two laser surgeons: case reports. *J Otolaryngol Head Neck Surg* 2013; 42(1): 54-7.
21. Mellor G, Hutchinson M. Is it time for a more systematic approach to the hazards of surgical smoke? Reconsidering the evidence. *Workplace Health and Safety* 2013; 61(2): 265-270. Published version available from: [doi.org/10.3928/21650799-20130516-12](https://doi.org/10.3928/21650799-20130516-12).
22. Goon PKC, Goon PKY, Tan EKH et al. Virus-induced cancers of the skin and mucosa: Are we dealing with "Smoking Guns" or "Smoke and Mirrors" in the operating theatre? *Dermatol Ther* 2017; 7: 249-54.
23. Tan E, Russell K. Surgical plume and its implications: A review of the risk and barriers to a safe workplace. *ACORN: The Journal of Perioperative Nursing in Australia*, 2017; 30(4): 33-39.
24. Fox-Lewis A, Allum C, Vokes D et al, Human papillomavirus and surgical smoke: a systematic review. *Occup Environ Med* 2020 May 8. [doi.org/10.1136/oemed-2019-106333](https://doi.org/10.1136/oemed-2019-106333).
25. Liu Y, Song Y, Hu X et al. Awareness of surgical smoke hazards and enhancement of surgical smoke prevention among the gynecologists. *J Cancer* 2019; 10: 2788-99.
26. CDC, The National Institute for Occupational Safety and Health (NIOSH), Health and Safety Practices Survey of Healthcare Workers: Surgical Smoke. Accessed at: [www.cdc.gov/niosh/topics/healthcarehps/smoke.html](https://www.cdc.gov/niosh/topics/healthcarehps/smoke.html).
27. Beswick A, Evans G. Evidence for exposure and harmful effects of diathermy plumes (surgical smoke). Health and Safety Executive 2012. Accessed at: [www.hse.gov.uk/research/rrpdf/rr922.pdf](https://www.hse.gov.uk/research/rrpdf/rr922.pdf).
28. Kofoed K, Norrbom C, Forslund O et al. (2015). Low prevalence of oral and nasal human papillomavirus in employees performing CO2-laser evaporation of genital warts or loop electrode excision procedure of cervical dysplasia. *Acta Dermatovenereologica*, 2015; 95(2): 173-176. [doi.org/10.2340/00015555-1912](https://doi.org/10.2340/00015555-1912).
29. Searle T, Ali FR, Al-Niaimi F. Surgical plume in dermatology: an insidious and often overlooked hazard. *Clin Exp Dermatol* 2020; 45: 841-7.
30. [www.bad.org.uk/shared/get-file.ashx?itemtype=document&id=6728](https://www.bad.org.uk/shared/get-file.ashx?itemtype=document&id=6728).
31. [www.bad.org.uk/shared/get-file.ashx?itemtype=document&id=6670](https://www.bad.org.uk/shared/get-file.ashx?itemtype=document&id=6670).