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Retinal burns from laser pointers, a risk in children with behavioural problems.

Keywords: CHILDREN, EYE INJURY, LASER, RETINA, SELF-INJURIOUS BEHAVIOUR

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ABSTRACT

Objective: To explore self-inflicted retinal burns from laser pointers in children.

Methods: Literature review of laser pointer retinal injuries in childhood and online survey of UK Consultant Ophthalmologists. A cohort of local children with self-inflicted injury are described. The matter is topical. We review progress in recent legislation and policy change in the UK

Results: Four of 77 case reports of laser burns in childhood analysed reported psychological or behavioural issues. Three of 4 children in our cohort had such issues. Delay in diagnosis occurred in two of our patients. Structural retinal damage persisted for over 12 months in all 4 children (7 eyes). Our survey of UK ophthalmologists found 159 cases of injury (85% male), 80% under 20 years of age. The majority of the laser pointers were purchased online. Many patients (36%) suffered moderate vision loss (6/18 to 6/60 Snellen), while 17% (at least 11 patients) suffered severe vision loss (<6/60 Snellen).

Conclusion: We highlight the risk of macular damage and vision loss from handheld lasers specifically in children with behavioural, learning or mental health issues. The diagnosis may be difficult or delayed in such children. In children with uncertain macular changes, ophthalmologists should explore the history for possible instances of exposure to handheld lasers pointers. Regulatory authorities and manufacturers of handheld lasers need to be aware of the risk to children. Furthermore, there is a need to better inform parents, carers and teachers of the risk of ocular self-injury from such lasers pointers

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1 INTRODUCTION

2 Laser pointers (sometimes termed laser pens) are handheld laser devices intended for
3 pointing out objects or locations, including for demonstration and amusement purposes.
4 Such lasers should have minimal risk of causing harm to vision. However, retinal injury
5 from laser pointers is causing concern due to the wider availability of more powerful and
6 cheaper laser pointers. The authors have encountered both adults and children with such
7 injuries, including self-inflicted retinal injury from the misuse of high-powered handheld
8 laser pointers. To explore this further in childhood we undertook both qualitative and
9 quantitative ('mixed methods') research and also met with stakeholders in the UK. The
10 material presented herein includes a literature review, a survey of UK ophthalmologists,
11 clinical follow up of 7 eyes of 4 local children with self-inflicted laser burns diagnosed in UK
12 hospital practice and an update of our engagement with stakeholders and policy makers.

13

METHODS

15

1 Literature review.

17 We located all reports of laser pointer injury available on MEDLINE (on Ovid from
18 1966) and EMBASE (on Ovid from 1980) and ISI Web of Science (from 1990).

19 Keywords and MESH terms for 'laser pointer' and 'retina' or its similes were used. The
20 final list of titles and abstracts was screened by two reviewers (EL and AW) and full
21 publications were obtained where articles were thought to be potentially relevant.

22 Bibliographies of included studies and review papers were screened to identify other
23 relevant studies. The literature search is accurate and up to date as of 19th March
24 2018. We searched for reports of self-inflicted laser burns where children were involved
25 and then systematically explored for any psychological and behavioral features

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26 recorded in such reported childhood cases. We excluded patients described as being
27 over 18 years old at time of injury and studies where the full articles were not available in
28 English.

29

2 Survey of UK Ophthalmologists.

31 An online survey of UK consultant ophthalmologists was undertaken in January 2016 by
32 one of our senior authors to explore their experience of laser pointer injury. A brief online
33 survey was emailed to 990 consultant ophthalmologists in the UK, asking whether they
34 had encountered a patient who suffered macular injury due to misuse of a handheld laser
35 device.

36 Ophthalmologists who gave a positive answer were also asked: the number of such laser
37 pointer burn patients they had encountered; ages and gender of patients; whether the
38 injury was accidental, self-inflicted or deliberate; the power and colour of the laser beam
39 and where purchased; visual outcome and optical coherence topography (OCT) and visual
40 field evidence. To keep the survey brief and encourage completion, ophthalmologists who
41 indicated seeing more than 2 patients were only asked to provide the details of the most
42 and least affected patients. The data was analysed based on fully completed surveys.

43

3 Case Series.

45 A convenience sample of four children (7 eyes) with self-inflicted retinal injury from laser
46 pointers who presented to hospitals in Bolton, Bristol and Preston within a 12 month period
47 and who have over 12 months follow up are presented. Informed parental consent for
48 publication of clinical details and images was obtained all children in this cohort

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49 RESULTS

50

51 Literature review

52 In the literature review we located 84 cases of handheld laser burns in children age 18
53 years or younger reported on 19/03/2018.¹⁻⁴⁶ (**Table1:Supplementary Material**).This
54 includes a case series that the senior authors (SPK and FMQ) previously provided.¹²
55 Within these reports we systematically located one child with a pre-existing diagnosis of
56 attention deficit hyperactivity disorder (ADHD), a second child had known learning
57 difficulties and the third who was undergoing psychological treatment following a road
58 traffic accident.^{8-9,17} In one further case report we detected that a young person was
59 referred for psychiatric evaluation following retinal injury from self-harming behaviour with
60 handheld lasers.³⁸ We acknowledge a case report of laser maculopathy in a twenty year
61 old man in France with schizoid personality, but this is excluded from Table 1 which
62 highlights cases of children.²¹ Two further abstracts were identified of laser eye injuries in
63 children but the full articles were not available in English, therefore limited information is
64 included in Table 1 and we cannot exclude any contributing psychological or behavioural
65 problems in these children.^{22,29}

66

67 Survey of UK Ophthalmologists

68 The survey submitted to 990 Consultant Ophthalmologists in the UK, using a 'mailing'
69 database of email addresses of UK NHS Consultants, by one of the senior authors (FMQ)
70 had a response rate of 15.5% and identified 159 cases of macular injury. Many injuries
71 occurred within the year preceding the survey (54%) with most of the affected patients
72 (80%) under 20 years of age or male (85%).

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73 Most laser pointers were reported as having been purchased online. Many patients (36%)
74 suffered moderate vision loss (6/18 to 6/60 Snellen), while 17% suffered severe vision loss
75 (<6/60 Snellen). Visual acuity was not affected in 15% of cases.

76 Many of the injuries happened due to lack of awareness of the danger, and were either
77 self-inflicted (35%) or caused by a third party (36%). There were no cases of assault
78 reported. No relevant results on the colour of laser beam was provided. The power of
79 known devices exceeded 50 mW in 33% of cases. The survey has been presented as a
80 poster.⁴⁷

81

82 **Case series.** We describe 4 local children (7 eyes) with self-inflicted retinal
83 damage from handheld laser pointers with more than 12 months follow up. All showed
84 persistent outer retinal lamellar layer defects on spectral domain ocular coherence
85 tomography (SD-OCT). Three children had a history of mental health or psychological
86 challenges. All cases presented to our 3 hospitals within a 12 month period.

87

88 **Case 1**

89 An 11 year old male, with a diagnosis of pathological demand avoidance (PDA) and
90 migraine, presented to a community optometrist with a two day history of a black spot in
91 the central vision of his right eye. The optometrist reported that the best corrected visual
92 acuity (BCVA) in the right eye was reduced to 6/10 Snellen having been normal at a prior
93 visit. Left was 6/5 Snellen. New pigmentary changes at both macula were observed by the
94 optometrist and referral was made to the hospital eye service (HES). He was taking
95 pizotifen prescribed for migraine. There was no relevant past ocular, medical or family
96 history. Six weeks later, in the hospital eye service (HES) review, he described a
97 persistent 'blur' in the central vision of the right eye. Unaided VAs were 6/9 right and 6/5

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98 left. Pigmentary changes were noted at the central macula in both eyes. Spectral domain
99 optical coherence tomography (SD-OCT) and imaging revealed bilateral outer lamellar
100 layer defects. (**Figure 1**). Electrodiagnostic tests were normal but with limited co-operation.
101 His mother accompanied him for all HES visits. In due course and following direct
102 questioning he admitted to constructing a device made from Lego™ consisting of a laser
103 pointer with a condensing lens used just prior to the onset of visual symptoms. The
104 patient's mother revealed that she had purchased the laser pointer online for him. During
105 follow up he reported symptomatic improvement and the VA remained stable. Centre
106 involving structural defects at both macula persisted on clinical examination and OCT
107 imaging to most recent follow up 24 months later. (**SUPPLEMENTARY IMAGE 1**). The
108 mother confirmed the laser had been purchased from a well-known UK online retailer and
109 was still available for online purchase a year following the incident.

110

111 Case 2

112 A 13 year old male with attention deficit disorder (ADD) presented to the Emergency
113 Medicine Department accompanied by his mother complaining of visual disturbance after
114 staring into the beam from a toy laser for a few hours earlier that day. The patient stated
115 that the toy laser belonged to a friend but the injuries were self-inflicted. The BCVA was
116 6/60 in the right eye improving to 6/36 with pinhole, and 6/12 in the left eye. SD-OCT
117 images on presentation showed full-thickness hyper-reflective damage involving both fovea
118 (**Figure 2**). The patient was on methylphenidate 57mg daily treatment for ADD and was
119 known to Child and Adolescent Mental Health Services (CAMHS). He attended mainstream
120 school with additional classroom support but was not classified as having special
121 educational needs, with no statement of educational needs undertaken previously. Six
122 weeks later, his BCVA had improved to 6/12 right and 6/9 left. An improvement in SD-OCT
123 images was observed, notably an improvement in inner retinal layers. However, the centre

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124 involving outer lamellar layer defects on OCT and fundus changes persisted throughout 24
125 months of follow up but decreased.

126 Case 3

127 A 15 year old female with no past medical or psychological history was referred following a
128 routine sight test where new discrete pigmentary changes at the right fovea were
129 observed. The patient was asymptomatic. Her past ocular history, medical and family
130 history were unremarkable. The unaided VA was 6/7.5 in both eyes. Two full thickness
131 centre involving round scars at the right fovea were observed and a third slightly eccentric.
132 SD-OCT revealed defects in the ellipsoid zone in the outer retina in these lesions (**Figure**
133 **3**). The patient admitted to being involved in a 'competition game' with three other children
134 about two years previously in the home. The 'game' consisted of ascertaining which child
135 could withstand a green laser beam in one eye for the longest time. She recalled shining
136 the laser into her right eye for short duration, perhaps 10 seconds twice. The laser pointer
137 had been purchased online by the patient's mother.

138 The laser pointer responsible was retrieved from the family and sent for analysis. The
139 analysis found the laser pointer was of wavelength 532nm with an average power of
140 47mW, making it a Class 3B laser. The label on the laser pointer incorrectly stated that it
141 was "Class II" with a maximum output less than 1mW. (**SUPPLEMENTARY IMAGE 2**). At
142 latest follow up, at 24 months the macular changes persisted with 6/6 Snellen in each eye.
143 **SUPPLEMENTARY IMAGE 3**).

144 Case 4

145 A 12 year old boy was referred with a several month history of reduced vision in both eyes.
146 He had a history of expressive and receptive language impairment and was attending a
147 specialist school for children with cognitive impairment and disturbed behaviour. He was

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148 under CAMHS for anger and behavioural problems. There was no relevant past ocular or
149 family history. The presenting BCVA were 6/30 right eye and 6/75 left eye. Colour vision
150 was reduced, with only 4/17 Ishihara plates correctly identified in the right eye and 9/17 in
151 the left eye. Bilateral multifocal macular pigmentary changes were noted. **(Figure 4)**. To
152 investigate abnormal visual function, electrodiagnostic tests and magnetic resonance
153 imaging (MRI) of the brain and orbits were performed, both of which were normal.

154 At subsequent follow up and on direct questioning, the boy revealed he had been playing
155 with laser pointers at school, particularly in games involving looking directly into the beam
156 of the laser pointer. His BCVA at 12 months follow-up was 6/19 right eye and 6/48 left eye.
157 Fundus examination showed irregular pigmentation at the right macular and a scar at the
158 left macular. OCT scan showed small, round, punched-out lesions more frequent in the left
159 than the right macula.

160

161 DISCUSSION

162

163 Retinal burns from handheld laser pointers are an important and increasingly topical public
164 health issue. Such devices are becoming more powerful, less costly, are often incorrectly
165 labeled, and can be easily purchased online. Furthermore, there is increasing
166 apprehension for aviation safety following suspected retinal injuries to commercial airline
167 pilots falling victim to laser attacks.^{19,27} Lee et al reported that young males were the most
168 frequent group reported to sustain handheld laser pointer injuries in reports from 1999-
169 2014.² Our survey of UK ophthalmologists supports these findings, with results showing
170 85% of reported cases were male and 80% of all patients were under 20 years of age.⁴⁷
171 Our literature review also concurs with these findings, with 73% of cases being young
172 males. While laser burns, including self-inflicted, can affect adults it is opined that children

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173 are at greater risk of laser pointer injuries than adults as they are intrigued by their
174 appearance, and lack protective mechanisms of blinking and gaze aversion that adults
175 exhibit and furthermore have clear ocular media which provides little protection from laser
176 injury.^{2,6-7} The majority of the laser pointer injury cases encountered by the UK
177 ophthalmologists were reported as having occurred from laser pointers that had been
178 purchased online. Clinical management of laser-induced retinal injuries is anecdotal, on
179 occasion oral corticosteroids have been prescribed.^{2,7,13}

180 In our survey of UK ophthalmologists, the reported visual acuity in affected patients was
181 reported as 6/18-6/60 in 36% and worse than 6/60 in 17% of cases.⁴⁷ In our literature
182 review the visual acuity at presentation was 6/18-6/60 in 36% and worse than 6/60 in 28%
183 of cases. The final visual acuity, where reported, was 6/18-6/60 Snellen acuity in 24% and
184 worse than 6/60 in 5% of cases.

185 We acknowledge a recent review by Birtel et al which identified 111 patients of unstated
186 ages with laser pointer eye injuries in the literature.⁵ They found highly variable retinal
187 injuries across the literature, including; macular holes, retinal haemorrhage and on OCT
188 imaging disruption of retinal pigment epithelium, outer retinal hyper reflectivity and
189 disruption of outer retinal layers. That review did not document patient factors or patient
190 age or if the injury was self-inflicted.

191

Classifications and misclassification of lasers.

193 The revised UK classification of laser products consists of eight categories; Class 1, 1C,
194 1M, 2, 2M, 3R, 3B and 4, with Class 4 lasers being the highest radiation hazard.⁴⁸ The
195 World Health Organisation (WHO) stated in 1998 that "laser pointers higher than class 2
196 are considered too powerful for general use as laser pointers and present an unacceptable

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197 risk in the hands of consumers because they may cause eye injury”.⁴⁹ Class 2 laser
198 products have a maximum power of 1 milliwatt and fall within the visible wavelength range
199 400-700nm. In 2014 Public Health England advised “the sale of laser products to the
200 general public for use as laser pointers should be restricted to Class 1 or Class 2 devices”
201 and further advised “toys should be class 1 or of such low output that they do not need to
202 be classified”.⁵⁰ In the United States (US) the Food and Drug Administration (FDA) are:
203 class I, IIa, II, IIIa, IIIb and IV with increasing numbers corresponding to higher output
204 power.⁵¹ FDA permits laser pointers with a maximum power of 5 milliwatts (class IIIa) in
205 the visible wavelength region of approximately 400-710 nanometers.⁵² However, handheld
206 laser pointers are widely available to purchase online, often do not conform to such
207 regulations or carry appropriate labelling of the laser power or carry warnings with regard
208 to the ocular risk involved. There are reports of these devices being misclassified and
209 found to have a higher output than stated when objectively tested.^{2,3,9,11} Incorrect labelling
210 increases ocular hazards; a consumer or parent may think that a Class 2 laser will be safe
211 – but if in reality the device is a Class 3B then the risk will be far greater than anticipated.
212 Recent publications have highlight concerns of incorrect labelling of lasers in the USA,
213 Australia and UK.⁵³⁻⁵⁵ Case 3 in our series is a further example of misclassification. The
214 parents of the children in our series reported that they were unaware of the ocular risks of
215 children misusing laser pointers. This also chimes with other case reports. Lastly, in some
216 cases the parents were unaware that their child was in possession of such devices.²

217

Classification and misclassification of laser retinal injury in children

219 Diagnosis of laser pointer retinal injuries in childhood can be difficult, as children and
220 parents may be hesitant to admit to use and purchase of such devices. Additionally, laser
221 retinal injuries may have similarities in clinical appearance to other retinal disorders and

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222 lead to misdiagnosis, delayed diagnosis and unnecessary investigations or treatment. A
223 recent case series from Moorfields Eye Hospital reported that 5 of the 16 children with
224 laser injury were initially suspected to have macular dystrophies which delayed their
225 diagnosis.³¹ Cases 1 and 4 in our series were also initially similarly mistaken as such. We
226 are aware of another case locally being mistaken for macular inflammation. However, the
227 changes seen on SD-OCT imaging namely focal disruption of the ellipsoid zone are
228 diagnostic of photic maculopathy.^{2-4,7,9,11,13,39} The recognition of such outer retinal layer
229 defects should prompt a thorough history to enquire if the child has been exposed to a
230 beam from a laser pointer or sun gazing. Zhang et al also commented on similarities
231 between photic macular injuries and macular genetic conditions and opined laser pointer
232 burns patients may improve over time whereas genetic conditions do not.¹⁵ We noted
233 some improvement in the 7 eyes studied but all had centre involving structural damage on
234 SD-OCT persisting after a year or more of follow up. It has been opined that it may be
235 possible to differentiate between self-inflicted and third-party induced laser retinal injuries
236 on SD-OCT imaging. Bhavsar et al reported that self-inflicted laser injuries had a streak-
237 like appearance, whereas injuries caused by others tended to be discrete lesions in close
238 proximity to the fovea.⁴ Our study does not confirm this impression as we saw discrete
239 injury in the presence of self-inflicted injury. A recent report of 4 children suggested that
240 the most significant variables predictive of retinal injury in laser pointers are the amount of
241 energy delivered by the laser, duration of exposure and location of retinal involvement.⁴⁴
242 The Moorfields study of children added a proposed classification of severity of laser burn
243 structural damage which we welcome.³¹

244

245

246

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247 **Behavioural and psychological issues in children with self-inflicted injury**

248 Neither of two recent case series of childhood laser retinal burns or a recent literature
249 review of cases of any age reported any children's co-existent behavioural profiles or
250 whether self-injurious behaviour was a factor.^{31,44,5} Similarly in the literature review we
251 undertook searching systematically for such matters in children few reports gave details of
252 children's general or psychological status. We opine that many authors were either
253 unaware of children's behavioural issues or else did not report such details, including
254 absence of any behavioral matters, in their case reports. In any event although we found a
255 small number of case reports that noted existing psychological, psychiatric, behavioural or
256 learning problems in those affected, to our knowledge no reports to date highlight the risk
257 of handheld laser possession in such children or explore a relationship between these
258 diagnoses and laser eye injuries.^{8,9,17,38} Case 1 in our series had a diagnosis of
259 pathological demand avoidance (PDA) syndrome. Newson et al described children with
260 PDA as having a resistance and avoidance of demands as well as impulsive and
261 obsessive behaviour and suggested it be a clinical entity in its own right rather than a sub-
262 type of autism.⁵⁶ The first systematic comparison of PDA and autism spectrum disorders in
263 2014 reported that children with PDA showed characteristics of both autism - such as peer
264 problems - as well as traits of conduct disorders such as anti-social behaviour.⁵⁷ In our
265 Case 2, the patient had a diagnosis of attention deficit disorder (ADD) , also known as
266 attention deficit hyperactivity disorder (ADHD). Children with ADD/ADHD exhibit
267 behavioural problems and inattention, hyperactivity or impulsivity.⁵⁸ In our opinion the
268 common themes of impulsive, obsessive behaviours and a resistance to following
269 instructions puts children with such conditions at risk of self-injurious behaviour and
270 importantly more so if they are in possession or playing unsupervised with objects such as
271 powerful handheld lasers. Our third child did not have any diagnosed mental health
272 problems but did take part in a 'game' that exposed her to direct laser pointer exposure for

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273 whatever reason. Case 4 had complex behavioural challenges. Two of our 4 children were
274 linked to CAMHS services.

275 Self-injurious behaviour (SIB) is considered “a class of behaviours, which the individual
276 inflicts upon his/herself that have the potential to result in physical injury”.⁵⁹ Weiss explains
277 the subtle comparison between individuals with developmental disabilities unknowingly
278 behaving in a way that leads to harm, and those who set out with an intent to hurt
279 themselves, for example in attempts to take their own life.⁶⁰ Self-injurious behaviour has
280 an estimated prevalence of 35-60% amongst people with autism.⁶¹ Self-injurious trauma to
281 the eye is recognised in children with autism and related conditions. Patton reviewed the
282 relevant literature in 2004 and reported that ‘head-banging’ was a common mechanism of
283 ocular injury in children with autism.⁶² Very recently, Lee et al reported three case of
284 bilateral cataract following self-inflicted trauma in children with autistic spectrum disorder.⁶³
285 Our report highlights another novel ocular self-injurious behaviour in such individuals.

286

287 Regulation of laser pointers

288 Recent editorials by Marshall et al and Bartsch et al provided perspectives on the
289 regulation and safety and hazards of laser pointers from a UK and US viewpoint.^{26,64} The
290 review by the Swedish Radiation Safety Authority of 46 cases from the world literature of
291 laser pointer burns is useful as severity and mechanism of injury where known are outlined
292 in that report.⁶⁵ In our clinical experience powerful handheld laser pointers in the hands of
293 children with behavioural, learning and or mental health problems is a dangerous risk. We
294 thus wish to draw attention to this hazard. The matter is relevant for parents and regulators.
295 Importantly the classification of laser pointers in various jurisdictions and the advice by
296 Public Health England in the UK does not take into account the potential for ocular harm
297 from prolonged self-inflicted exposure, as occurred in the children reported herein. With

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298 regard to retinal hazards, labels seem designed for laboratory scientists and not
299 necessarily for the general public and importantly labeling may not reflect the true class of
300 the laser –as misclassified. A word such as “Class 3R” means little to the non-expert. The
301 public may falsely assume that these ‘toys’ are safe as they are approved for general sale.
302 Self-inflicted injury at close range in children and from misclassified laser pointers adds to
303 our concern as does the increasing availability of cheaper and more powerful handheld
304 lasers.

305 The senior authors (SPK and FMQ) have alerted the Royal College of Ophthalmologists
306 and the Royal Society for the Prevention of Accidents on our concerns and attended a
307 workshop on the matter hosted by Public Health England (PHE). The UK government
308 reviewed the evidence of harm to children and risk to pilots following a multi-agency
309 meeting in February 2016 before deciding it’s approach to tackling this mounting ocular
310 public health problem. One of the senior authors (FMQ) used the data from the recent
311 online survey of UK ophthalmologists to inform that multi-agency meeting.⁴⁷ Following
312 this multi-agency meeting PHE launched an online health awareness video following the
313 concern surrounding ocular hazards from laser pointers.⁶⁶ We welcome that video and
314 publicity about laser pointers by some local trading standards authorities.⁶⁷ In May 2018,
315 the Laser Misuse (Vehicles) Act gained Royal Assent. Under this new legislation
316 individuals who target drivers of trains, buses, boats or planes can be jailed for up to five
317 years, and the previous cap on the maximum fine of £2500 has been lifted.⁶⁸ The
318 Government Department for Business, Energy and Industrial Strategy ran a Call for
319 Evidence on Laser Pointers in 2017 and published their response in January 2018.⁶⁹ This
320 document summarises the four steps the Government will take in reaction to the call for
321 evidence; provide additional support for enforcement activities around the import of high
322 powered lasers, encourage more effective voluntary labelling of laser pointers, promote
323 public awareness on the hazards of laser pointers particularly eyesight and address pilots

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324 concerns via the aforementioned Laser Misuse (Vehicles) Act 2018.^{68,69} We believe that
325 this mixed methods publication assists promoting awareness of a specific ocular public
326 health concern in children in addition to the known wider concerns including for adults.
327 Furthermore the conviction and sentencing in 2016 of an individual for the sale of a laser
328 pointer that caused eye injury in a child was an important step by UK authorities in the
329 enforcement of the regulations surrounding sale of laser products.⁷⁰ However we remain
330 concerned about online sale of powerful laser pointers.

331 The strengths of this mixed methods contribution include its addition to the public health
332 debate and literature by highlighting the risks of retinal burns from laser pointers in children
333 - particularly with respect to children with behavioural problems - and our engagement with
334 UK laser safety stakeholders. We assessed the number, age and gender and visual
335 outcomes of patients with laser injury encountered via UK consultant ophthalmic
336 colleagues using an online survey. A limitation was the poor response rate and thus data
337 so obtained does not provide the true incidence and clinical features of such cases; this
338 which would require formal case finding such as the British Ophthalmic Surveillance Unit
339 (BOSU) undertakes. Our case series is small but has over 12 months follow up data. We
340 are of the opinion that further formal public health case finding and surveillance research is
341 warranted to assess the epidemiology of retinal laser pointer burns and the profile and
342 outcomes of patients who sustain such injury. Cohort studies from hospital eye clinics
343 would be of merit to provide information on OCT biomarkers and prognosis. Such matters
344 may be complicated by the issues that parents may not be aware of their children having
345 laser pointers and or families may be reluctant to disclose such information even where
346 known.

347

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350 **IMPLICATIONS FOR POLICY**

351

352 The recognition by UK Government for the need for more robust regulation of the
353 importation and sale of laser pointers, including online sales is reassuring as is the Laser
354 Misuse (Vehicles) Act 2018 which was recently given Royal Assent.⁶⁷ There is a need for
355 ophthalmologists to closely question all patients especially children with retinal outer
356 lamellar layer defects (best appreciated on SD-OCT imaging) for any history of laser
357 pointer exposure before considering further tests for macular disorders. Importantly there
358 is a need for increased public awareness and education of the ocular hazards of laser
359 pointers.⁶⁹ In particular, parents, and especially parents of children with conditions that
360 may increase risk of self-injurious behaviour should be aware powerful and often
361 incorrectly classified handheld lasers pointers can be dangerous to sight. Specifically the
362 availability of high powered and also mislabeled laser pointers remains a concern.
363 Because such lasers are readily available, children likely to self-harm may be at greater
364 risk of shining laser beam into their eyes, perhaps for longer periods of time. We urge the
365 manufactures of handheld laser pointers and their vendors to consider our concerns. We
366 urge the regulators, manufacturers and distributors of laser pointers -including online
367 merchants- to be more vigilant given this novel concern of vision loss in at risk children.

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