

## PEPYS'S EYES: A MODERN ANSWER TO AN OLD CONUNDRUM?

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### ABSTRACT

Samuel Pepys was forced to abandon his renowned diary because of increasing pain and fear of impending blindness. In addition to having refraction errors, it has been suggested that he may have had ocular surface disease to account for his hitherto unexplained photophobia. This article uses new resources to re-examine Pepys's symptoms working on the hypothesis that he suffered from dry eye disease. Applying the diagnostic algorithm provided by DEWS II corroborates the hypothesis and provides the basis of a unifying diagnosis of eye strain similar to digital eye strain that would explain all of his symptoms.

**Keywords:** samuel pepys, diary, dry eye disease, digital eye strain.

31st May 1669. *"And thus ends all that I doubt shall ever be able to do with my own eyes in the keeping of my journal, I being not able to do it any longer, having done now so long as to undo my eyes almost every time that I take a pen in my hand; ... And so I betake myself that course which [is] almost as much as to see myself go into my grave - for which, and all the discomforts that will accompany my being blind, the good God prepare me."*

So ended the most famous diary in English literature authored by Samuel Pepys nearly every day from 1st January 1660 to 31st May 1669. Written in shorthand the diary chronicled not only major historical events such as the restoration of Charles II, the Fire of London, and the Great Plague but also minute and often intimate details about his daily life in restoration-era London.

Pepys was a polymath with a wide variety of interests including matters concerning his health perhaps engendered by his surviving the removal of a bladder stone at the age of 23 years. For much of the later diary period, Pepys was dogged with symptoms related to his eyes which eventually forced him to abandon the journal, he described these in great detail yet generations of clinicians have struggled to reach an overarching diagnosis.

Starting with Sir D'Arcy Power in 1895, authors have come to a consensus that Pepys had some sort of refractive error combined with an imbalance of the ocular muscles.<sup>1, 2, 3, 4, 5</sup> The most recent and comprehensive review suggests that he had mild hypermetropia and astigmatism combined with a convergence deficiency obliging him to strain to focus both eyes on close work.<sup>6</sup> The authors acknowledged however that their proposed diagnoses would not explain the photophobia about which Pepys complained so bitterly and suggested other mechanisms such as chronic inflammation secondary to systemic disease or ocular surface disease (OSD) due to chronic infection or pollutants like candle smoke.

This article takes the hypothesis that Pepys had OSD one step further using information that was not available to previous researchers, and presents for the first time a credible unifying diagnosis.

The only version of the diary available to early medical writers was H.B. Wheatley's incomplete transcription published in 1893. A complete version with comprehensive sub-notes was edited by Latham and Matthews in 1971<sup>7</sup> and in 2003 a searchable online version appeared as a realtime blog created by Phil Gifford.<sup>8</sup>

Secondly, there has never been such a comprehensive review of OSD in general and dry eye disease (DED) in particular as the two Dry Eye Workshops (DEWS) sponsored by the Tear Film and Ocular Surface Society (TFOS) published in 2007 and 2017 respectively.<sup>9</sup> The 12 subcommittee reports make it possible to analyze Pepys's ocular history through a sharper lens than ever before.

The diary is such a rich source of detail of so many aspects of Pepys's life that it enables us to trace the progress of his eye problems from beginning to end; not only is it possible to discern his symptoms change in nature, frequency and intensity as time goes by but also correlate those changes with changes in his lifestyle and working conditions. Along the way, he also gives many clues, some direct and some circumstantial as to possible causes.

DED, a form of OSD, was only classified as a disease a little over 30 years ago and it is extremely common with a global prevalence of anything between 5–50%.<sup>10</sup> Despite its recent recognition and the fact that many risk factors for DED such as refractive surgery and air-conditioning are strictly modern, others like air pollution and dietary deficiencies date back hundreds if not thousands of years so there is no reason to suppose it is a novel diagnosis.

The formal definition of DED is “a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles.”<sup>11</sup>

The tear film is inherently unstable and there are many circumstances in which its composition may be compromised ultimately rendering it hyperosmolar. If those conditions are allowed to persist the hyperosmolarity of the tears may trigger an inflammatory response which can damage any part of the ocular surface leading to further instability. This creates a vicious cycle perpetuating the dry eye state possibly leading to long-term complications such as neuropathic pain and permanent damage to the ocular surface.

The symptoms of DED vary considerably and commonly include stinging, burning, or scratching sensations of the eyes, sometimes with a sensation of

a foreign body in the eye. There may also be blurred vision, redness, watering, and sensitivity to light along with fatigue and pain on over-use. Progression of the disease is often accompanied by increasing severity of these symptoms which in turn can result in psychological issues such as anxiety and depression, increasing expenditure on treatment, and a negative impact on work productivity and quality of life.<sup>12</sup>

## CONTEXTUAL BACKGROUND TAKEN FROM THE DIARY

Pepys was 26 years old at the opening of the diary in January 1660 and six months later he had fallen almost by accident into the post of Clerk of the Acts to The Navy Board. This was a low-level appointment which he probably would not have found particularly taxing. For much of the first two or three years of the diary period, the Board only met a few times a week, mainly in the mornings, leaving Pepys with plenty of time to socialize and network, often in taverns.

During this time he was not even sure he wanted the job and considered two substantial offers to buy him out, but he soon began to appreciate the potential of the position which by dint of talent, vision and sheer hard work he transformed until ultimately he became the most influential member of the Board.

In July 1660 Pepys and his household moved to a complex of apartments and offices owned by the Navy in Seething Lane near the Tower of London; it was a large building taxed at 48 hearths. The principal working and meeting area was a large room known as the great office which housed several clerks, messengers and porters etc., and where Pepys and his colleagues met to conduct the administrative business of the Navy.

The great office must have been a busy and distracting place offering little or no privacy so in early 1662 Pepys negotiated the construction of a small private office or closet cut from the great office. We know this office was adjacent to the great office because in July 1662 Pepys drilled a hole in his wall to enable him to see into it. Henceforth he usually, but not always, referred to the great office as “the office” and his closet as “my office”

The closet was a source of pride and pleasure to him, it was completed in February 1662 and he spent 26 days in March making it fit for work. This was

unusual, from his appointment in July 1660 through to the end of May 1662 he spent on average only 12 days a month at the office. On May 6th 1662 he lamented that he found it hard to settle to business after too much leisure and pleasure, and at the end of that month he swore off wine and plays and buckled down to work. At a stroke, he transformed the trajectory of his career and fortune but ironically may also have unwittingly created the circumstances that led to the ruin of his eyes.

By definition a closet is a small space but Pepys gave no dimensions, he had a table and chair, there was a hearth and it was lit by candles; this is almost all we know. Daylight came from an external window which would almost certainly have been shut in winter for Pepys was averse to cold weather. Apart from the borehole there was no other source of ventilation.

From June 1662 onwards Pepys more than doubled his attendance at the office averaging 25 days a month until September 1665 when the Navy Office was forced to relocate to Greenwich for four months to escape the plague.

Not only did the intensity of Pepys's work increase but there was also a shift in his pattern of attendance. In his first two years in post, most of his recorded visits to the office occurred in daylight hours but once he acquired his closet that changed and he spent more time there after dark, often into the small hours.

His work capacity was exceptional. In January 1665 he recorded being in his office in the evening on 24 days; on four occasions he was there until or past midnight, twice he was working until 11 o'clock, once nine p.m., and when he did not specify the time he wrote "very late" eight times. This was in a month when it would have been too dark to work in natural light by about four o'clock in the afternoon.

To accommodate such working hours Pepys had to recourse to artificial light provided by candles which were made of tallow, rendered animal fat usually beef or mutton. These candles smelled and issued acrid smoke as attested by one of Pepys's contemporaries the playwright Richard Flecknoe who complained in 1669 that the candlelight at a theater performance nearly ruined his eyesight as the smoke arising from the cheap tallow candles was so irritating.<sup>13</sup> It irritated

Pepys too who was driven to trial a cleaner but more expensive alternative.

15th Dec. 1664. "*This night I began to burn wax (i.e. Beeswax) candles in my closet at the office, to try the charge, and to see whether the smoke offends like that of tallow candles.*"

He never mentioned the outcome of this experiment but two months later he was back to using tallow.<sup>14</sup>

The closet fireplace added to the problems. In early December 1663, he looked for a cradle in which he could burn charcoal but that did not work so three weeks later he tried a different option.

28th Dec 1663. "*This evening I had a stove bought me to the office to try, but it being an old one it smokes so much as if there was nothing but a hearth as I had before, ....*"

Pepys was reading and writing complicated reports and letters for long hours in a poorly ventilated confined space working in the dim light in the air often heavy with a miasma of tallow and coal smoke. It is little wonder that his eyes suffered and he recognized it when he wrote a detailed reflection on his health in 1677. "The present ill state of my health" (PISH)<sup>15</sup>

*"That this has risen from my over labouring them as long as I was able to work with my own eyes by daylight and candlelight for little less than 18 or 20 hours a day for several years together, and therein very much using shorthand and doing this in a constant smoke of candles till I have wrought my eyes to such weariness as at last hardly able to see my way out of my office by candlelight, ..."*

During the first seven years of the diary Pepys's references to his eyes were sparse, totaling fewer than 30. The first was in 1660 and related to an unfortunate encounter with a cannon, then in 1662 he noted his eyes suffered after too much alcohol,<sup>16</sup> in 1663 there were just two, but they set the scene and became more frequent in 1664 when there were 16.

19th Feb 1663. "*...my eyes begin to fail me, looking so long by candlelight upon white paper.*"

31st Jul 1663. "*So, at almost 12 o'clock and my eyes tired with seeing to write, I went home and to bed*"

19th Jan 1664. "*...eyes begin to fail me and be in pain which I never felt to nowadays, which I impute to sitting up late writing and reading by candlelight.*"

1st Apr 1664 *"I being come to have a great pain and water in my eyes after candle-light."*

The pain Pepys described was suggestive mainly of eye strain using adjectives such as tired, failing, weary, and aching. His eyes were sensitive to light but there were no descriptions of the severe photophobia that he endured in the last few months of the diary. On the contrary, he took steps to increase the level of light in his office when he sought help from the engraver Edward Cocker who, on 7th October 1664, supplied him with a glass globe which he used for *"... gaining light to the grave by..."*

During 1664 even though Pepys ocular symptoms were escalating they were not a significant issue for him for in the occasional reviews of his health that he liked to make he did not mention his eyes at all.<sup>17, 18</sup> It appears that any damage done was not serious and probably, at this stage, reversible since 1665 and early 1666 saw very few references to his eyes.

Mid-December 1666 brought a singular and lasting change to his condition. On 13th he noted again that his eyes were sore and watery when he worked by candle-light.

13th Dec 1666. *"... and for these three or four days I perceive my overworking of my eyes by candlelight do hurt them as it did last winter, that by day I am well and do get them right, but then after candlelight, they begin to be sore and run so that I intend to get some green spectacles."*

A week later he took delivery of a pair of green-tinted spectacles but those did not ameliorate his symptoms which he recorded in every month of 1667, except March, a total of 42 times, more than the number of the previous seven years put together. He still complained of strain but also frequently cited soreness, a significant development (see discussion). The following entries were typical.

Aug 19th, 1667. *"... which I cannot refrain (reading) though I have all the reason in the world to favour my eyes, which every day grow worse and worse by overusing them."*

14th Sep 1667. *"... mightily troubled \* in mind at the liberty I give myself of going to plays upon pretense of the weakness of my eyes, that I cannot continue so long together at work in my office ...,"*

25th Sep 1667. *"My eyes so bad since last night's straining of them, that I am hardly able to see, besides the pain which I have in them."*

10th Dec 1667. *"... and then to my office again, where did much business till night, that my eyes began to be sore, ..."*

\*(Troubled or not he managed to go to the theater 69 times that year and 88 times in 1688!)

1688 brought him no respite, there were 45 references to his eyes usually related to what were becoming progressively shorter periods that he could tolerate reading and writing especially by candlelight. By now and into 1669 he virtually abandoned characterizing his pain other than reporting that his eyes were bad or ill but there were still some references suggesting eye strain.

4th Apr 1668. *"My eyes being every day more and more weak and apt to be tired."*

2nd Aug 1668 *"... unable to read myself anything, for above two lines together, but my eyes grow weary."*

1669 brought a significant deterioration with a sharp increase in the frequency of entries regarding his eyes which were now coming weekly and photophobia was now a major problem.

22nd Feb 1669. *"... my eyes being very ill ..., with the light of the candles, I was in a mighty pain to defend myself now from the light of the candles. (at a playhouse)."*

8th Mar 1669. *"My eyes being sensibly hurt by the too great light of the playhouse ..."*

12th May 1669 *"... but the trouble of my eyes with the light of the candles did almost kill me."*

As Pepys's symptoms progressed his quality of life suffered in ways explored in two of the DEWS II reports.<sup>19,20</sup>

By late 1688 and into 1669 Pepys was forced to curtail many of the activities which gave him most pleasure; others read for him, he could not enjoy his music books<sup>21</sup> and his theater attendances declined dramatically because he found the experience uncomfortable.

17th Apr. 1669. *"But more, my eyes will not let me enjoy the pleasure I used to have in a play."*

His worsening symptoms affected his mood, the usually mirthful ebullient Pepys began to complain of



being sad, mighty sad, and melancholy.<sup>22–24</sup> he was also anxious that his deterioration foreboded blindness.

20th Jun 1668. “*so home, and there able to do nothing by candlelight, my eyes now constantly so bad that I must take present advice or be blind ...*”

In common with modern sufferers of advanced DED, Pepys spent increasing amounts of time and money on seeking remedies none of which helped him much if at all. He tried conical tubes later mounted in a vizard with adjustable lenses, he was let blood, bought new spectacles and a reading glass, and tried pills and eye drops from various sources.

Finally, his work was impacted; he became increasingly reliant on his clerks to read and write for him (PISH), he reduced his working hours after dark favoring instead walks in the garden with his wife to rest his eyes and he rearranged the furniture in his office to avoid the glare of the window.<sup>25</sup> The crippling photophobia on top of his other symptoms was the last straw for Pepys and the pain of writing together with the fear of imminent blindness forced him to give up the diary on 31st May and, with the permission of the King, take a prolonged leave of absence.

## DIAGNOSIS OF DRY EYE DISEASE

The DEWS II Diagnostic Methodology subcommittee provides a diagnostic algorithm that starts with a series of triaging questions designed to inform the differential diagnoses. These are followed by an analysis of potential risk factors and finally diagnostic tests comprising the application of one of two validated questionnaires and some sort of objective marker of disordered homeostasis.<sup>26</sup>

Pepys's furnished enough information in his diary and PISH to enable the algorithm to be completed on his behalf and in sufficient detail to be reasonably confident that it points to a concrete diagnosis even though the objective measures of dry eye are necessarily absent.

## TRIAGING QUESTIONS

### 1. How severe is eye discomfort?

Comment: Unless severe, dry eye presents with signs of irritation such as dryness and grittiness rather than pain; if pain is present, investigate for signs of trauma/infection/ulceration.

Eye discomfort was central to Pepys's ocular problems. It started benignly but in the final years, there was no doubting its severity after years of ineffective treatment.

Pepys never complained of dry eyes; he suffered irritation which he described as “pricking heat” in his eyes which followed reading and writing (PISH), and he did complain of discomfort however with increasing severity and frequency as time went by.

1st Apr 1664. “*...I being come to great pain and water in my eyes after candle light*”\*

8th Jun 1664 “*...to bed, my eyes aching mightily since last night*” (when he had been working late).

1st Oct 1664. “*...my eyes sore with writing and reading - and to bed.*”

These were the only references to discomfort in 1664; in 1667 of the 42 references to his eyes, 18 described discomfort in some way such as pain, aching, weariness, soreness, and badness, almost always after excessive use by candlelight.

1668 was similar except the references to his eyes became more frequent and in 1669 he was even worse. In the five months until he abandoned the diary there were 39 references to his eyes; there was now no doubt that he had photophobia and the discomfort was severe.

### 2. Do you have any mouth dryness or swollen glands?

Comment: This question is designed as a prompt to consider investigation for Sjogren's syndrome in dry eye patients.

Many of the symptoms that Pepys described in the Present Ill State of my Health at the age of 45 years were compatible with Sjogren's syndrome.<sup>26</sup>

Pepys did not complain of a dry mouth in the diary but was explicit later in life. “*I have been for the most part, and now more than ever, subject to a mighty drought, so as upon intent [of] speaking to be rendered unable to speak articulately till I take time to moisten it. In the morning also my mouth is very foul, dry and furred.*” (PISH)

He described respiratory symptoms, opening PISH with “*Besides shortness of breath.*” he did not elaborate but went on later to explain how he suffered from “*retching and spitting*” on every occasion that he

transitioned from a warm place to the cold, a common feature of bronchial hyper-responsiveness.

He also described excess moisture in his head attended by heaviness in the forepart of his head and pain in his eyes which he was careful to mention was different to his usual pain that followed reading and writing and suggesting frontal sinusitis.

Pepys did not complain of swollen glands but in at least some of the many images of him, it is not difficult to imagine that there is fullness in the region of his parotid glands. Unfortunately, his salivary glands were not examined at his post mortem.

He developed arthralgia in multiple joints later in life and complained of some muscle pain and weakness also. *"Pain increasing two or three months backwards in the joints of my hips and knees upon any motion till it is now fallen down to the calves of my legs, joints of my ankles and feet upon motion, and a constant weariness in my legs even when abed. As also risen up to my back, shoulders, elbows, wrists, and fingers, and particularly a constant pain in my wrist."* (PISH)

Skin involvement is not uncommon in patients with Sjogren's syndrome and Pepys described particular sensitivity to cold weather when he tended to develop pimples and itching all over his body.<sup>28,29</sup> There was a curious episode also when he was about 42 yrs. old when, during a period of wet weather, he developed all over his body *"great bladders"* which quickly disappeared when he induced sweating but recurred within a few days for as long as the wet weather lasted (PISH).

Pepys's response to question 2. would surely these days warrant referral to appropriate specialists for consideration of the diagnosis of Sjogren's syndrome?

### **3. How long have symptoms lasted, was there any triggering event?**

Comment: Dry eye is a chronic condition present from morning to evening but generally worse at the end of the day.

Pepys's symptoms began in 1663 and reached a crescendo in 1669 but were still present to a lesser degree when he wrote PISH in 1677. He described symptoms at any time of day but overwhelmingly

most commonly at the end of an evening's work. He was usually worse in the winter too.

It seems the probable and key trigger for Pepys's problems was the adoption of his punishing work regime in the polluted air of his new closet in June 1662 which he knew had been detrimental to his eyes. (PISH)

There may have been an additional trigger identified by Pepys in PISH.

*"...the first time that I took particular notice of the suddenness of my pain upon reading and writing it was immediately upon my having been at the glasshouse and showing some friends the works therein gazing much upon the flame within the furnaces, and never before and always since."*

He recorded this visit and the pain it caused in his diary on 23rd Feb 1669, raising the possibility that he further damaged an already compromised ocular surface.

### **4. Is your vision affected and doesn't clear on blinking?**

Comment: Vision is generally impaired with prolonged staring, but should largely recover after a blink; a reduction of vision that does not improve with blinking, particularly with sudden onset, requires an urgent ophthalmic examination.

Pepys's vision was compromised.

30th Jun 1668. *"...; for I am to come that I am not able to read out a small letter, and yet my sight good for the little while I can read, as ever they were, I think."*

It returned to normal when he rested his eyes but we will never know if blinking helped. In the 17th century blinking was not a word Pepys would have used in the modern context. (see below)

### **5. Are the symptoms or redness worse in one eye than the other?**

Comment: Dry eye is generally a bilateral condition, if symptoms or redness are much greater in one eye than the other, detailed eye examination is required to exclude trauma or infection.

Pepys ocular symptoms were almost always bilateral, when he talked about his eye problems in the diary he usually used the plural with very few exceptions, even years afterward he recalled that both eyes were affected.

## 6. Do the eyes itch, appear swollen or crusty, or have given off any discharge?

Comment: Itching is usually associated with allergies while a mucopurulent discharge is associated with ocular infection.

Pepys never described his eyes as itching. There were a few occasions, usually when he had a cold, that he had unilateral soreness and discharge which he referred to as rheum and seems almost certainly to have been a mucopurulent discharge associated with conjunctivitis, distinct from the watery discharge he described after overworking his eyes.<sup>30,31</sup>

## 7. Do you wear any contacts?

Comment: Contact lenses can induce dry eye signs and symptoms and appropriate management strategies should be employed by the contact lens prescriber.

Contact lenses were used for the first time in the late 1880s so Pepys missed out by more than 200 years but he did try two types of spectacles and conical tubes, later fitted with lenses. None of these impinged on his ocular surface.

## 8. Have you been diagnosed with any general health conditions (including recent respiratory infections) or are you taking any medication?

Comment: Patients should be advised to mention their symptoms to the health professionals managing their conditions, as modified treatment may minimize or alleviate their dry eye.

Pepys passed stones and gravel during the diary period and often complained of fever, back pain, and "slimy" urine. When he died Hans Sloane performed his post-mortem which showed that his left kidney was a bag of pus containing about seven ounces of adherent stones.<sup>32</sup>

The stone disease was unlikely to have affected his eyes directly but the medication he took to ward it off may well have done. At the beginning of 1664 he learned about a drug that might be useful to him.

1st Jan 1664. "..., but the Dr's discourse did please me very well about the discourse of the stone, above all things extolling Turpentine,..."

On 1st Jul 1664 Dr. Burnett diagnosed Pepys with a kidney or bladder ulcer after detecting pus in his urine and prescribed a "hazel-nut" quantity of Cyprus Terebintine (Turpentine) twice daily.

Two weeks later the doctor showed Pepys how to take the turpentine which he appeared to do regularly.

31st Dec 1664. "*But I am at a great loss to know whether it (his good health) be my hare's foot, or taking every morning of a pill of turpentine,*"

26th Mar 1665. "..., or whether it be my taking of a pill of Turpentine every morning which keeps me loose,"

Pepys took the turpentine for its action as a diuretic to help flush his kidneys and bladder. This highly fat-soluble organic solvent was used from ancient times, well into the late nineteenth century, for a wide variety of conditions including eye diseases.<sup>33</sup>

Turpentine is extremely toxic to the eyes and exposure to vapor at a concentration of 100 ppm. for 30 minutes reduces tear break up time (TBUT).<sup>34</sup>

When ingested it is rapidly distributed through the body's fatty tissues and has a half-life of about 48 hours. It is reasonable to speculate that it might have a similar destabilizing action on the lipid layer of the tear film as alcohol (see below).

In addition to oral medication, Pepys tried a variety of eye drops, some were from reputable sources such as Daubney Turbeville the famous occultist, and John Chase the King's apothecary. Others came from more dubious practitioners such as "*the oldish woman in a hat*" whose drops made his "*eyes smart most horribly*".<sup>35</sup> It is only possible to guess what these drops might have contained; 17th-century pharmaceuticals were famous for their exotic ingredients, but despite the pain they induced Pepys vowed to persevere with them!

The answers to the triage questions generally support a diagnosis of DED and encourage a move to the next step of the algorithm - examination of Pepys's risk factors.

## PEPYS'S RISK FACTORS FOR DED

### Palpebral Fissure

There is reason to suppose that Pepys was susceptible to OSD before he was exposed to any other risk factors because he had protuberant eyes; this is evident in almost all of the many images of him that exist and was summed up by his great nephew four generations removed Samuel Pepys Cockerell in a paper read to members of the Samuel Pepys Club in 1911.<sup>36,37</sup>

*"The eyes were brown-blue - a common colour with fair people - large, very prominent, and, if we are to trust Hayles (his portraitist), rather watery and bloodshot."\**

The correlation between the increased height of the palpebral fissure and reduced TBUT has been shown,<sup>38</sup> not only would Pepys's large and prominent eyes have a tear film stretched thin but they also presented a larger than average surface area for attack by the noxious pollutants and chemicals to which they were exposed almost every day.

\*Pepys recorded starting a cold on the day he began sitting for the picture on 17th March 1666

### ENVIRONMENTAL POLLUTION

The DEWS 11 Epidemiology report cites environmental pollution as a consistent risk factor.<sup>39</sup>

The air of London was famously polluted as a result of burning hundreds of thousands of tons of bituminous sea-coal every year releasing vast amounts of smoke and sulfur dioxide.<sup>40</sup> The coal was used for domestic heating, cooking, and to fuel the multitude of small industries which peppered the city. The output from thousands of domestic hearths must have been impressive but even that was insignificant to John Evelyn who wrote a treatise in 1661 in the hope of promoting legislation to control the pollution which he blamed on industry.<sup>41</sup>

*"The problem is caused by the works of brewers, dyers, salt and soap burners and other private traders; the emissions from a single one of these pollutes the air more than all of London's chimneys put together".*

Outdoor pollution was not confined to smoke. Most of London's streets, lanes, and alleys were unpaved and filthy; they were boggy in wet weather and dusty when dry. The dust was a mixture of grit, soot, and powdered horse dung thrown up by wagon wheels, horses hooves, or just by the wind. It was irritating and Pepys complained about it frequently.

28th Jan. 1664. "... being mightily troubled with my left eye all this evening from some dirt that is got into it."

10th Jul. 1665. "Having a coach of Mr. Povy's ..., it being a pretty chariot but most inconvenient as to the horses throwing dust and dirt into one's eyes and upon one's clothes."

27th Jul. 1667. "It rained this day to our great joy, it not having rained, I think, this month before, so as the

*ground was everywhere so burned and dry as could be and no traveling on the roads and streets of London, for dust."*

And so on at least 14 times.

The air indoors was polluted too. Through the seventeenth-century annual tobacco imports rose from 11,000 kgs to peak at just over 16 million kgs. in 1680,<sup>42</sup> in 1660 there were over a thousand clay pipe manufacturers in London. People smoked almost everywhere but nowhere more so than the coffee houses which had proliferated since the first one opened in 1652.

*"For in general the coffee rooms reeked of tobacco like a guard room: and strangers sometimes expressed their surprise that so many people should leave their firesides to sit in the midst of eternal fog and stench. Nowhere was the smoking more constant than Will's"*<sup>43</sup>

Pepys did not smoke but he would have been very familiar with the fog and stench of tobacco in Will's coffee house which he visited many times.

Notwithstanding the pollutants already mentioned, probably the most pervasive and relevant to Pepys's eye condition was tallow smoke. In 17th century London almost, all artificial light was provided by candles. The poor used rush lights, the church, and gentry could afford beeswax and everyone else employed tallow which as, already noted burns with a lot of irritating smoke. Tallow candles were burned almost everywhere that Pepys frequented; his house, shops, taverns, theaters, and coffee houses but nowhere was his exposure so prolonged or intimate than in his closet.

### ALCOHOL

Alcohol is considered to be an inconsistent risk factor for DED in the DEWS II Epidemiology report.<sup>44</sup>

Alcohol may act on the tear film indirectly as a diuretic leading to dehydration and reduced tear volume or directly as a solvent disrupting the lipid layer of the tear film so increasing evaporation.<sup>45</sup> Studies have shown that ethanol appears in the tears within two hours of ingestion, significantly increasing osmolarity and shortening TBUT.<sup>46</sup>

Pepys acknowledged the association between drinking alcohol and his eye pain several times, corroborating the swift and probably direct effect of alcohol on his eyes.

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9th Jun. 1666. "...the drinking of some stronge water (gin) did immediately put my eyes into a fit of soreness again as they were the other day. I mean my right eye only." (he had conjunctivitis in his right eye ten days previously)

28th Mar 1669. "My journal writ, my eyes being very bad, and every day worse and worse, I fear: but I do find it almost certain that stronge drinks do make my eyes sore, as they have done heretofore always: ..."

\*It seems plausible that ingested Turpentine could affect his eyes in similar ways - see above.

(Personal observation. A brandy balloon containing 15 mL. of brandy [40% ABV] warmed to body temperature and held to my unblinking eye caused intolerable stinging in less than 30 secs.)

### Nutritional Considerations

Vitamin A is essential for maintaining eye health and more recently vitamin D has been implicated also with a study showing an association of low levels of vitamin D and TBUT.<sup>47</sup> Another study reports the benefit of vitamin D supplementation in dry eye patients with refractory symptoms.<sup>48</sup>

Pepys's diet was heavily biased towards meat which contains insignificant amounts of vitamin A except for liver, an ingredient of umble pie which he recorded eating on four occasions.

He ate cheese and butter regularly, oily fish such as salmon, sturgeon, and eels occasionally, and a few vitamin A rich fruit such as apricots and cantaloupes when they were available; in ten years of the diary he recorded eating carrots just once. On the face of it, Pepys would have struggled to achieve the recommended daily allowance of 900 mcg<sup>49</sup> so it is reasonable to suppose that he might have been close to being vitamin A insufficient.

The case that Pepys was vitamin D insufficient, if not deficient, is stronger. Vitamin D deficiency was very common in the 17th century, rickets regularly appeared in the top 10–15 causes of death in the bills of mortality.<sup>50</sup>

London lies at 51.5 degrees North, a latitude at which it is said to be impossible to synthesize vitamin D from mid-August to late April.<sup>51</sup> The city lay under skies which were often cloudy and almost always polluted, the jettied houses were packed closely together

and Pepys was clothed from head to foot including gloves, a voluminous wig, and a broad-brimmed hat ensuring virtually no sunlight reached his skin. As his descendant remarked, "But Pepys lived in a moment when men clothed themselves more completely than they ever have done before or since."<sup>37</sup>

Even in modern times with a wide variety of foods fortified with vitamin D it is difficult to achieve the recommended daily intake of 600 i.u. from diet alone.<sup>52</sup>

Pepys's main dietary sources were the oily fish he mentioned occasionally and oysters, but from what we know about his diet it is hard to believe he came even close to the recommended daily intake.

### QUESTIONNAIRES

If symptom and risk factor analysis still suggest the possibility of DED the next step of the algorithm is to apply either the Ocular Surface Disease Index Questionnaire (OSDI) or the five-item Dry Eye Questionnaire (DEQ-5) with scores of > 13 and > 6 respectively being positive.

Both questionnaires apply to Pepys with the proviso that the strict timescales of each are relaxed.

#### OSDI

score

1. Eyes that are sensitive to light? 4
2. Eyes that feel gritty? 0
3. Painful or sore eyes? 4
4. Blurred vision? 0
5. Poor vision? 3
6. Difficulty reading? 4
7. Difficulty driving at night? N/A
8. Working with computer or ATM? N/A
9. Watching TV? N/A
10. Uncomfortable in windy conditions? 0
11. Uncomfortable in low humidity? 0
12. Uncomfortable in air conditioning? N/A

Pepys's OSDI score. \_\_\_\_\_

$$15 \times (100) = 48.8 = \text{Positive notes.}$$

$$8 \times (4)$$

1. 16th Feb. 1669., 22nd Feb. 1669., 8th Mar. 1669., 14th Apr. 1669. 8th May 1669.
2. Grit, Gritty and Grittiness were not words used in any context by Pepys in the diary.

3. Pain, soreness and aching were common symptoms from 1664 onwards.
4. Blurred was not in Pepys's lexicon.
5. Pepys vision quickly failed him when reading. 30th June 1668., 25th Sep 1667.
6. 1st Sep. 1667., 15th Sep. 1667., PISH.
10. Dust irritated Pepys's eyes but he did not record discomfort from the wind alone.
11. Wet weather exacerbated his symptoms. (PISH.)

#### DEQ - 5

Question about eye discomfort in a typical day

1. a) Frequency? Constantly. 28th March 1669. "*...my journal writ my eyes bad and every day worse and worse.*"

1. b) How intense within two hours of going to bed? Working late by candlelight until forced to stop by his symptoms was an almost constant refrain.

2. Questions about dryness.

2. a). How often did eyes feel dry? Pepys never described his eyes as dry.

2. b). As above

3. Question about watery eyes.

3. How often did your eyes look or feel excessively watery? "*... I was never free from paining them (eyes) night or day, with a constant redness and issuing of a waterish humour ...*" (PISH)

#### DEQ - 5 score.

1. a). 4

1. b). 4

2. a). 0

2. b). 0

3. 5

Pepys's total DEQ-5 score = 13 = Positive

### DISCUSSION

The overwhelming majority of the more than 150 references Pepys made to his eyes occurred after he had spent long hours in his closet reading and writing by candlelight. There were other occasions when dust, alcohol and theater lights discomforted him but these were few in comparison.

There are some special difficulties in trying to analyze Pepys's symptoms some of which relate to language, an important consideration for modern clinicians.<sup>53,54</sup> Pepys wrote in English of course but

the language has changed considerably in the past 350 years; new words have been adopted, some have been lost and others have changed their meaning.

The importance of blinking in DED for example is well recognized but is not a word that Pepys would have employed in the context of his eyes. In the 17th century, blinking meant twinkling or gleaming; as a star, it did not appear in the diary. Blurred in the sense of indistinct or dim did not come into use until 1701 and similarly gritty was not in common usage.<sup>55</sup>

The adjectives he used to describe his eye discomfort were often rather vague especially later when he usually restricted himself to his eyes being "ill" or "bad." He did not use any of the commonly used modern descriptors for dry eye such as stinging, burning, scratchy or gritty at all nor at any point did he describe his eyes being dry.

Simply relying on the diary for information leads to underestimating the severity, or even the presence of important and informative symptoms that he revealed in PISH, all suggestive of DED.

The only time Pepys mentioned having a red-eye in the diary was the day after he injured it by getting too close to a discharging cannon in 1660<sup>56</sup> and he only described excessive watering twice, yet in PISH he told us that he was never free from pain in his eyes night or day

*"... with a constant redness and issuing of a waterish humor..."*

A little later he described the heaviness in his eyes that he associated with wet weather but stressed that it was

*"... not attended with that pricking heat, redness and wateryness that follow reading and writing."*

This was the first and only time we heard of pricking heat which he implied was a regular feature.

The answer to this may be that rather than writing pricking heat, redness and wateryness each time it would have been much more economical for him simply to have said "sore", an adjective he used to describe his eye discomfort frequently and one he used on occasions when he definitely would have had red and runny eyes - when he had conjunctivitis.

The dry eye symptom which Pepys did specify often in the diary was hypersensitivity to light.

19 Feb 1663. *"my eyes begin to fail me, looking so long by candlelight upon white paper."*

When Edward Cocker delivered his glass globe to intensify the candlelight for Pepys to work by it came equipped with a frame of oiled paper to "...lessen the glaringness of it..."

He elaborated after the diary in PISH.

*"Partly from my being conscious of my having for many years together employed my eyes constantly against a bright window by day and candles by night, and my observing from thence to this day looking against the light or any near bright object doth presently bring my pain, redness, and water in my eyes. Even the brightness of a white paper will do it after my eyes begin once to ache."*

This appeared to be nociceptive pain that accompanied signs of inflammation and appeared sometime after Pepys had been employing his eyes in unfavorable conditions.

At first the discomfort seemed fairly innocuous but by 1667 and 1668 the references were increasingly frequent and the pain was severe enough to force him to take walks in the garden in the dark to rest his eyes and to curtail his hours of work. In 1669 however, the discomfort stopped being merely an inconvenience and it appeared almost immediately on exposure to light that he had always been able to tolerate before such as theater lights. Did this change herald the onset of neuropathic pain?

The pattern of Pepys's symptoms and their relentless progression from late 1666 onwards suggests that it was the summer of 1666 that his disease entered the predicted vicious cycle of self-perpetuating inflammation and damage.<sup>57</sup>

In June 1666 England's Navy was fighting the Dutch and after the relative respite of the plague months in Greenwich, Pepys and his colleagues in the Navy Office, by now back in Seething Lane, moved into top gear to keep the ships manned and operational. True to form Pepys shouldered his responsibilities with gusto.

8th June 1666. *"Up very betimes (early) to attend the Duke of York by order, all of us to report to him what the works that are required of us to divide among us, wherein I have taken a very good share, and more than I can perform, I doubt."*

Once again, he was back in his closet working late into the night, shortly afterward in early September 80% of London was destroyed by the Great Fire. The Navy Office was spared but his routine of daily diary entries was disrupted and references to his eyes were few. The fact that they were troubling him however was clear when he wrote a memorandum in October explaining that he had not been able to complete his diary entries until January 1667 because his attempts to do so had made his eyes so sore.<sup>58</sup>

As observed the number of diary entries related to his eyes increased year on year, there were 42 in 1667, 45 in 1668 and the five months of 1669 until the end of the diary there were 39.

The nature of Pepys's symptoms, their obvious progression, the effect they had on his quality of life, his exposure to risk factors, and the questionnaire scores are all circumstantial but compelling evidence that he had severe DED. It may be that Pepys's account is the earliest and most complete description of the natural history of untreated DED available anywhere.

## A UNIFYING DIAGNOSIS

In 2003 Sheedy proposed that asthenopia consists of two elements, internal and external, the former being related to refraction, accommodation and convergence errors and the external element predominantly related to dry eye.<sup>59</sup>

There is already a consensus that Pepys had minor refractive errors and recently it was postulated that he also had a convergence deficiency which contributed to the pain he experienced upon his eyes assuming the reading posture.<sup>6</sup> This paper makes the argument that Pepys also had DED so fulfilling the internal and external elements of asthenopia and explaining all of his symptoms.

In a modern context, Pepys would surely be considered to be a candidate for computer vision syndrome (CVS) or digital eye strain (DES) despite the fact of course that he did not come within three hundred years of a digital device. The different effects on the eyes during sustained near-vision tasks on digital displays versus printed copies have been explored<sup>60</sup> and are real but rather subtle and their significance not

**TABLE 1** CVS Questionnaire

Symptom	a. Frequency	b. Intensity	a. × b.	Recode. 0 = 0, 1 or 2 = 2, 4 = 2
Burning (=pricking heat)	1	1	1	2
Itching	0	0	0	0
Foreign body sensation	0	0	0	0
Tearing	2	2	4	2
Excessive blinking	0	0	0	0
Eye pain	2	2	4	2
Eye redness	2	2	4	2
Heavy eyelids	1	1	1	2
Dryness	0	0	0	0
Blurred vision	0	0	0	0
Double vision	0	0	0	0
Difficulty focusing for near vision	1	1	1	2
Increased sensitivity to light	2	2	4	2
Colored halos around objects	0	0	0	0
Feeling that sight is worsening	2	2	4	2
Headaches	1	1	1	2

*Pepys's total CVS-Q score = 18 (Score > 6 = diagnostic of CVS).*

fully understood such as the difference in incomplete blink rates and the contribution of screen flickering.

Research in this area is made difficult because the technology is advancing so quickly; electronic devices of all sorts are proliferating and the screens and displays are increasingly sophisticated with the introduction of innovations such as eInk. There is evidence that these advances are making the differences between digital and printed displays less pronounced<sup>61</sup> giving grounds to believe that in the future they may be eliminated altogether and that DES and printed eye strain may become the same condition.

Pepys provided enough detail to enable completion of the CVS questionnaire on his behalf arriving at a score of 18, (Table 1.) well above the threshold score of 6 required to diagnose CVS.

Despite his fears, Pepys did not go blind. He continued to cultivate an illustrious career that was eventually cut short by political events in 1689, but a year before he died in 1703 at 70 years of age he could see well enough to supervise the cataloging of his library of 3000 books.

Pepys's symptoms did not leave him entirely after the diary but they did not worsen. He benefited from his absence from work and the fresh air of France during his furlough in the summer of 1669 and his increasing use of amanuenses must have helped too. But just a few years later there were two profound events that completely changed his circumstances.

On 29th January 1673, the Navy buildings on Seething Lane were destroyed by fire, and Pepys's cherished closet was gone forever. Shortly after that



Pepys was appointed Secretary to the Admiralty Commission, a significant promotion which brought with it spacious and well-appointed lodgings and offices in The York buildings in Buckingham Street. Never again would he have to toil for hours on end in the confined smoky space of a closet and who knows, given his lofty position he may, at last, have been able to indulge in beeswax candles.

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None.

#### DECLARATION/CONFLICT OF INTEREST

None.

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