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INVITED REVIEW

Do video display units cause visual problems?—a bedside story about the processes of public health decision-making

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Barry L Cole PhD MAppSc BSc LOSc
Department of Optometry and Vision Sciences, The University of Melbourne

Purpose: Since the 1980s, it has been common for employers to provide eyesight testing for operators of screen-based equipment (SBE). This practice arose because many SBE operators reported symptoms of visual discomfort at work and there was apprehension that radiation emitted by SBE might be harmful to vision. Visual screening of SBE operators has been encouraged by government guidelines and in some countries, is required by legislation. This paper questions whether this practice should continue.
Method and results: A review of the literature shows: 1. SBE does not emit radiation in sufficient quantity to be harmful and there is no credible epidemiological evidence that work with SBE will damage the eyes; 2. SBE operators often report symptoms of visual discomfort but office workers who do not use SBE also report visual symptoms with the same or slightly lower frequency; 3. about 20 per cent of office workers have some uncorrected defect of vision that can contribute to the occurrence of visual discomfort at work and optometric intervention to correct these defects does reduce the occurrence of visual symptoms. However, defects of vision are not the only cause of visual symptoms at work. Other contributing factors are poor workplace ergonomics and psychosocial stress arising from poor work systems or poor inter-personal relationships at work.
Conclusions: There is no compelling public health justification for requiring vision screening of SBE operators but it could be introduced as one element of a more comprehensive strategy to enhance visual comfort at work. If it is introduced, it should be for all employees engaged in visually demanding tasks, not just SBE users. An alternative to eyesight testing of employees is to encourage but not require employees to obtain eye care privately on their own initiative. This option has the advantage of restoring autonomy to employees to arrange their own eye care. Eyesight testing of employees in vision-critical occupations should be undertaken to ensure safety. In occupations in which there is a risk of eye injury, vision screening should be undertaken to provide a pre-injury record of vision.

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Video display units (VDUs) are interfaces between computers and human operators. They began to appear in ordinary workplaces in the 1970s, when commerce and industry embarked on the process of exploiting the potential of computers to enhance productivity. Two concerns quickly emerged. One was that VDUs appeared to cause visual distress and the other was that they might emit radiation that could be harmful to eyesight, as well as have other adverse health consequences.

The first concern was driven by publication of reports that a high proportion of VDU operators reported symptoms of visual discomfort.[1-6] By the early 1980s, the first reviews on VDUs and health were published[7-10] and the first of many international conferences on VDUs had been organised.[11]

The second concern arose because video technology has the potential to produce X-radiation, which is known to be harmful to biological tissue. Cathode ray tube (CRT) electronics also produce low frequency electro-magnetic fields, about which there is also public concern, even though the biological effects, if any, of exposure to low power low frequency radiation are uncertain.

CRT displays are beginning to be supplanted by liquid crystal displays and other non-video technologies and the acronym SBE (screen-based equipment) is now often used rather than VDU. These new kinds of displays do not have the same potential to produce X-radiation as does video technology but there remains concern about the possible effect of low frequency radiation that is emanated by electronic equipment.

The concerns about radiation emitted by VDUs were fuelled by a US ophthalmologist, Milton Zaret, who reported 10 cases of patients with cataract, which he claimed were the result of exposure to radar screens[12] or VDUs.[13,14]

In 1977, an industrial dispute between the *New York Times* newspaper and the Newspaper Guild of New York added to the controversy. This involved two subeditors aged in their early 30s who had been assigned to VDU work when the newspaper converted to computerised writing, editing and layout in 1975. They were found to have posterior sub-capsular cataract, which Zaret diagnosed as due to radiation. The matter was arbitrated with the finding that the VDUs did not pose a safety hazard but the arbitrator directed that the newspaper company carry out regular monitoring of its VDUs and report any abnormal radiation emissions detected.[a]

These concerns were the subject of numerous alarmist articles in newspapers and other media and aroused the interest of unions.[15-19] VDUs quickly became a significant public health issue that was to be pursued intensely for the next 10 years. As a result, government agencies and public health organisations developed guidelines for VDU use and national and international standardising organisations published standards for VDU equipment and workplaces.

PUBLIC HEALTH GUIDELINES FOR VDU USE

The VET Advisory Group

The newspaper industry was particularly concerned about the research publications making adverse comment about VDUs and the public alarm these were causing. The industry had begun the process of computerising the production and printing of newspapers and the controversy provided grounds for unions to resist the immense changes to newspaper work practices that computerisation would bring.

The International Research Association for Newspaper Technology (Inca-Fiej Research Association or IFRA) funded Ahmet Cakir of the Technical University of Berlin and Tom Stewart from the University of Loughborough, UK, to undertake research into VDUs and their interface with human operators. Together with David Hart who was the research Director of IFRA, they wrote the first book reviewing the technical, ergonomic and human aspects of VDUs.[7] The book was published by the IFRA in 1979. It was and remains an excellent book and it quickly became an influential reference source.

Appendix 2 in the book is a discussion document on eye tests for VDU operators. This discussion paper had been drafted by the VDU Eye Test (VET) Advisory Group in 1978.[20] The group included Hart and Stewart, authors of the VDT manual; medically qualified representatives of the Trades Union Congress and the UK civil service; and Robert Weale from the UK Institute of Ophthalmology. Curiously, no optometrists were on the advisory committee although help from the British Optical Association is acknowledged.

The VET Advisory Group recommended that SBE operators should have their eyesight tested if their VDU work was 'particularly intensive or prolonged'. The recommended screening tests included unaided vision and (corrected) visual acuity, refraction, amplitude of accommodation, suppression and heterophoria at distance, one metre and near. The goal was to collect data about the vision of SBE operators in a standardised way over the long-term to be able to allay anxieties about SBE. The committee was at pains to remark that there was no evidence that SBE was a health risk and it did not expect the data collected to show that SBE had an adverse effect on vision.

The NHMRC guidelines

At that time, the National Health and Medical Research Council (NHMRC) was responsible for occupational health matters in Australia. The Council issued draft guidelines for eyesight tests for visual display terminal (VDT) operators in 1980,[21] one year after the UK based VET Advisory Group made its views known. However, two years elapsed before the NHMRC-approved guidelines were published in 1982.[22]

The delay between the draft and the publication of the approved guidelines was due to differences of opinion between the two ophthalmic professions, optometry and ophthalmology, on the most suitable test procedures that should be used for screening the eyesight of VDT operators. Hocking[23] explains how inter-professional jealously and the vested interests of the Australian Optometrical Association (AOA), the Royal Australian College of Ophthalmologists and the unions caused confusion and dissent.

The original draft guidelines recommended that VDU operators should have their vision screened by four tests: distance visual acuity for each eye; binocular near

a. This account is summarised from information in Matthews and Calbrese,[17] which in turn is based on the Opinion and Award of the Arbitrator in the dispute between the *New York Times* and the Newspaper Guild of New York.

visual acuity; horizontal and vertical heterophoria at near; and, if colour coding was used in the visual display, a test of colour vision. I had recommended these tests to the NHMRC in 1979. They were different from the VET group recommendations, as the NHMRC-recommended tests were focused on uncovering existing vision deficiencies among SBE operators, rather than on establishing a bank of data for epidemiological purposes, as was the intent of the VET group recommendations.

The Royal Australian College of Ophthalmologists told the NHMRC that it saw no value in tests of heterophoria or colour vision and these two tests were omitted from the approved 1982 guidelines, with explanatory notes that they had been omitted on the advice the college.

Specific criteria for passing or failing the eyesight tests were defined by the NHMRC in its 1980 draft. SBE operators who did not meet the criteria were to be referred to an optometrist or an ophthalmologist for a full assessment of their eyes and eyesight. The expectation was (and is) that most of those who failed to meet the requirements would have their visual deficiency corrected by glasses and only rarely would it be necessary to refuse employment as a VDU operator on the grounds of inadequate vision.

The approved NHMRC guidelines omitted these pass/fail criteria except for the test of near visual acuity. The omission of two of the four tests and the failure to define specific pass/fail criteria meant that a revised version that reverted to the original draft had to be published the following year.

The NHMRC guidelines did not satisfy the unions, especially the unions representing Federal Government employees. The unions sought a more comprehensive and regular program of surveillance of the eyesight of VDU operators, including slitlamp examination and ophthalmoscopy, to detect cataract and other ocular diseases.

These guidelines were supported by optometry[24] and ophthalmology,[23] even though the latter had previously said that the simplest of functional tests of vision were sufficient. To be fair, the AOA position was that a full eyesight examination was preferable to a truncated screening examination—which it is—if there was an eyesight disorder but it is a costly option if more than 80 per cent of SBE users have no visual disorder. The optometric and ophthalmological professions seemed to be in rare agreement but this was not so because the ophthalmologists claimed that only they were competent to do biomicroscopy and ophthalmoscopy.

To resolve the conflicting advice, the Commonwealth Government reached agreement with the public sector unions in 1984 that an expert study group would be commissioned to make recommendations for eyesight testing of users of SBE in areas of federal government employment.

The Worksafe Australia Study Group

The Study Group was convened in 1987 by the National Occupational Health and Safety Commission, also known as Worksafe Australia. At the time, this was a new body that, among other things, had been assigned the occupational health responsibilities of the NHMRC.

Professor Fred Hollows was appointed to represent the views of ophthalmologists and I was appointed to represent the views of optometrists, although, as it turned out, neither of us agreed with the positions taken by our respective organisations. Dr A Crowe from Worksafe Australia chaired the study group.

The Study Group finalised its conclusions in November 1987 but for some reason the report was not published until 1992.[25]

The Study Group's conclusions were:

1. There is a need for eyesight testing of SBE operators

The Study Group concluded that there is a need for eyesight testing of SBE operators because:

a. SBE work is vision dependent
b. certain standards of vision are needed to carry out SBE proficiently
c. SBE work can be visually demanding and often requires work without interruption for long periods and it is desirable to know that operators' vision is adequate for such work
d. SBE operators have fewer opportunities to adapt their work place to suit their personal needs
e. minor disorders of vision that may cause visual or eye symptoms when undertaking intensive work occur frequently
f. there is a community expectation that SBE operators have routine eyesight testing.

2. Eyesight testing should be carried out on employment and periodically after age 40

The Study Group advised that eyesight testing should be carried out:

a. On commencement of work with SBE, where SBE work occupies more than 25 per cent of work time or, if SBE is used for a lesser proportion of time, when the SBE work undertaken is especially intensive or is critical to safe operations
b. every two years after the age of 40 years
c. whenever symptoms indicate that a problem exists.

3. Five eyesight tests should be used for screening the vision of SBE operators

The Study Group advised that the four vision screening tests and pass/fail criteria recommended by the NHMRC be used for preliminary screening of the vision of SBE operators. They also recommended an additional test of the ability to converge the eyes on a near point target.

4. A full eye examination must follow a failure of the screening tests

The Study Group emphasised that the tests can be carried out by nurses or other appropriately trained health personnel but that a failure to meet the pass criteria of these screening tests must lead to a full assessment of vision to confirm that there is a deficiency of vision and to correct it with glasses or other treatments, if possible.

If normal vision cannot be restored, the Study Group advised that refusal of employment as an SBE operator should not be automatic but that consideration should be given to whether the person's

vision was none-the-less adequate for the proposed SBE work.

5. There is no need for diagnostic tests in the vision screening of SBE operators

The Study Group specifically advised that slitlamp biomicroscopy and ophthalmoscopy should not be included in any preliminary screening assessment of the eyesight of SBE operators, as had been proposed by the unions.

The Study Group rejected the use of these tests because their inclusion in routine vision assessment of SBE users would not help to quantify risk of cataract due to SBE use because of the absence of a means to assemble the results in a database and the absence of a control group of non-SBE users. The Study Group observed that this question would be better addressed by a longitudinal research study but it also noted that 'there is no convincing evidence that SBE causes eye abnormalities'.

The Safety, Rehabilitation and Compensation Commission's guidelines

In 1992, the Australian Government's Safety, Rehabilitation and Compensation Commission[b] approved publication of its *Guidelines for Eyesight Testing and Optical Correction for Visually Demanding Tasks*.[26] These were based on the Worksafe Australia Study Group report.

The document advises employers and employees in the jurisdiction of the Federal Government, both the public service and organisations owned or majority owned by the Federal Government, on the frequency of eyesight testing and the tests that should be included in any preliminary eyesight testing. It closely follows the NHMRC guidelines but the scope was broadened to embrace any employee engaged in visually demanding work rather than just SBE users.

Eyesight testing is recommended on first employment in a visually demanding job, whenever there are symptoms associated with the work, and every two years for employees over the age of 40 or under the age of 25 years (if critical distance vision is required at work). A visually demanding task is defined as one requiring sustained focus at less than 30 cm or between 50 and 150 cm or whenever very good vision is judged to be required by the task.

The European Community directive

Similar guidelines had been promulgated elsewhere. The European Community issued a directive[27] in 1990, which required employers to ensure that SBE workstations meet minimum ergonomic requirements and which directed that all SBE workers are entitled to have an eyesight test on employment and at regular intervals thereafter, especially if they experience visual difficulties that may be due to SBE work.

The UK government introduced regulations in January 1993 under the Health and Safety Act 1974 that gave legislative effect to the EC directive and, among other things, required employees using SBE to be given eyesight tests.[28]

IS EYESIGHT TESTING OF SBE USERS NECESSARY?

More than 10 years have elapsed since the Safety, Rehabilitation and Compensation Commission guidelines on vision and SBE use were published and the European Community directive was issued. We have had three decades of experience using SBE at work and at home. People now accept SBE as a part of life and there is much less anxiety about using it. Technology has changed and research has added to our knowledge.

Perhaps it is now time to review the guidelines that propose vision screening for SBE operators. This review gathers the evidence about the effects of VDU use on the eyes and vision to establish whether vision screening of SBE users and others engaged in visually demanding work is needed. Indeed the guidelines of the Safety, Rehabilitation and Compensation Commission are currently under review.

Does SBE work cause visual symptoms?

There have been numerous studies of the prevalence and nature of visual symptoms associated with SBE work, which have been reviewed on several occasions. The early authoritative reviews are those of the US National Research Council (NRC)[8] in 1983 and Bergqvist[9] in 1984. More recent reviews are those of Burns,[29] Thomson[30] and Mutti and Zadnick.[31]

The general consensus is that SBE users report visual symptoms more often than do non-SBE office workers. Certainly, this is the conclusion of Bergqvist.[9] However, many of the studies of the prevalence of symptoms associated with SBE are methodologically flawed and for this reason the National Research Council[8] was more reserved in its conclusions. The NRC report acknowledges that most of the studies of visual symptoms show a higher prevalence of symptoms among SBE users compared to non-users, but questions whether this is due to the SBE *per se* or to other differences between SBE work and ordinary office work, such as lighting, workplace ergonomics, job design and work intensity.

This doubt about whether SBE imposes any special visual demands is reinforced by the well-constructed studies that did not find a difference in the prevalence of symptoms between SBE and non-SBE users,[32-35] or which when analysed correctly did not.[36]

Other studies found differences for only some symptoms. Coe and colleagues[5] found differences only for 'fatigue-like' eye symptoms and not 'irritant-like' eye symptoms. Cole, Maddocks and Sharpe[37] found differences for only four visual symptoms after taking into account age, gender and the use of glasses, and for some of these symptoms the differences were small or inconsistent. They found that lack of properly prescribed glasses was a much more powerful factor than SBE use for three of the four visual symptoms.

Knave and co-workers[38] found that there was no difference in the proportions of SBE users and non-users reporting visual symptoms in newspaper offices. Both groups had a high proportion (58 per cent) reporting visual symptoms. In

b. The SRCC is established under the Safety, Rehabilitation and Compensation Act 1988. It has regulatory functions and provides strategic directions with respect to occupational health, safety and compensation in the Federal jurisdiction.

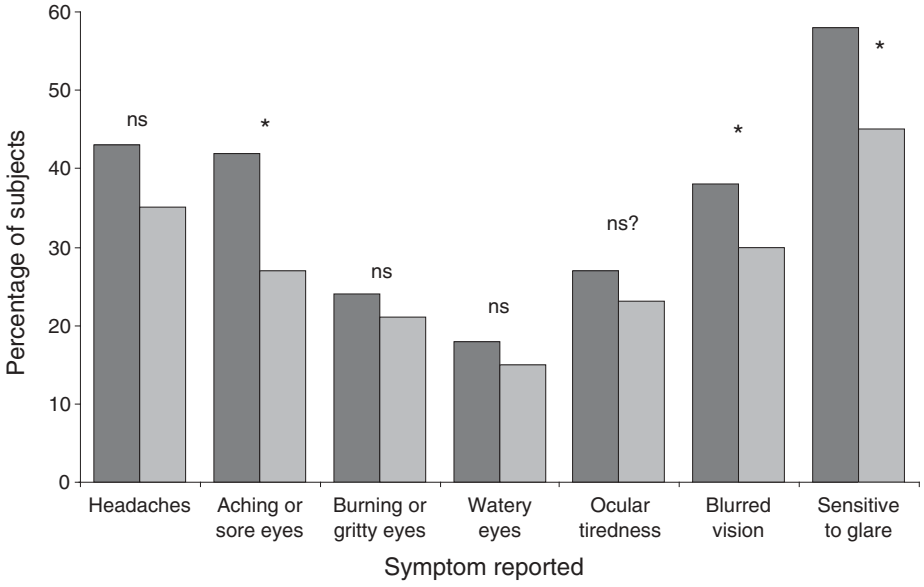

Figure 1. The percentage of SBE users (black bars) and non-SBE users reporting certain symptoms. Differences between the SBE and non-SBE groups reach statistical significance, after allowing for age and whether glasses are worn, only for those symptoms marked *. The figure is redrawn from Cole.[41] Data is from the SEC-VDU study, which is reported in full in Cole, Maddocks and Sharpe.[37]

contrast, they found there were significant differences between SBE users and non-users in other work environments, including an insurance office, an airline and a post office.

Howarth and Istance[39] compared the prevalence of visual discomfort among SBE operators doing data entry and word processing with that among clerical workers and typists. The prevalence was higher among the SBE operators at the end of the day but it was also higher at the beginning of the day. There was no difference between SBE users and non-users, when the measure was 'change in symptoms over the day' and no difference in a cross-over study when a sample of workers used SBE on one day and a typewriter on alternate days. Collins, Brown and Bowman[40] also used a cross-over study, in which their subjects acted as their own controls by making a diary record of symptoms when doing a variety of tasks, some of which involved use of SBE. Contrary to the finding of Howarth and Istance,[39] they found that SBE tasks in general are associated with more symptoms than non-SBE tasks performed by the same person.

The picture that emerges from these reports is that both SBE and non-SBE users often experience visual discomfort at work and that in many work environments, but not all, more SBE users than non-users will report symptoms but the differences are small. Figure 1 illustrates this point.

A further point that needs to be made to put the symptoms of office workers in perspective is that asthenopic symptoms are usually mildly discomforting and rarely acute or disabling. The symptoms may not be unduly troublesome. Figure 2 illustrates this point.

Lastly, when people say they experience visual symptoms, it does not follow that they necessarily do so every day. Figure 3 illustrates this point.

In short, while many office workers when asked may report experiencing visual symptoms at work, it does not follow that those symptoms are necessarily severe or frequent.

What is different about SBE work?

SBE workers report visual symptoms more often than non-users in many but not all work environments. The following reasons have been advanced[8,9,29,30] to explain why SBE work may cause visual complaints more often than non-SBE office work.

VIEWING ANGLE

The eyes look down 20 to 30 degrees when viewing hard copy material on a desk but SBE screens are usually placed just below eye level so that the operator's downward gaze is typically only zero to 15 degrees. This difference in downward gaze has several potential adverse effects.

1. SBE operators working with 'eyes-up' are more exposed to discomfort glare in offices in which lighting has been designed on the assumption that workers' eyes will be depressed downwards when reading.
2. The anatomy and mechanics of eye muscles are such that cyclovergence takes place on convergence when the eyes are not depressed.[42] This cyclovergence places stress on fusion and therefore vision is less comfortable with near work when the eyes are not in downward gaze.
3. When gaze is near horizontal, the eyelids are not dropped as they are with reading hard copy on a desk so that a greater area of conjunctiva and cornea is exposed to air. This increases the chance of irritant-like symptoms, especially if air temperature and humidity are not optimal.[43,44]
4. SBE operators who wear multifocals may have to tilt their head back to see through the reading part of their lenses if the reading segment is not set high enough. SBE operators who use bifocals have been found to have significantly higher neck discomfort and lower performance than non-bifocal users in a study of screen positions.[45] A screen monitor set 40 degrees below horizontal was also found to cause less neck discomfort than a monitor set 15 degrees below. There is supporting evidence in the studies of Cole, Maddocks and Sharpe[37] and Collins and associ-

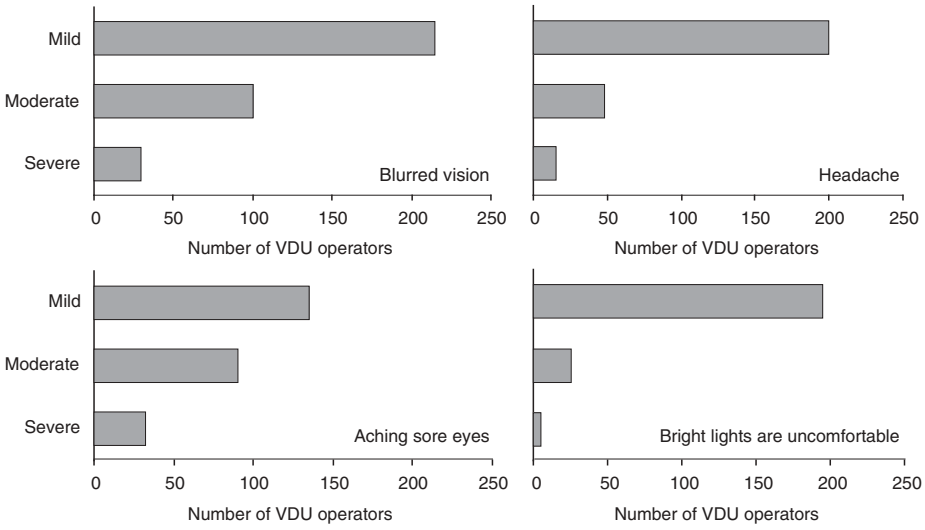

Figure 2. Reported severity of selected symptoms for SBE users. The figure is redrawn from Cole.[41] Data is from the SEC-VDU study, which is reported in full in Cole, Maddocks and Sharpe.[37]

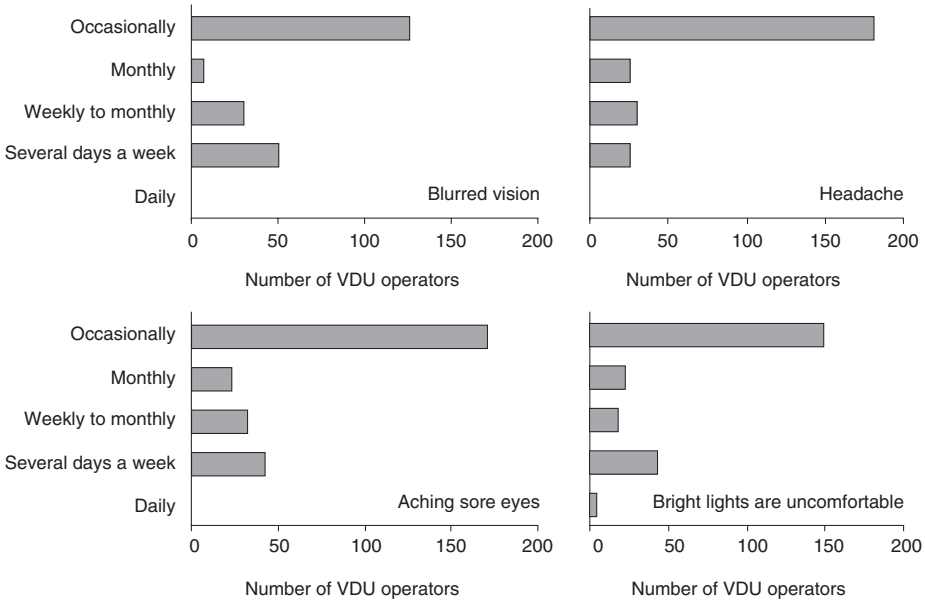

Figure 3. Reported frequency of selected symptoms for SBE users. The figure is redrawn from Cole.[41] Data is from the SEC-VDU study, which is reported in full in Cole, Maddocks and Sharpe.[37]

ates,[46] that wearers of multifocal lenses may have more neck discomfort.

WORKING DISTANCE AND EYE SHIFTING

SBE screens are often located at longer distances from the eyes than the usual distance for reading and, where hard copy is used in conjunction with the screen, there has to be a shift of fixation from screen to the hard copy. This can pose a problem for presbyopes, whose glasses are prescribed for ordinary reading distances. Also it has been suggested that the need to focus between hard copy at 400 mm and the screen at 500 mm may be a source of visual discomfort. Smith and co-workers[47] found that a task that involved eyes shifting from screen to hard copy or keyboard was a significant factor in the occurrence of ocular symptoms.

READING IS SLOWER WITH SBE

Several studies have shown that reading from a SBE display is slower than reading paperwork[35] and that proofreading on a computer screen is less accurate.[48,49] This suggests that proofreading tasks are more difficult on SBE than with hard copy and task difficulty does create greater stress. The reasons for proofreading being more difficult on SBE are not clear but it has been suggested that SBE screen refresh rates of 50 Hz may disrupt saccadic eye movements.[50]

IMAGE QUALITY

Early SBE displays had lower contrast and resolution than high quality printed text and did not always use the most readable fonts. Collins and colleagues[46] found a significant relationship between the occurrence of visual symptoms and screen legibility as graded by an investigator.

IMAGE STABILITY AND FLICKER

Early SBE often exhibited flicker and instability of the displayed characters, which have been associated with the occurrence of visual symptoms.[30]

SCREEN REFLECTIONS

Screen reflections reduce display contrast and can be irritating distractions. Screen reflections were troublesome in the early years of SBE use when reverse polarity was common. It is no longer an important factor with the almost universal use of positive polarity and higher contrasts between text and background.

WORK INTENSITY

SBE facilitates high work input without the need for breaks. Hard copy visual activity requires breaks because of the need to get material from files, to find stationery, to speak to others in person or by telephone or to reorganise the desk. SBE work is sometimes machine-paced, precluding

individual decisions about work breaks. Collins and associates[40] found that increased work pressure was significantly associated with increased visual symptoms, where work pressure was rated on a five-point scale by the participating subjects.

LACK OF WORK FLEXIBILITY

SBE equipment does not always lend itself to flexible positioning to suit individuals.

If some or all of these various special features of SBE work do contribute to the occurrence of visual symptoms, the solution lies with improved workplace ergonomics and changed work practices. Eyesight screening and optometric treatment cannot be expected to improve visual comfort when the underlying fault lies in the nature of the task or workplace ergonomics.

Good workplace ergonomics reduces visual complaints

When SBE was first introduced, the quality of the screen image was often poor, office lighting was not necessarily appropriate to SBE use and workplace ergonomics often fell far short of ideal. Coe and colleagues[5] surveyed nine locations of five firms in 1979 and found 28 per cent of display screens had technical faults, half had distracting screen reflections or were exposed to excessive glare, and lighting was too low (less than 250 lux) in 31 per cent of workplaces. They found no SBE workplace complied with all the suggested ergonomic guidelines.

The quality of screen images has vastly improved and ergonomic standards for SBE workplaces have been developed. Office lighting standards now take into account 'head-up' work with SBE. Increasingly over the past two decades, work systems have been developed for SBE that take into account the requirements of the user but this does not mean that modern SBE workplaces are without fault.

A 1997 study[51] of 45 SBE workplaces in the Netherlands found them to be generally of poor quality and ergonomic intervention resulted in fewer complaints of postural discomfort. Some other recent reports show that there is room for ergonomic improvements that will improve both visual and postural comfort.[52-55] Aaras and associates[56] found that improvement of lighting significantly reduced complaints of visual discomfort and the incidence of headache for SBE workers compared to a control group for which improvements were not made. The improvements were found to be sustained three years later[57] and at this time the lighting for the control group was also improved, with similar reduction in visual complaints.

Job stress is a factor

Several studies have shown that job stress and poor job satisfaction are factors contributing to the occurrence of visual symptoms with SBE use.

Coe and colleagues[5] found that visual symptoms were less prevalent among SBE workers engaged in 'creative' tasks and most common among those whose task was highly structured, whose working routine was inflexible and whose work was done against productivity pressures. Smith and co-workers[58] found that 'professional' SBE users had a lower prevalence of visual symptoms than did clerical SBE workers.

In a diary study of visual symptoms of SBE operators, Collins, Brown and Bowman[40] found that factors reducing the occurrence of symptoms were general well-being and high work interest, while factors increasing the likelihood of symptoms were work pressure and non-creative tasks such as data entry. Smith and co-workers[58] found that clerical SBE users not only had a much higher frequency of reporting visual problems but also had significantly higher levels of job demand stress (workload dissatisfaction, boredom, uncertain job future). Several other studies reaching similar conclusions are summarised by Bergqvist.[9]

Most of the studies of visual symptoms of SBE users were conducted in the late 1970s and the 1980s, which was when SBE equipment was being introduced. If work stress is a factor in the occurrence of visual symptoms, the change to SBE use would have generated stress and contributed to the occurrence of those symptoms. Twenty years later, SBE is now accepted as an integral part of work and a requirement to work with a computer is unlikely to cause stress.

Nevertheless, psychosocial factors are still considered as important as physical ergonomics in the prevention of SBE health-related problems.[59,60] A recent study[61] of 298 bank employees who had no eye dysfunction (as shown by an ophthalmological eye examination) found that psychological aspects of work explained 30 per cent of the variance of the visual symptoms they reported. The particular psychological aspects of work that reached significance as predictors of the occurrence of visual symptoms were self-esteem, group conflict, work satisfaction, under-use of skills and lack of co-worker support.

Despite their generally good physical work conditions and the fact that they had no eye defect or dysfunction, 32 per cent of these bank SBE users reported that they experienced visual symptoms at work. Fourteen per cent met the study criterion of 'strong asthenopia' in that they reported at least one visual symptom every day.

Does optometric intervention decrease symptoms for SBE workers?

Optometrists would expect an affirmative answer to this question. Optometrists know from long clinical experience that correction of refractive errors and treatment of disorders of binocular balance relieve visual and ocular symptoms.

It is also well known that uncorrected eyesight problems are common among working-age adults. In a sample of 1,200 office workers, half of whom used SBE, Cole, Maddocks and Sharpe[37] found that 11.5 per cent required a change for glasses they already had and six per cent needed glasses prescribed for the first time, a total of about 18 per cent. Mocci, Serra and Corrias[61] found 22 per cent of a sample of 385 bank employees, all of whom used SBE, had some kind of uncorrected visual defect. Silver and Daniel[62] found 21 per cent of a small sample of 103 SBE users either needed spectacle correction for the first time (11 per cent) or a change of correction (10 per cent). There were another 12 per cent whose glasses could have been changed but there was no functional reason to do so.

Thus, eyesight testing of office workers

and subsequent provision of optical correction should reduce the visual and ocular symptoms experienced by up to 20 per cent of employees. On this argument, eyesight testing of VDU employees would seem to offer considerable benefit.

Therefore, it is surprising that two well-constructed investigations of VDU workers failed to find a significant association between ocular deficits and the occurrence of symptoms at work. One of these two studies[63] involved a small sample (N = 79) of mainly young persons, few of whom had ocular deficits. The other study[47] had a larger sample of 588 newspaper employees who were subject to a comprehensive ophthalmological examination. Factor analysis failed to find any significant association between symptoms and the adequacy of the subjects' ocular refractions. However, their analysis of adequacy of correction seems to have been confined to that which the authors describe as hyperopia relative to the subjects' usual correction, although associations with 'abnormalities of binocular vision, muscle balance and accommodation' were also tested without any significant association being found.

Optometrists will be relieved to learn that there are several studies that do show that uncorrected optometric anomalies are associated with the occurrence of visual and ocular symptoms at work.

Dain, McCarthy and Chan-Ling[64] and Daum, Good and Tijerina[65] both found significant differences between symptomatic and non-symptomatic VDU operators in the degree to which their refractive errors were adequately corrected. In their large sample study of VDU and non-VDU users, Cole, Maddocks and Sharpe[37] showed that the probability of reporting symptoms of aching, sore eyes and blurred vision was significantly greater for those who needed glasses for the first time or needed a change of prescription. Not surprisingly, this was the case for both VDU and non-VDU operators.

Lastly, in a recent study of the effects of various interventions on the prevalence of visual symptoms among SBE users, Arras and associates[57] found that optometric correction brought about a significant reduction of symptoms.

However, to illustrate that the occurrence of visual symptoms will often have its solution in good ergonomics and good work practices rather than correction of visual deficiencies of workers, Silver and Daniel[62] found that only eight per cent of their SBE users complained of difficulties with SBE work, even though 20 per cent of them needed optical correction. The reason for the low prevalence of complaints may be that the employer organisation prided itself on its strong health and safety policy and it had already ensured that the SBE workplaces were ergonomically satisfactory.

DOES SBE USE CAUSE CATARACT OR OTHER OCULAR DISEASE?

The introduction of eyesight testing of SBE users in the 1980s was in part a response to the fear that SBE could cause cataract and other adverse health outcomes. The idea was that regular eyesight testing of SBE users would bring about early recognition of any eye disease caused by SBE, to the benefit of the employees so affected and that it would also help establish more quickly whether SBE posed a hazard to sight.

The fear that SBE might be a threat to eyesight was based on the fact that the video technology used in SBE has the capacity to produce X-radiation. The electrons beamed at the phosphor of the video screen are abruptly decelerated at the screen and the exchange of energy can result in the emission of X-radiation. However, the glass of SBE screens is thick and is lead impregnated to absorb any X-radiation produced. This combined with control of voltages that determine electron speed ensure that emission of X-radiation from SBE is very low.

However, it is known that X-radiation can damage biological tissue generally and can cause cataract[66] and there was the concern that even very low levels of X-radiation emissions could have adverse effects for operators sitting within 500 mm of SBE for long periods.

Concern has also been expressed that SBE may emit ultraviolet and microwave radiation, which are known to have adverse effects on the eyes, if thresholds for damage are exceeded. The electronic and electrical circuity of SBE also emit low frequency radiations although the biological effects of these wavelengths are not well documented and are not known to harm the eyes.

Do VDUs emit sufficient radiation to cause biological damage?

An association between VDU work and cataract and other eye disease is improbable as VDUs do not emit hazardous electromagnetic radiations to an extent likely to cause biological damage, even over a long period of exposure.

There have been numerous measurements of the radiations emitted by VDUs,[67-70] which show either no measurable emissions or emissions well below internationally accepted threshold limits.

For example, Joyner and colleagues[69] measured X-ray, UV, microwave and radio-frequency emissions from 11 colour and 39 monochrome VDUs. They were operated with a screen full of 'M's at full intensity. Using a detector capable of measuring 0.05 mR/h placed 50 mm from the screen, they found no measurable emission of X-radiation. The international exposure standard is 0.5 mR/h. They found no measurable UVB (erythymal UV) and although they could measure UVA from some units, the emissions were minuscule compared to the UVA in sunlight and fluorescent lighting. They found no detectable microwave emission. Radio-frequency radiations were typically one-third the limits recommended by the International Radiation Protection Association for members of the public. Levels are about the same as those from AM radio signals in a suburban living room.

In common with all electrical machines and electrical distribution systems, SBE also produces low frequency emissions from its internal circuitry and power supplies.[c] There is concern that these

c. The emissions of concern are very low frequency radiation (VLF) in the range 10 to 500 kHz and extremely low frequency (ELF) in the range 30 to 300 Hz.

emissions may have adverse health effects, although no clear evidence has emerged to show that this is the case. Office workers are exposed to only moderate levels of these emissions: for comparison their exposures are five to 10 times lower than those of electrical distribution linesmen.[71] SBE is only one source of emission in the low frequency band: photocopiers, printers, electric fans and many other sources also emit electromagnetic radiation in this range. If a clear connection between exposure to low frequency radiation and health were established in the future and exposure in office environments is found to exceed safe levels, then emissions from all sources, not just SBE, must be controlled.[d]

Is there any epidemiological evidence?

Table 1 summarises the epidemiological studies that have explored whether work with SBE is associated with a higher incidence of eye disease or impairment of sight.

None of the studies shows that SBE use is associated with a higher prevalence of cataract or other ocular disorder with the exception of that of Frank,[73] which found two per cent of the VDU group had cataract compared to 0.7 per cent of the control group. However, this study derived its data from a questionnaire rather than direct eye examination and the difference reported must be held in question for that reason.

Epidemiological study	Description
Zaret(1980)[13,14]	10 cases, six with cataract that did not reduce VA. Claims disputed. Not a case controlled study.
The Baltimore Sun Study. Smith, Tanaka, Halperin and Richards (1982)[33,47]	82 VDU users, 200 non-users. 27% of the VDU group and 33% of the non-VDU group had a lens opacity but most had no decrease in visual acuity. 1.4% of both groups had cataract that had reduced visual acuity.
Canadian Labour Congress (1982)[16]	N = 2330. For subjects younger than 45, 1.1% of the VDU group had cataract and 0.9% of non-VDU group. For subjects older than 45 years, 3.6% of the VDU group and 4.6% of the non VDU group had cataract.
Association of Ophthalmologists Quebec (1982)[72]	392 VDU and 74 controls. Data collected 1977 to 1982. Fifty of the subjects were said to have been 're-examined after several years'. Incomplete report. No data given but report concludes that VDU is not a risk factor.
The Mount Sinai Study. Frank (1983)[73]	N = 1047. 2% of VDU group had cataract, 0.7% in controls. However, the study is based on a questionnaire, not direct examination of the eyes and vision of the subjects: the subjects simply reported their recollections of diagnoses made by their ophthalmic practitioners.
Boos, Calissendoff, Knave, Nyman and Voss (1985)[74]	Cross-sectional study of 379 VDU and 126 controls. Lens changes in 2.5% VDU and 1% control. Not significant. Variations between ophthalmologists greater than between groups.
Rubino (1992)[75]	A longitudinal study of more than 40,000 VDU users examined in 1986–88 and 1990–91 by ophthalmologists. Prevalence of pathology was the same in the two examinations. No detailed data given in the published abstract: a full report does not seem to have been published.
Carenini B, Grignolo FM, Di Bari A, Molinatti A, Romano C and Maina G (1992)[76]	Lens transparency measured for 485 VDU-using telephone company employees and 185 controls. No significant difference in lens transparency between the two groups nor any relationship to VDU exposure. No detailed data given in the published abstract: a full report does not seem to have been published.
The SEC VDU Study. Cole, Maddocks and Sharp (1996)[37]	Six-year prospective study with 692 VDU and 624 controls in the first year. No clear trends to support the hypothesis that VDU use may be a risk factor for ocular disease. However, VDU users were significantly more myopic than non-users but VDU use accounted for only 4% of the variance in refractive error and there was no discernible trend for the difference in myopia to increase over the period of the study.

Table 1. Summary of the epidemiological studies of ocular health of VDU operators

Only three of the studies, those of Smith and colleagues,[33,47] Boos and associates[74] and Cole, Maddocks and Sharpe,[37] have been published in the open literature following peer review.

The Boos and associates study[74] found a higher prevalence of cataract (defined as 'definitely pathological lens changes as judged by the examining ophthalmologists') among SBE operators (2.4 per cent versus 1.0 per cent) but the difference is not statistically significant. There were no other differences in eye pathology between the SBE and reference groups. There were also no differences in visual acuity between the two groups. There were greater differences between the three examining ophthalmologists in the proportion they report as having lens opacities or cataract than between the SBE and

d. Various National Radiation Boards have published exposure guidelines for low frequency radiation based on acute effects but these are more than 1,000 times greater than the emissions of SBE. There are some voluntary emission guidelines for SBE such as the Swedish MPR2 published in 1990 but most authorities note that low frequency radiation emitted by SBE is extremely small and there is insufficient information to define safe/unsafe levels. (Source: Sawdon D. Low frequency VDT emissions. Sources, measurement, reduction and standards. Paper given to Visual Display Terminals Electromagnetic Fields and Health Conference. Australian Faculty of Occupational Medicine and the Australian Radiation Protection Society. February 1994).

non-SBE groups. The authors attribute the differences between examining ophthalmologists to sampling differences but it is more likely that there were differences in the diagnostic criteria for cataract adopted by the three ophthalmologists.

Cole, Maddocks and Sharpe[37] conducted a prospective study over six years. They found a significantly higher prevalence of lens opacities among non-SBE users than SBE users in the first year of the study. There was also a slightly higher prevalence of cataract[e] among non-SBE users but the difference was not significant. They found that a greater proportion of SBE users developed cataract over the six years of the study but the difference did not reach statistical significance. They found no evidence of a higher prevalence or incidence of other ocular disease among SBE users compared to the control group.

They concluded, 'There are some differences between the VDU and control groups, which might be interpreted as evidence that VDU work is a risk factor (for eye disease) but there is no definite pattern of trends to support that conclusion.' Smith and colleagues[47] bluntly stated that 'no significant association was found between VDT use and the prevalence of eye abnormalities, including cataracts'.

In addition to raising the prospect that radiation from VDUs might cause cataract, fears were also expressed that the radiation might cause miscarriages and skin rashes. Clusters of miscarriages among VDU workers have been described in union reports.[17,19] It is of interest to note that the many subsequent studies of adverse pregnancy outcomes have failed to show any credible association with SBE use[77,78] and skin conditions associated with SBE use seem to have a multi-factorial basis including psychosocial factors.[79] Radiation emitted by SBE does not appear to be a factor in skin or pregnancy disorders.

Does SBE use cause myopia?

Concern has been expressed that SBE use might cause myopia,[17] although there is little evidence that this is so. The major reviews of the US National Research Council[8] and of Bergqvist[9] dismiss the possibility. The recent review of Mutti and Zadnik[31] concludes that there is no evidence that SBE work causes myopia.

Presumably, the concern arises from the now substantial body of evidence that near work may be a factor in the genesis of myopia[80] and that SBE work can involve sustained periods of intensive near work uninterrupted by those breaks and variations in the pattern of work characteristic of desk office work.

Bergqvist[9] alludes to a Japanese study of 1,591 SBE workers (but only 125 controls) that suggested that SBE work might lead to myopia on the basis that more SBE users needed to obtain glasses in a one-year period than did the controls. However, neither Frank[73] nor Cole, Maddocks and Sharpe[37] found significant differences in the need for glasses or a change of glasses between SBE users and non-users.

Several studies have compared the refractive error of SBE and control groups and did not find any difference in the prevalence of myopia between the two groups.[33,74,81] Two of these three studies had relatively small sample sizes and in the third the sample was barely sufficient. Refractive error varies widely and to compare the refractive errors of SBE subjects with non-users, the size of each group should be at least 200 to 350.[31,37]

Cole, Maddocks and Sharpe[37] had sufficient statistical power in their study. They found SBE operators to be significantly more myopic than non-users after taking account of age and gender. The difference was small, only 0.35 D, and use or non-use of SBE accounted for only four per cent of the variance of refractive error. They were unable to show that myopia increased at a faster rate for the SBE group over the six years of the study as would be expected if exposure to SBE use was a factor in the progression of myopia.

Cole, Maddocks and Sharpe[37] are not convinced that their data supports the proposition that SBE work may be a factor in the development of myopia. The small difference they found may be from sampling error or there may be another confounding factor, for example education or intelligence, both of which are correlated with the occurrence of myopia.

Two more recent studies found no relationship between SBE use and the development of myopia. One was a longitudinal study of 23,000 SBE users over four years.[82] It showed no relationship between refractive error and SBE exposure (six hours per day for more than six years). The second study[83] found no significant relationship between the time spent working with SBE and the development of myopia for 224 engineering students, although it did find a relationship with other near tasks, such as time spent reading the literature.

There is no compelling evidence that there is a significant increase in the risk of myopia or aggravated progression of myopia from use of SBE by adults. If it is a factor, it will have a small impact among the many other genetic and environmental factors that determine the development of myopia.

STRATEGIES FOR REDUCING VISUAL DISCOMFORT AT WORK

There is no justification for eyesight testing of SBE workers on the grounds that SBE threatens eye health. There is no evidence that SBE poses any eye health risk.

However, a high proportion (40 to 60 per cent) of office workers report visual discomfort at work and it is known that about 20 per cent have uncorrected deficits of vision that cause visual symptoms.[37,61,64,65] Optometric intervention to correct those deficits will decrease the prevalence of visual symptoms.[57]

This may seem a good reason for screening the vision of all employees who are engaged on visually demanding tasks. As the prevalence of visual symptoms at work is essentially the same for those who do not use SBE as it is for those who do, workplace eyesight testing, if it is undertaken, should be for all employees engaged in visually demanding work, not just those who use SBE.

Defects of vision are only one source of

e. In the Cole, Maddocks and Sharpe study,[37] cataract was defined as a lens opacity that has caused a loss of vision.

symptoms of visual discomfort. About one-third of SBE users without vision defects still experience visual discomfort at work.[61] An eye sight testing program will not ensure visual comfort at work for all employees and is only one possible element in any strategy to ensure that employees do not unnecessarily experience visual discomfort at work.

Essential steps to reduce visual discomfort at work

A strategy to reduce visual discomfort at work should include:

LIGHTING IN ACCORDANCE WITH NATIONAL STANDARDS FOR OFFICE LIGHTING

In Australia lighting should conform to the Australian Standard AS 1680, especially AS 1680.2 1994 *Interior Lighting, Office and screen based tasks*. Other countries will have their own standards or use can be made of Commission Internationale de l'Éclairage (CIE) standard ISO 8995:2002/CIE S008:2001 *Lighting of indoor workplaces*. Good lighting diminishes the prevalence of visual symptoms.[47,57]

GOOD AIR QUALITY

General comfort is enhanced by good control of atmospheric temperature and humidity. The occurrence of visual symptoms is related to general well-being,[40] and in part general wellbeing is determined by physical comfort. Therefore, good air quality can be expected to reduce the occurrence of visual discomfort. In addition, low humidity can cause dry eyes with consequent irritating eye symptoms. VDU users, in particular, may be more vulnerable to dry eye symptoms because they have a slower blink rate and their eyes are more widely open (because of their more elevated gaze at SBE screens compared to ordinary reading).[43]

VISUAL DISPLAYS THAT CONFORM TO GOOD ERGONOMIC PRINCIPLES

Printed and screen displayed text should be of a size that is easily read at the intended working distance. Characters and graphics should be realised with good resolution and contrast.[46,84 f] SBE generated displays should be free of flicker. More detailed guidance can be found in Australian and International Standards, notably AS 3590 1990 and ISO 9241.

WORKPLACES THAT CONFORM TO GOOD ERGONOMIC PRINCIPLES

Inappropriate relationships between the worker and SBE screens or hard copy can cause the adoption of poor posture, with the risk of consequent musculo-skeletal symptoms. It can also make the information more difficult to see if it is located too close or at too great a distance or if it has to be viewed at an oblique angle. Difficulty seeing task material will cause stress and fatigue. Clearly this is especially important for presbyopic workers. In addition, the centre of SBE screens should be well below horizontal so that users look down when using the screen as viewing screens with elevated gaze for extended periods is uncomfortable.[45] Guidance on workplace requirements can be found in AS 3590 and in ISO 9241 and 13406.

GOOD MANAGEMENT ENVIRONMENT AND SUPPORTIVE PEER RELATIONSHIPS TO MINIMISE PSYCHOSOCIAL STRESS

Psychosocial stress arising from group conflict, low work interest, low work satisfaction, lack of control and lack of flexibility in the discharge of work duties, under-use of skills and poor peer support is related to the occurrence of visual discomfort at work.[5,40,58-61]

WORK SYSTEMS THAT ARE USER-FRIENDLY TO MINIMISE FRUSTRATION AND COGNITIVE DEMAND

Guidance with respect to the useability of SBE visual displays can be found in ISO 9241.

EMPLOYEES HAVE EYESIGHT ADEQUATE FOR THE TASK

This should be the last step of a strategy to enhance visual comfort at work and certainly should never be the sole component. Ensuring adequate eyesight for the work task can be achieved by the introduction of a work-based vision screening program but an alternative is to encourage employees to seek their own eye care as needed. This can be done by providing employees with information about vision and eye care or by the provision of subsidies for the cost of glasses.

What is a demanding visual task?

It has been argued in the preceding sections that if workplace eyesight testing is introduced, it should be for all employees who are engaged on visually demanding tasks, not just for those who use SBE. There is no easy definition of what constitutes demanding visual activity.

The usual defining element of a visually demanding task is 'prolonged near work'. Prolonged near work might be conceived as sustained and concentrated attention to text, numerals or graphics at distances of 350 to 500 mm for unbroken periods of several hours a day.

This leaves the question of the definition of 'prolonged'. There is no clear relationship between the probability of visual symptoms and hours of sustained visual activity. Knave and colleagues[38] found that SBE employers reporting eye discomfort worked longer hours and spent more hours in the day with their gaze directed at the screen than those who had no eye symptoms but not all the time variables they tested reached statistical significance. Smith and co-workers[47] found that hours of SBE work was a

f. Legge and co-workers[84] find that reading rate on SBE screens is dependent on character size, matrix sampling and spatial frequency content. They show that, for maximum reading fluency, text characters should have a minimum size such that their height subtends an angle at the observer's eye of 0.3 degrees. Reading fluency tends to decline when characters are larger than one degree of subtended angle. Reading rate increases with bandwidth but only up to two cycles per character. Reading rate increases with matrix sampling and should be at least 4 x 4 for small (0.1°) characters and 20 x 20 for larger (24°) characters. They found screen polarity (black-on-white versus white-on-black) does not have an effect although practical consensus is that black text on a white background is easier to read. In addition, screen reflections are less troublesome for black on white displays.

significant factor but only for some symptoms. Conversely, Collins, Brown and Bowman[40] found the relative frequency of visual, systemic and ocular symptoms increased progressively through the day but the relative frequency of all kinds of visual symptoms was high in the first of two morning sessions of work.

This lack of a strong connection between hours of work and the occurrence of symptoms suggests that visually demanding office work cannot be easily defined by a specified number of hours.

The criteria for judging a visually demanding office work task

In the absence of precise data on which to base a definition of a demanding visual task, a decision on which work tasks are visually demanding is simply a matter of judgement.

The following characteristics could be used to judge whether a task is visually demanding.

1. The visual task requires near work at distances of less than 500 mm, which is usually sustained for periods of several hours with few interruptions to attend to other tasks.
2. The text characters and graphics have an angular height of less than 0.3 degrees. Fluency of reading decreases for characters less than 0.3 degrees (18 minutes of arc) in angular height[84] and Standards such as AS 3590.1 1980 recommend a minimum character height of three millimetres for SBE displays, which is equivalent to 0.34 degrees (20 minutes of arc) angular height at an observation distance of 500 mm.
3. The visual material is crowded and complex. It is well known that crowding of characters reduces their legibility[85-86] and dense displays of information will lead to errors in eye movement scanning. Searching for target information is increasingly difficult with crowded and dense visual displays.[87]
4. The cognitive demands of the task are high. Tasks that require a high level of accuracy, have to be done quickly or require sustained cognitive processing can cause psychosocial stress and psychosocial stress is associated with the occurrence of visual symptoms. Alternatively, the high work interest that may be associated with a cognitively challenging task will be an offsetting factor as several studies[5,40] have shown a lower prevalence of symptoms with creative or high-interest tasks. Ideally, tasks should be designed to avoid boredom on the one hand and the need for excessive sustained mental concentration on the other.
5. Workplace ergonomics are not optimum. Optimum ergonomic design may not be practical in some special occupations. For example, the work may have to be done in darkness or under low levels of lighting.

THE BENEFITS AND DISBENEFITS OF WORKPLACE VISION TESTING

A workplace eyesight testing program may contribute to the reduction of visual discomfort at work and provide some other incidental benefits but there are several drawbacks to vision screening programs.

Benefits of vision screening of employees

ENSURING GOOD VISION AT WORK

People often do not seek eye care even when they are aware that they have a problem. The reasons are diverse, namely, procrastination, fear that some serious eye disease may be found, a dislike of the idea of wearing glasses or concern about the cost. A workplace vision screening program can ensure that employees who have an uncorrected defect of vision obtain eye care.

RECORD OF PRE-EXISTING OCULAR DEFECTS

Eyesight testing on employment provides a record of any pre-existing eye defect at the time of commencement of work. This can be useful in the event of a claim that there has been a loss of sight caused by work.

INCREASING GENERAL SAFETY AND REDUCING OCULAR MORBIDITY

The last advantage, which is tangential to work but has general social benefit, is that a system that ensures regular eye examination will enhance vision for non-work activities and will lead to a reduction in ocular morbidity through early detection of eye disease. In the small sample study of 103 SBE operators of Silver and Daniel,[62] two subjects were found to have previously undiagnosed glaucoma.

Disadvantages of work-based programs of vision screening

There are several economic and social dislocations that can arise from work-based eyesight testing programs. These are:

DEPENDENCE ON OTHERS FOR PERSONAL HEALTH CARE

The creation of a culture of dependence on others for personal health care decision-making is socially undesirable. It runs counter to current views that people should be empowered to manage their own health and to participate with their health care providers in decisions concerning their health. It is not really the role of and it is unduly paternalistic for employers to decide on and arrange health care for their employees.

THIRD PARTY INTERVENTION IN HEALTH CARE CAN DISTORT HEALTH CARE DELIVERY

The intervention of a third party in health care delivery tends to limit freedom of choice of practitioner (for administrative convenience) and to limit treatment options (to constrain costs). Employees sent to health care providers by an employer may feel constrained in confiding their past history and present problems to the practitioner, fearing that the information may adversely affect their employment prospects and this may lead to diagnostic error.

SCREENING EYESIGHT TESTS CAN BE TAKEN AS A SUBSTITUTE FOR A FULL EYE EXAMINATION

Eyesight testing of employees is a screening examination and signs of a serious eye

disorder may not be discovered. A further risk is that employees who pass the screening eyesight test may hold the belief that passing the test means they have no eye disorder. As a result they may delay seeking a more comprehensive eye examination, thereby missing the opportunity to treat an underlying eye disease before the onset of visual loss.

EMPLOYER EYESIGHT TESTING PROGRAMS TRANSFER HEALTH COSTS TO THE EMPLOYER ORGANISATION

The cost of workplace eyesight testing programs is not inconsiderable. Transferring health care costs from individuals and their health funds to the employer adds to the cost of production.

WHEN IS WORKPLACE VISION SCREENING NEEDED?

It has been argued in the preceding sections that routine eyesight testing of SBE operators is not needed as a public health measure and will be only partly effective in reducing visual discomfort at work. Therefore, policies that encourage or require eyesight testing of SBE operators could be abandoned. Are there circumstances when workplace vision screening would be appropriate?

When the task is visually very demanding

Office workers who have visually demanding jobs would benefit from a work-based vision screening program but such a program should be part of a broader multistep strategy to reduce the occurrence of visual symptoms. The elements of such a broader strategy have been outlined above. An alternative is to educate and encourage employees to obtain the eye care they need on their own initiative. A subsidy for the cost of glasses could be one means of encouraging regular eye care.

When vision is critical for safety

Eyesight testing should be introduced when good vision is critical to safety and the proper discharge of essential work duties.

A distinction needs to be made between occupations, such as office work, that require an adequate level of vision to ensure that assigned work can be done with reasonable proficiency and without undue discomfort, and those occupations for which good vision is critically important. Vision-critical occupations are those where failure to acquire essential visual information may have serious safety or economic consequences.

Examples of vision critical occupations are drivers of commercial motor vehicles, pilots of aircraft, air traffic controllers, aircraft maintenance inspectors, train drivers, seafarers, police, customs officers, defence force personnel, quality control inspectors and those who work with colour-coded cables.

Vision standards should be set for vision-critical occupations. These standards should define the visual abilities considered to be necessary for safe performance of the assigned tasks. Employees engaged in these occupations should have a pre-employment eyesight test and should have their vision reassessed at periodic intervals during employment.

For some vision-critical occupations, statutory vision standards have to be met to obtain a licence or certification to engage in the occupation. However, holding such a licence or certificate does not necessarily ensure the holder has safe vision for the job. Statutory vision standards are not always well constructed and administered. They tend to be set to fail the smallest number of people and they are often further weakened by appeals to equal opportunity tribunals.

As a part of their risk-management strategies, employers should ensure that employees in vision-critical occupations have the vision deemed necessary for the safe performance of their job and should not necessarily rely on vision testing done by a licensing agency.

When there is risk of eye injury

There are risks of eye injury in a range of occupations and while the risk is minimised by the conventional strategies of hazard elimination, hazard control and personal protection, accidents still occur and eye injuries are sustained. There are about 50,000 eye injuries per year in Australia, costing about $60 million. About eight per cent of workplace injuries are eye injuries and each year about seven in 1,000 workers have an eye injury.[88]

Evaluation of loss of sight due to an accident should be based on the known level of vision prior to the accident. The processes of determining the extent of impairment after an accident and compensation are much more efficient and certain if vision prior to the accident is known.

The Australian Standard AS/NZS 2211.1:1997: *Laser Safety* recommends that the vision of employees should be documented before commencement of work with lasers. This principle could be extended to all employees whose occupation exposes them to the risk of eye injury.

CONCLUSION

The question asked in this paper is: 'Do VDUs cause visual problems?' The answer is that a significant proportion of VDU operators report symptoms of visual discomfort associated with their work. However, a similar proportion of office workers who do not use SBE also report visual discomfort at work. After three decades of extensive use of SBE in the workplace and several surveys of the ocular health of SBE users, including one six-year prospective survey,[37] there is no credible evidence that they cause cataract or other eye disorders.

Some 20 per cent of office workers have uncorrected or partially corrected vision defects and optometric treatment does reduce the prevalence of complaints of visual discomfort at work for this group. There are other causes of the symptoms. These include ergonomic faults, which although less frequent now than when VDUs were first introduced, are still not uncommon.[51] Psychosocial stress due to work-pressure, boredom or the lack of a supportive workplace has been identified as a significant factor in the reporting of visual discomfort: it can contribute as much as 30 per cent to the variance in visual symptoms.[61]

There is no compelling reason for employees who use SBEs to be subject to

pre-employment and periodic screening, as is recommended by the NHMRC and the Safety, Rehabilitation and Compensation Commission guidelines. Vision screening may be a useful strategy to initiate remedies that will reduce visual discomfort in visually stressful tasks but it can only be one element of a broader occupational health strategy to reduce the incidence of visual discomfort.

The alternative to work-based vision screening is to educate and encourage employees to seek the eye care they may need on their own initiative. This has the advantage of placing control over their personal health care in the hands of employees and avoids the drawbacks to health care that can arise from third-party intervention. It is also a cost-saving for industry.

Vision-screening programs should be adopted by employers when vision is critical to safe operations or when the nature of the work undertaken exposes employees to risk of eye injury. In the latter circumstance, work-based vision screening provides a record of vision prior to injury so that loss of vision as a result of eye injury can be properly evaluated.

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Author's address:
Professor Barry L Cole
Department of Optometry and Vision Sciences
The University of Melbourne
374 Cardigan Street
Carlton VIC 3053
AUSTRALIA