Sound and vision

The School Screener system is an innovative new way for school nurses to carry out vision and hearing tests. Professor David Thompson from City University London explains how it works

"Can you read the letters on the chart?", I inquired of the five year old. The rather blank look and shake of her head suggested she could not. "What about these larger letters?" Still no response. Eventually, with some difficulty she read the largest letters on the screen.

This child was one of approximately 18% of five year olds who have poor vision in one or both eyes. The child, her teacher and her parents were apparently unaware that her vision was poor and without school vision screening, it is likely to have been several years before the problem was detected. While it is difficult to predict exactly what effect this may have had on her social and educational development, there is little doubt that it would have been detrimental to some degree.

Three weeks later she was proudly wearing her new glasses and already interacting more in the classroom and showing increased enthusiasm for reading.

Learning has been defined as the "acquisition of understanding through the senses" (Dictionary, 2012). While all of the senses are important conduits of information, vision and hearing are particularly important in this respect.

Professor David Thomson, Department of Optometry and Visual Science, City University London

The importance of good vision during the formative years led to the introduction of routine vision screening in schools in the UK more than 100 years ago. While the school screening programme has been less than perfect, there is no doubt it has provided a useful safety net, detecting children with significant vision problems at an early stage before it impacted on their educational development.

Screening policy

General policy on vision screening is set by the National Screening Committee (NSC) and guidance is provided in a related publication known as Health for All Children (Hall, 2003). In 2003, the NSC recommended that vision screening was limited to a single screening on school entry at the age of four to five years and that screening at the age of seven and 11 should cease (Hall, 2003).

While some localities have implemented good screening programmes, surveys carried out by the RNIB (McLaughlin, 2009) and Which? (Pearl, 2011) suggest that at least a third of authorities have no screening programme in place at all. Even where screening programmes are in place, in many cases the programmes lack proper mechanisms for audit or

adequate pathways to manage the children who "fail" the screening.

Since 1995, a team from City University London has been investigating ways of improving the sensitivity, specificity, efficiency and cost-effectiveness of screening in schools. One of the outcomes of this work is a computer system known as the School Screener. This system offers a radical new solution for providing an efficient and effective vision and hearing screening programme.

This article gives a brief overview of the School Screener system and the evidence for its effectiveness. The article is focused on vision screening although the system can also be used for hearing screening and collecting height and weight data.

The target conditions for vision screening

The first few years of life are a time of radical development for the human visual system. While the eyes themselves are fully formed at birth, the complex network of cells in the brain which interprets the information received from the eyes is immature. As a result, a newborn infant has very limited visual perception (Daw, 2006).

The brain matures rapidly over the first few months of life and by the age of one year most attributes of vision are present, although the visual system does not reach full maturity until the age of approximately seven years.

In order for the cells in the brain to develop normally, the two eyes must be well co-ordinated and focused. If a child has a squint (where the two eyes are misaligned) or a focusing problem (refractive error), vision in the affected eye(s) may not develop normally and the child will develop a condition known as amblyopia, or 'lazy eye'.

Amblyopia results in visual impairment in the affected eye and means there is a reduced or absent 3D vision (stereopsis).

If the condition is detected before the age of approximately seven, vision in the amblyopic eye can often be improved by prescribing spectacles and/or patching the good eye for a few hours each day. Treatment becomes less effective after the age of seven as the brain loses its plasticity.

Another challenge for the developing eye is the change in focal length as the eye grows. In order to keep the image in focus on the retina as the focal length of the eye changes, the shape of the cornea has to change in exact proportion. This process, known as emmetropisation, works well in most cases and the majority of children retain good focus throughout the growth period.

However, in some cases the process fails and this results in the child developing a focusing error (refractive error). If the eyeball grows too long for the shape of the cornea a child becomes short-sighted (myopic). If the eyeball is relatively short, the child will be long-sighted (hypermetropic). If the cornea develops an egg-shape rather than being spherical, the child will become astigmatismic.

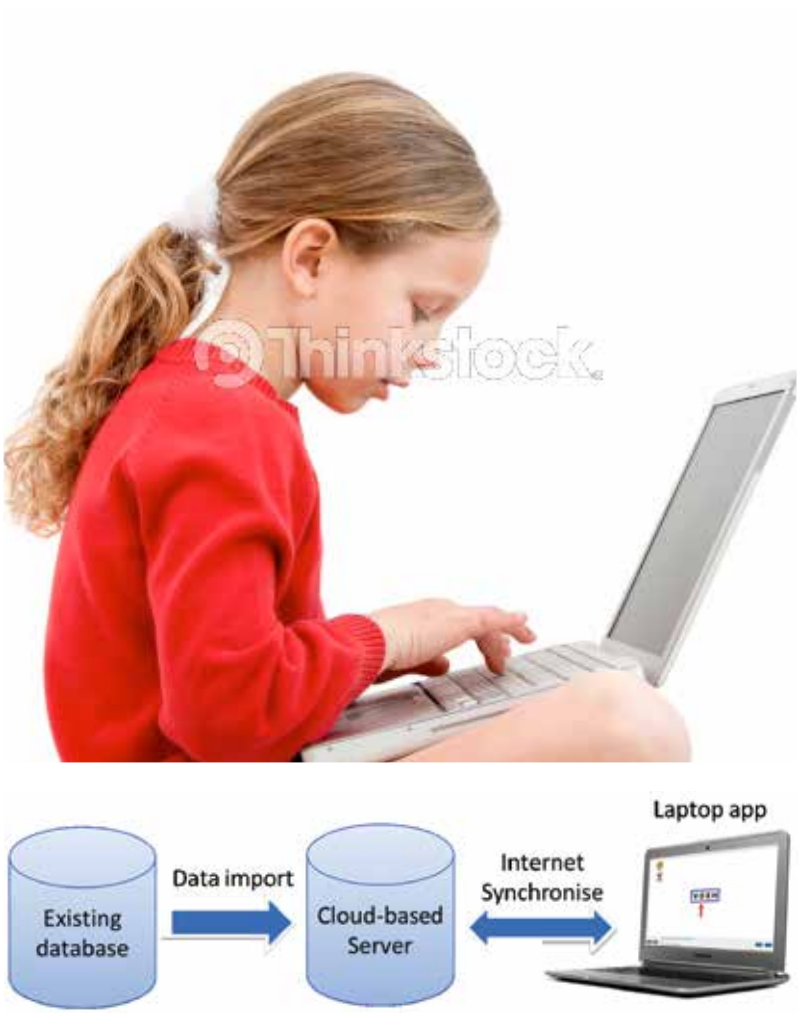

Figure 1. The names of the children to be screened are uploaded to the central server and then synchronised with the laptop used for screening.

In general, short-sightedness results in poor distance vision while long-sightedness tends to cause problems with near vision. Astigmatism tends to affect both distance and near vision. All of these conditions can be corrected using glasses or contact lenses.

Therefore, the primary target conditions for vision screening are amblyopia and significant refractive error. While there are many other problems and conditions that can affect a child's eyes, they are not common enough or serious enough to justify being included as target conditions for universal screening.

Amblyopia, myopia and astigmatism can be detected by simply measuring the visual acuity in each eye. Hypermetropia can be detected by including a blur test in the protocol.

The School Screener software

The School Screener system consists of software which runs on a standard laptop (running Windows XP or later) and a secure cloud-based server. The software is fully compliant with NHS information governance standards.

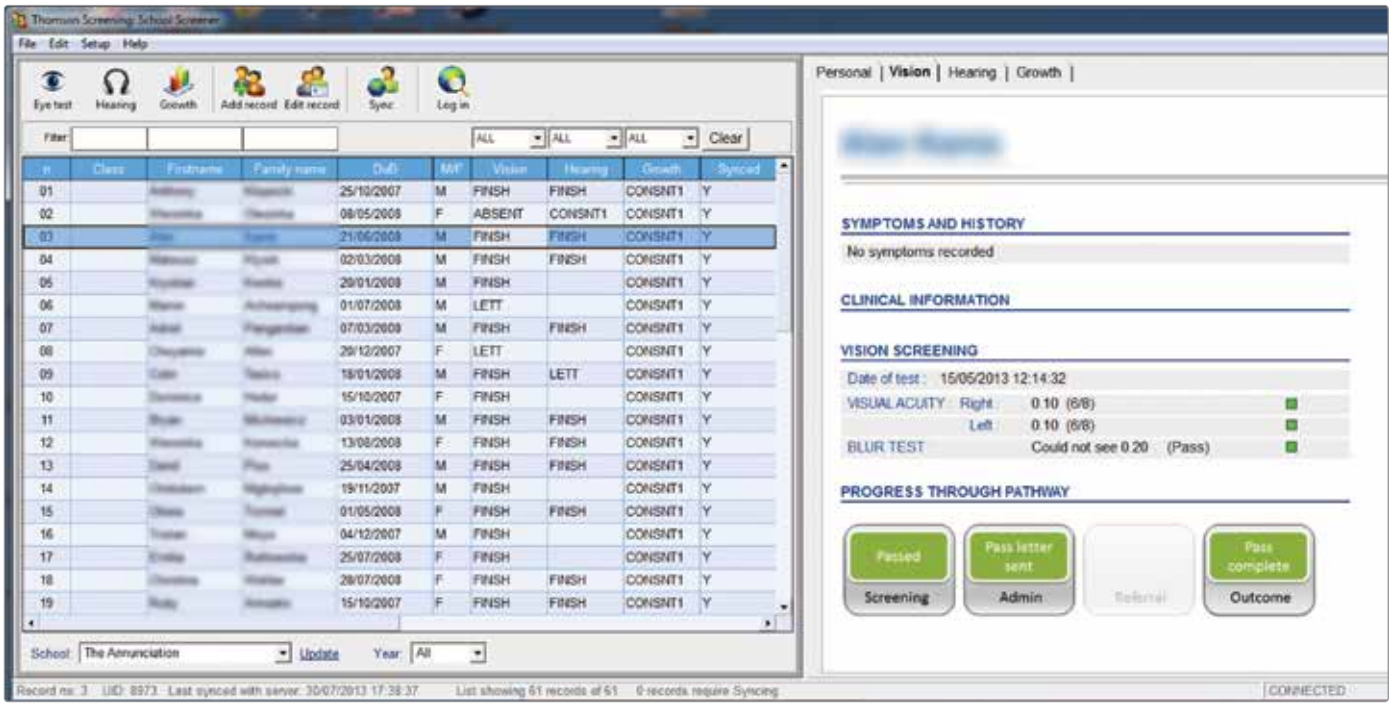

Figure 2. The names of the children in each school are displayed on the laptop screen along with their screening status.

Figure 3. A cartoon character helps to engage the children during the vision screening test.

Figure 4. Having entered a child's height and weight, the software automatically calculates their BMI and corresponding centile for the child's age and gender.

A screening cycle begins by uploading a list of the children to be screened. It is recognised that these lists are subject to change and children can be added or removed from the list at any stage throughout the year.

Each school nurse or team member is then registered on the system and required to generate a password. Nurses can be allocated all the schools in the locality or a subset.

Before attending a school, the nurse synchronises the laptop software with the server by connecting to the internet and clicking on Sync. This downloads a list of all the children at the schools that the nurse has been allocated. This information is stored locally so that internet access is not required when the nurse visits the school (figure 1).

How does it work in practice

The nurse or team member then visits the school and sets up the laptop in a suitable room. As each child is called, the nurse simply selects the child's name from the list and selects vision or hearing screening (figure 2).

For vision screening, a cartoon character gives the child exact instructions about when to cover each eye and put on the "special" glasses. Instructions can be spoken in 27 different languages or muted so that the nurse or team member gives the instructions. The software uses the gold standard tests for vision screening as recommended by the NSC. Visual acuity is measured with the child standing at three metres from the laptop screen and viewing letters displayed in a crowded LogMAR format (figure 3). Displaying the letters on a laptop screen rather than using printed charts provides better control over the luminance and contrast of the charts and allows the letter size to be scaled to accommodate different viewing distances. Matching cards may be used with children who are not yet able to name letters.

To progress the test, the nurse simply clicks on the Next button using the mouse or uses the wireless remote control. For the visual acuity test, letter size is varied automatically according to the recommended protocol and all scoring and recording of results

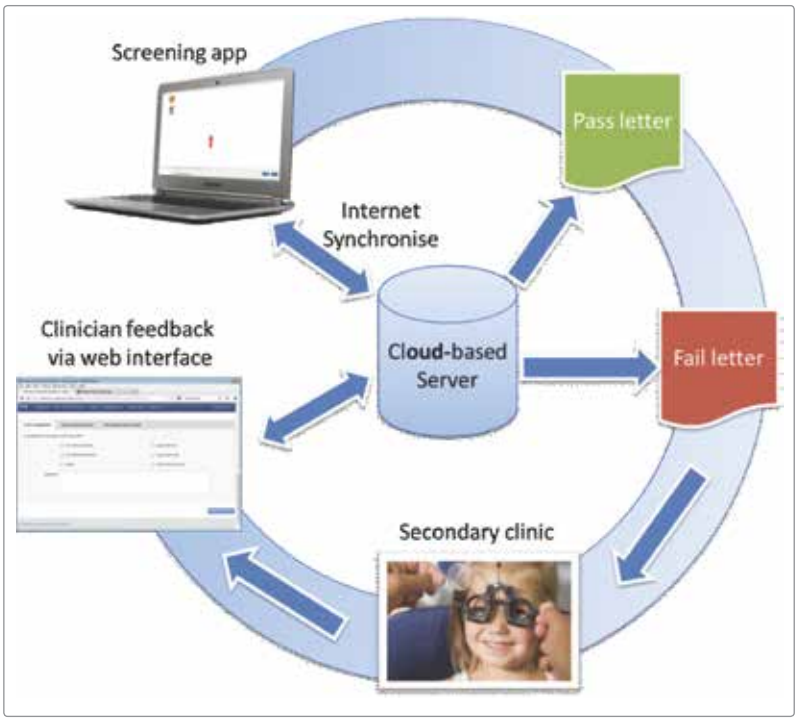

Figure 5. Children who fail the screening are automatically tracked through the referral pathway.

happens automatically. A vision screening can usually be completed in less than three minutes.

For hearing screening, an audiometer device (the size of a spectacle case), developed specifically for the system, is plugged into the laptop. This device is used to generate test tones under computer-control through the calibrated headphones. The child is seated in front of the laptop screen and watches three cartoon characters appear on the screen. The child is asked to report which of the characters "squeaks". Three tones are presented to each ear at the predetermined frequencies and following the recommended protocols.

For height and weight screening, the measurements are simply entered into the system. The software automatically determines the BMI and the corresponding centile for a child of the corresponding gender and age and places the child into one of four categories: under-weight, healthy weight, over-weight or obese (figure 4). Personalised letters with appropriate wording can then be generated automatically and the final dataset exported to a spreadsheet for submission to the NCMP.

The tests are usually very well received by the children who are often so absorbed in the "game" they do not realise they are being screened. The results are all securely stored on the laptop removing the risks associated with paper-based records.

The results process

On completion of the screening the laptop is once again connected to the internet and with the click of a button, the results are synced with the server. The server then automatically analyses the results and generates personalised letters for the parents or carers of each child. The letters follow templates which are customised for each locality

The nurse or an administrator can then log-in to the server using a standard browser and print the reports at the click of a button. Alternatively, a printing service is available so that letters are delivered to each school, ready to be handed to the child's carer.

As a result, a task which often used to take days is achieved in seconds.

Referral pathways

Screening on its own is of little value without a robust pathway to ensure that those with vision or hearing problems receive the appropriate treatment or intervention. In the past, following children through the referral pathway has been a time-consuming and difficult process requiring the transfer of referral letters to the secondary clinic and the return of examination reports. In practice, most authorities do not track children beyond the initial letter to parents and therefore have no way of ensuring that those who test positive receive the tests and intervention they may require.

The School Screener provides an elegant and efficient solution to this problem. Parents of children who test positive at the screening receive letters giving clear and precise instructions about how to book the secondary examination. For vision screening, the examination might be with an optometrist, a secondary clinic or a hospital, depending on the local policy.

When the child attends the secondary clinic, the clinician can log-in to the server using a secure code and view the results of the screening and any comments recorded by the nurse (figure 5). They are also asked to record if the screening result was correct (true positive), i.e. did the child turn out to have the one of the target conditions. They may also record additional clinical information such as visual acuity, spectacle prescription and treatment/intervention prescribed.

Thus, at any moment in time, the system can provide information on the number of children screened, the number who have tested positive, the number of screen positives who have attended for a secondary examination and the number of these children who were true positives. This powerful audit information allows the programme director to constantly monitor the progress and effectiveness of the overall screening programme. Issues with over or under-referral rates can be readily identified and appropriate measures taken.

While most parents and carers tend to comply with the initial request to arrange a secondary examination, a minority often require further encouragement.

To address this issue, an automated reminder protocol can be set up so that the School Screener automatically generates reminder letters for all children who test positive but have not yet attended the secondary clinic. Up to three reminder letters can be sent at prescribed intervals following the screening.

Pilots show promising results

The system was first developed over 10 years ago and has been subject to extensive clinical and field trials. In a clinical trial involving more than 3,000 children in inner-London schools, all children were screened using the system and then examined by an optometrist and an orthoptist (Thomson, 1999).

Using the outcome of the clinical assessment as the gold standard, the program was found to have a sensitivity of 96.9% and a specificity of 96.1%; i.e. the program correctly identified 96.9% of the children with the target conditions and 96.1% of the children with "normal" vision.

The children responded very well to the screening tests, perceiving the whole process as a "computer game". The personalised reports generated for the parents and carers of the children were also very well received.

With appropriate organisation within the schools it was possible to screen between 10 and 15 children per hour using a single computer. Coupled with administration time savings, by virtue of the automated system, this allows school nurses to work more efficiently.

Since large scale pilots ended in March 2013, areas covering more than 30,000 children have started screening using the new system and many more areas are in discussions to start using either later in 2013 or early 2014.

In the pilots, overall, 18% "failed" the vision screening, compared to between 3% and 33% with traditional methods. Of these, approximately 10% of those who have received secondary tests were false positives, 17% required treatment for amblyopia and the remainder (73%) had a refractive error. 62% of those tested were given spectacles.

Summary

The School Screener provides a radical new solution for managing screening in schools. The system oversees the entire process including obtaining parental consent, testing vision and hearing, generating letters and reports, tracking through the referral pathway and collating audit statistics.

At a time when school nurses are under increasing pressure to take on new responsibilities, the School Screener removes a huge administrative burden (which is often borne at least partly by nurses).

Vision and hearing screening in schools is an extremely important safety net, without which many children with vision and hearing problems are disadvantaged at school. By making appropriate use of technology, the School Screener allows localities to provide a high quality, efficient screening programme while actually reducing the demands on school nurses.

School Screener users say:

"Many children with vision and hearing problems go undiagnosed. The pilots of the School Screener software demonstrate that screening effectiveness can be substantially improved with benefits for children's development and cost savings for special needs."

John Brown of the Institute of Education, University of London

"We have recently piloted School Screener. The benefits identified for patients, staff and the Sussex Community Trust quality agenda has led to the decision to now roll out School Screener across the West Sussex County."

West Sussex Healthy Child Programme team

"Implementing School Screener has demonstrated improvements to the standard of screening provision."

Sabeen Saeed, specialist orthoptist in Barnet

Further information

Thomson Screening Solutions, a spin-out company of City University London, has been set up by the university to implement and support School Screener.

Further details about the School Screener are available at www.thomsonscreening.com or by contacting the author at w.d.thomson@city.ac.uk

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