DIAGNOSIS AND MANAGEMENT OF AMBLYOPIA

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AIMS

This unit aims to outline the diagnosis and management of amblyopia via developing:

- A protocol for assessing vision in children
- A protocol for assessing amblyogenic factors in children
- A framework for the differential diagnosis of amblyopia
- Management guidelines for amblyopia

LEARNING OUTCOMES

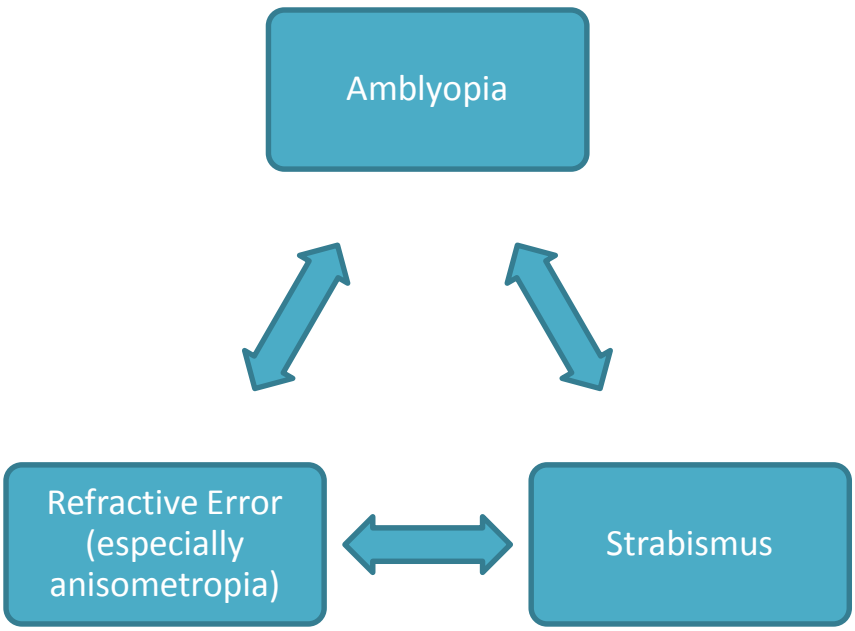
After completing this unit, students should be able to:

- Conduct a diagnostic assessment of a child with reduced vision in one or both eyes
- Differentially diagnose amblyopia from other causes of vision loss in children
- Identify and appropriately refer vision loss that is NOT amblyopia
- Manage amblyopia to the extent that fits within their legal scope of practice.

BACKGROUND

Amblyopia (lazy eye) is a developmental abnormality that results from physiological alterations in the visual cortex and impairs vision (Levi 2012). Clinically, this is seen as a loss of visual acuity in an apparently anatomically healthy eye, despite appropriate optical correction. The definition of visual acuity loss in amblyopia varies, but is usually defined as a difference of a one or two lines or more between the two eyes. The cutoff chosen will affect the incidence of the disease.

Amblyopia is common (2-4% of the population), and eye care practitioners commonly need to diagnose it, advise patients and families about it, and manage it. Amblyopia develops under the influence of *amblyogenic factors*, and amblyopia can worsen some amblyogenic factors:



Refractive error can cause amblyopia by reducing the quality of the neural signals coming from one or both eyes. Anisometropia is a particularly strong amblygenic factor because competition decides which inputs cortical cells maintain and which ones they ignore – an eye that sees clearly gains more cortical control than a eye that sees blurry. Amblyopia can also cause refractive error, because amblyopic eyes do not emmetropize well.

Strabismus can cause amblyopia by causing the cortex to suppress the image from one eye to avoid diplopia. Prolonged suppression of the inputs from one eye weakens the neural connections from that eye to the cortex while strengthening those from the other eye. Amblyopia can also cause strabismus, because it decreases the quality of fusion.

Other causes of reduced vision in early childhood (e.g. congenital cataract, ptosis, nystagmus) can also cause amblyopia.

Definitive diagnosis of amblyopia is difficult due to these circular cause-effect issues, and also because the definition of amblyopia includes the clause "in an apparently healthy eye" – it is extremely difficult in science or medicine to prove the absence of something (any kind of eye disease in this case).

WHY TREAT AMBLYOPIA?

- Amblyopia is one of the most common forms of visual impairment
    - Estimates of prevalence vary between 2 and 6% in developed countries
- But who cares? It's usually only monocular
    - With amblyopia, lifelong risk of blindness roughly doubles
    - The cause of the vision loss in the second eye (trauma, keratitis, glaucoma etc) is listed in the public health figures, but the amblyopia that impaired the first eye can be just as culpable
- Amblyopia treatment is an essential part of treatment for (non-cosmetic) strabismus
- Accommodative vergence disorders and associated symptoms are (probably) more common in people with amblyopia
- People have to live with it for a long time
    - Compare this with diabetic retinopathy
    - It has longer to affect quality of life
- Amblyopia is the cheapest condition to rehab from blindness…
- Treatment costs for rehabilitation of a 6/60 eye in Australia:
    - Amblyopia:
        - Optometrist (and/or ophthalmologist) time: $50+8x$25=$250
        - Glasses/patches/other equipment: $250
        - Expected life span post treatment: 70 years
        - Cost of rehab per year of life enjoyed = $7.14/year
    - Cataract:
        - Optometrist/ophthalmologist time plus surgery: $1600
        - Glasses: $200
        - Expected life span post treatment: 10 years
        - Cost of rehab per year of life enjoyed = $180/year
    - Corneal transplant/ diabetic retinopathy / retinal detachment / etc are all far more expensive

CLINICAL ASSESSMENT OF AMBLYOPIA

The definition of amblyopia leads to a need for a two part diagnostic process:

1. Direct diagnosis – by quantifying the visual capacity, identifying a cause, and judging how closely these match amblyopia as the probable cause

2. Diagnosis of exclusion – proving the absence of pathology as an explanation of vision loss.

A thorough assessment of amblyopia targets both processes via case history, and assessment of vision, fixation, eye movements, fusional vergence, accommodation, contour stereoacuity, a thorough search for the amblyogenic factor, and the best possible check of ocular and visual pathway health to exclude any other cause of vision loss.

HISTORY

Symptoms

- Often nothing – neither the parent nor the child notice anything because amblyopia itself is essentially invisible
  - May just attend for routine examination
  - May be referred from a vision surveillance activity (e.g. failed a vision screening)
  - Often parents are worried about a family history of lazy or turned eye
- Sometimes the amblyogenic factor may be apparent to family or others
  - Strabismus is the most common amblyogenic factor that family and others can see and react to
  - Sometimes families or others see leukocoria (e.g. in photographs), ptosis, or nystagmus
  - If an amblyogenic factor has been noticed, find out how long it has been present, any associated factors, etc.
- Search for alternative explanations of reduced vision
  - Remember that to definitively diagnose amblyopia, you will need to prove that both eyes and visual pathways are “healthy”
  - Enquire broadly: e.g. a pituitary tumour can cause reduced vision that may go with recent weight, mood or growth changes; an optic nerve glioma can reduce vision and be associated with proptosis.

VISION

Visual acuity is central to diagnosis and monitoring of amblyopia. Contrast sensitivity can also be useful.

Assess monocular visual acuities using a developmentally appropriate test

- We measure VA all the time without stopping to think about too many details. However, VA is such a critical measurement in the diagnosis and management of amblyopia that it is worth pausing to consider details and options.
- Contour interaction is increased in amblyopia – this causes a crowding effect, which often results in “single symbol acuity” being different than “line acuity” or “logMAR acuity”. These differences in acuity are strongly suggestive that any vision reduction is due to amblyopia rather than eye disease

- It is said that logMAR VA is amblyopia unfriendly (making it good for detection and quantifying amblyopia), but it is also child unfriendly (i.e. it is hard to do!). Even though it is difficult to do, it is essential to obtain an accurate VA from a logMAR formatted chart.
- It is said that single symbol VA is child friendly (i.e. it is easier for kids to do), but it is also amblyopia friendly. Single symbol VA provides evidence of the extent of contour interaction (by comparison to logMAR VA), but is not (in isolation) an ideal basis for monitoring treatment
- Record Single symbol AND logMAR acuities – note the significance of any difference
- Note mis-counting and mis-ordering of letters/symbols on a line
- Note the pattern of letter misrecognition on a logMAR chart
- It is worth being familiar with a variety of pre-literate VA charts (e.g. Lea or LH symbol chart, Patti Pics, HOTV, Pacific Acuity Test, Cardiff Acuity Test).

The ND Filter Test

- Neutral Density (ND) filters decrease illumination without changing colour. An ND 0.3 filter allows 50% transmittance of light. An ND3 filter allows about 0.1% transmittance (actually 0.098%)
- An ND3 filter affects different visual systems by different degrees:
    - Normals 1:0.50; retinal lesions 1:0.24; strabismic amblyopia 1:0.95
- This means that putting an ND3 filter over
    - a normal eye with 6/6 acuity will decrease the vision of that eye to 6/12
    - an eye with a macular dystrophy and 6/12 acuity will decrease the vision of that eye to 6/48
    - an eye with amblyopia and 6/12 acuity will decrease the vision of that eye to 6/15+

Consider assessing another point on the contrast sensitivity curve

- In some cases, amblyopia only reduces contrast sensitivity at high spatial frequencies, while in other cases the entire contrast sensitivity function is reduced.
- Visual acuity provides an estimate of the high spatial frequency end of the contrast sensitivity curve; other tests (e.g. the Melbourne Edge Test, the Pelli-Robson Contrast Sensitivity Acuity Chart, the Vision Contrast Test System) measure sensitivity at one or more other spatial frequencies.
- A measurement of contrast sensitivity at a low spatial frequency (e.g. Melbourne Edge Test) can be useful in monitoring treatment for deep amblyopia. In amblyopia with VA worse than 6/60, it can take time to see measureable VA improvements, making it difficult for the clinician to know whether they are providing the correct treatment and difficult to motivate patient and family (as they don't initially see an improvement). Low spatial frequency contrast sensitivity usually responds to treatment sooner, giving important feedback to both clinician and families.

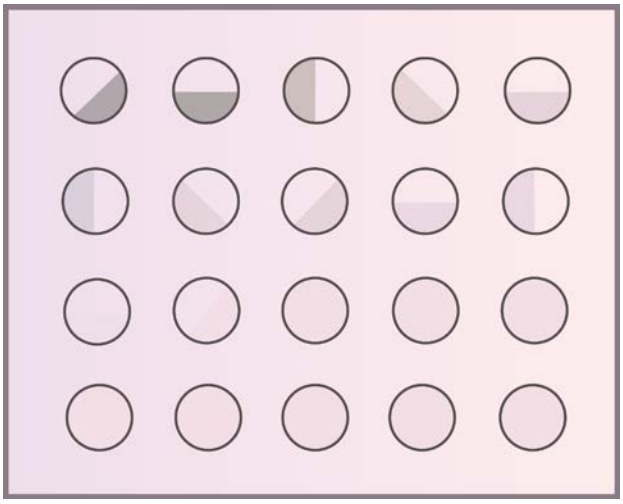


Figure 11.1: The Melbourne Edge Test (available through the National Vision Research Institute:http://www.nvri.org.au/pages/-products-logmar-charts-and-more-.html

FIXATION, EYE MOVEMENTS AND MOTOR FUSION

Monocular fixation in amblyopia can be either central or eccentric, and steady or unsteady. These qualities are best measured using the visuoscope, which is an ophthalmoscope with a target inserted in the illumination system. This target is imaged at infinity by the condensing system of the ophthalmoscope.

- Start by asking the patient to look at a point in the room, find a known spot somewhere in the fundus (e.g. the optic nerve head), focus your view, then ask the patient to “look at the target NOW”
- The test is most accurately performed through a dilated pupil with the other eye occluded, but can be done is less ideal conditions
- The target (depending on the manufacturer of the ophthalmoscope) will either be a star with two concentric rings, or a circle with a graticule
- The examiner notes the position of the foveal reflex in relation to the target that is projected on the fundus
    - Fixation is central if the foveal reflex is in the centre of the target, or eccentric if the foveal reflex is somewhere else
    - Fixation is steady (i.e. one retinal point is used for fixation) if the foveal reflex stays on the same point of the target, or unsteady (i.e. an area of the retina is used for fixation) if it moves about
- Note that illumination of the visuoscope should be kept low (or green) so the patient can see the target
- Visuoscopy takes practice: it is worth using your visuoscope on several normal and as many abnormal subjects as possible, and drawing or making brief notes on your observations.

Eye movements can be innaccurate in an amblyopic eye

- Check monocular saccades, and quantify on the SCCO 4+ scale, where “4+” is accurate, “3+” is some slight undershooting, “2+” is gross undershooting or overshooting or increased latency, and “1+” is inability to do task or any uncontrolled head movement
- Check monocular pursuits, and quantify on the SCCO 4+ scale, where “4+” is smooth and accurate, “3+” is one fixation loss, “2+” is two fixation losses, and “1+” is more than two fixation losses or any uncontrolled head movement. (Note that the jerky re-fixations here will be random in direction, unlike monocular naso-temporal smooth pursuit asymetry (MNTSPA) in infantile strabismus)

Motor fusion can be poor in an amblyopic visual system

- At worst this can cause a strabismus
- In more subtle cases this can cause an accommodation vergence disorder
- Measuring fusional vergence reserves is not particularly useful for the diagnosis of amblyopia, as the loss of fusional vergence is variable. However, it is useful for monitoring amblyopia treatment, as fusional vergence should improve, providing an extra indicator of treatment success.

ACCOMMODATION RESPONSE

The functional deficit of amblyopia includes decreased amplitude of accommodation and increased lag of accommodation. This is best quantified using MEM retinoscopy (refer to Accommodation-Vergence notes for details). In the case of strabismus and amblyopia, it is most important to note the differences between the right and left eyes.

REDUCED BINOCULARITY

Binocular summation, sensory fusion and stereopsis can all be affected by amblyopia. The effects are usually subtle in straight-eyed amblyopia, but marked in strabismic amblyopia. Binocularity of strabismic amblyopia will be covered in the Strabismus chapters, so here we will cover only the more subtle effects of straight-eyed amblyopia on binocularity.

The effect of straight-eyed amblyopia on binocularity is best measured using stereoacuity on a contour stereotest (e.g. the circles on the Randot Test). This is not particularly useful for diagnosis of amblyopia, as the effect on stereoacuity is variable. However, it is useful for monitoring amblyopia treatment, as stereoacuity improves in amblyopia but doesn't in other causes of vision loss.

Figure 11.2: The Randot Stereotest – photo courtesy of Tim Fricke

Note: these stereo tests are calibrated for one viewing distance and IPD. Changing the viewing distance or IPD can lead to erroneous results.

SEARCH FOR THE AMBLYOGENIC FACTOR

It is critical to identify the anisometropia, or strabismus, or ocular media anomaly, or organic basis, or the nystagmus that has caused the amblyopia. You must understand why THIS amount of amblyopia is in THIS child at THIS stage of their life.

- This must have a quantitative element. For example, 2.00DS of anisometropia would adequately explain 6/30 amblyopia; however, 0.25DC of anisometropia would not adequately explain 6/30 amblyopia. In the second case you would need to keep looking and find some other cause of vision loss.

AMBLYOGENIC FACTORS (IN ORDER OF DECREASING PREVALENCE AND PROGNOSIS)

1) **Anisometropia**

- Strength of neural signals depends on contrast, not absolute light levels
- So, blur in one eye causes neural signals from that eye to be weaker than neural signals from the other eye
- *A note on myopic and hyperopic anisometropia*: Myopic anisometropes are likely to show less incidence of amblyopia as viewing may be clear to both eyes at least at one viewing distance.
    - E.g. A child with OD+4.50 OS+1.50 is more likely to have amblyopia in the right eye than a child with OD-4.50 OS-1.50.

2) **Strabismus**

- Diplopia is confusing
- Suppression of some of the information from one eye is the most efficient sensory way to deal with the confusion caused by strabismus
- Note that suppression is a binocular adaptation
- Note that suppression does not usually involve the entire visual field of an eye
- Amblyopia is a monocular sequelae to suppression

3) **Visual deprivation (amblyopia ex anopsia)**

- Something blocks formation of a clear retinal image
- Most commonly congenital or traumatic cataracts, corneal opacities, complete ptosis, resolved perinatal macular haemorrhage
- Could also include high ametropia (e.g. -8.00 or more; +4.50 or more) and high cylinder
- Note that the clinical sign may no longer exist (may need to be a dx of exclusion)

4) **Organic**

- Subtle, sub-ophthalmoscopic morphological changes, or dietary insufficiencies

5) **Secondary to nystagmus**

- May be an obvious nystagmus, but watch for head tilt/turn (patient finding the null point of the nystagmus)
- Ophthalmoscopy (specifically visuoscopy) is the most sensitive way to detect nystagmus
- Observation with 20D lens (without BIO) is also useful

	Anisometropic amblyopia	Strabismic amblyopia
Visual acuity	20/60	20/80
Depth of amblyopia	Less than strabismic variety	More than anisometropic variety
Depth of amblyopia	Increases with magnitude of anisometropia	Stays constant with magnitude of strabismus
Primary cause	Sustained blur in one eye	Loss of retinal correspondence
Prognosis	Relatively better than strabismic variety	Worse than anisometropic variety

Table 11.1: *Comparison between strabismic and anisometropic amblyopia*

OCULAR AND VISUAL PATHWAY HEALTH

To be able to exclude any other cause of vision loss, you will need to complete the best possible anterior and posterior eye health assessment, and the best possible pupil assessment available to you. If you don't feel you are in a position to complete this adequately, you should refer to someone who can.

DIAGNOSING AMBLYOPIA

The definitive differential diagnosis of amblyopia requires partly a direct diagnosis of amblyopia (by quantifying the visual capacity and identifying the cause), and partly a diagnosis of exclusion (by proving the absence of anything else capable of causing the vision loss).

- The direct diagnosis of amblyopia uses the particular characteristics of the amblyopic visual system:
    - Crowding phenomenon, or impaired spatial localisation, leads to increased contour interaction between symbols – this means single symbol VA will be better than logMAR VA, and patients will be more likely to correctly identify the symbols on the ends of a logMAR line than the symbols in the middle
    - ND Filter Test – vision loss that has a large additional reduction in VA when an ND3 filter is placed on the eye is likely to be due to a retinal lesion; vision loss that doesn't change much when an ND3 filter is placed on the eye is likely to be due to amblyopia
    - Quantitative association with an amblyogenic factor – the identified amblyogenic factor will match the scale of vision loss in amblyopia
- Diagnosis of exclusion for amblyopia
    - Pupil assessment looking specifically for afferent pupil defects that could signify diseases such as optic pathway glioma
    - Best practice ocular fundoscopy (preferrably indirect lens method through dilated pupils) searching for optic nerve head asymmetries, macular dystrophies, other retinal abnormalities
    - Best practice assessment of the anterior eye (preferrably slit lamp) searching for corneal or lens abnormalities

DETERMINING PROGNOSIS

It is useful to consider the prognosis (predict the likely outcome) of the amblyopia you have just diagnosed.

- The cause of the amblyopia is a prognostic indicator
  - Fortunately, the best prognosis is for the most common causes (anisometropia is likely to give a better outcome to treatment than strabimus, which in turn is better than ex anopsia, organic, secondary to nystagmus)
- The length of time an amblyogenic factor has been present
  - The longer it has been present, the worse the prognosis – you should try to identify the time of onset
- The age of the child at the time the amblyogenic factor started
  - E.g. strabismus that started at 6 months of age is likely to cause more profound amblyopia than strabismus starting at 4 years of age
- Presence of anomalous retinal correspondence (ARC)
  - ARC is a re-organisation of the visual system aimed at generating some binocularity in the presence of strabismus. It is a binocular phenomenon, but makes treatment of amblyopia more difficult
- Presence of eccentric fixation
  - EF is a monocular consequence of ARC, where a non-foveal position becomes the preferred fixation point. It makes treatment of amblyopia extremely difficult

MANAGING AMBLYOPIA

Management of amblyopia has progressed from largely conventional thinking to evidence-based practice in the last 15 years. Prior to this century, the vast majority of textbooks, opinion pieces, guidelines from learned bodies included the conventional wisdom that amblyopia should be treated with all day patching of the good eye from the time of diagnosis, and treatment should cease when a child turned six years of age because after that, it wouldn't work (Fricke, 2014).

Although long-standing principles of individualizing and connecting with patient needs remain, new evidence should change the way we manage patients who have amblyopia.

Even the reasons for treating amblyopia have been better defined over the past 15 years. As eye care practitioners, we have always been quite comfortable with the idea that improving vision is a reason in itself, along with the positive reinforcement of individual patient anecdotes. But more recently, there is evidence that treating amblyopia is important to the patients themselves – as well as economists, actuaries and policy-makers, among others. For example, treating amblyopia has been shown to measurably improves quality of life for patients (van de Graaf et al 2007), and it provides a good return on health dollar investment (Membrano et al 2002).

As practitioners, our primary aim in amblyopia therapy is to improve monocular function – to achieve normal visual acuity and fixation in each eye separately. This provides a 'spare tyre' for life, or 'vision insurance', along with a better quality of life and better health economics outcomes. Our secondary aim is to improve binocular function – to achieve normal fusion (all levels) and binocular correspondence measured with both eyes open. This provides insurance against, or part treatment of, uncosmetic strabismus, along with a better quality of life (Fricke 2014).

AMBLYOPIA TREATMENT PROTOCOLS

The Monitored Occlusion Treatment of Amblyopia (MOTAS) group in the United Kingdom and the Pediatric Eye Disease Investigator Group (PEDIG) in the United States have been instrumental to the accumulation of new evidence for the treatment of amblyopia. For the first time, we can base amblyopia treatment protocols on solid evidence with flexible details. My interpretation of best evidence-based practice divides treatment into four stages, which will be elaborated on but can be summarized as:

- Stage 1 – prescribe glasses only for three months, or until vision of the amblyopic eye stops improving (whichever is longer)
- Stage 2 – prescribe glasses and all day patching of the non-amblyopic eye for preschool children, or glasses and two hour/day patching of the non-amblyopic eye for school children
- Stage 2 modification one – when compliance/resolve for patching wanes, or if patching is unsuccessful, change to glasses with atropine penalization of the non-amblyopic eye (if legal in your jurisdiction)
- Stage 2 modification two – when approaching equal visual acuity between eyes, consider translucent or refractive penalization (e.g. Bangerter Filter, or over-correcting hyperopia)
- Stage 3 – use glasses, prisms, vision therapy and/or surgery to treat any strabismus
- Stage 4 – use vision therapy and/or glasses modifications to treat accommodation-vergence issues (particularly high lag of accommodation in the previously amblyopic eye)

STAGE 1 – PROVIDE CLEAR RETINAL IMAGES

As a first step after amblyopia diagnosis, MOTAS and PEDIG have independently established that it is worthwhile to start with up to three months treatment with glasses alone (Stewart et al 2004, Cotter et al 2006, Cotter et al 2007). This stage in treatment provides equally clear retinal images by correcting anisometropia, with a bias towards fusion and supporting the impaired accommodation of the amblyopic eye.

It is also the practitioner's opportunity to set up a trusting relationship with the child— building rapport and understanding without doing anything that the child will strongly dislike (Fricke 2014). In this time, around 75 per cent of children with either anisometropic or strabismic amblyopia will gain approximately two lines improvement in visual acuity (Stewart et al 2004, Cotter et al 2006, Cotter et al 2007).

Prescribe glasses that make retinal images as similar as possible in each eye, and bias towards fusion. Consider the following principles:

- Correct 100% of the anisometropia
- Corneal anisometropia may be better off with a contact lens correction (to avoid aniseikonia), but axial length anisometropia will be better off with glasses
- Maximise plus/minimise minus corrections in the presence of esotropia (but keep the anisometropic correction complete)
- Minimise plus/maximise minus corrections in the presence of exotropia (but keep the aniosmetropic correction complete)

STAGE 2 – DECREASE THE STRENGTH OF NEURAL SIGNALS FROM THE NON-AMBLYOPIC EYE

After refractive-only treatment for up to three months, MOTAS and PEDIG have shown that a variety of occlusion and/or penalization therapies can be used to decrease the strength of the neural signals from the non-amblyopic eye (Fricke 2014). Practitioners can devise suitable treatments for individual patients within the following bounds:

- Opaque patching of the non-amblyopic eye achieves a faster initial treatment response (e.g. visual acuity improvement of the amblyopic eye) than penalization (PEDIG 2002, Repka et al 2005, PEDIG et al 2008, Scheiman et al 2008).
- More patching hours probably gains faster and sometimes fuller treatment response, but part-time patching works (Stewart et al 2004, PEDIG et al 2013, PEDIG 2003).
    - PEDIG has shown that instructing families to patch for 6 hours per day is as successful as instructing them to patch all waking hours over 6 months
        - 3 - 7 year olds with severe amblyopia (worse than 6/30)
    - PEDIG has shown that instructing families to patch for 2 hours per day is as successful as instructing them to patch for 6 hours over 6 months
        - 3 - 7 year olds with moderate amblyopia (6/12 to 6/30)
        - One of the 2 hours was spent doing concentrated near activities
    - But, note that longer patching hours works faster in the initial weeks, particularly when amblyopia is deeper
- Weekend atropine penalization of the non-amblyopic eye achieves similar results (e.g. visual acuity improvement in the amblyopic eye) to daily atropine (Repka et al 2004).
- Prescribing specific activities (e.g. concentrated, interactive near activities) to be done during part-time patching *might* not matter (PEDIG 2008, Christoff et al 2011).
- Atropine penalization and opaque patching have different impacts (e.g. social, physical comfort, effort required) on children and families (Holmes et al 2003).
- The younger that treatment can be started the better, but there is no age limit to amblyopia treatment (Stewart et al 2005, Scheiman et al 2005, Stewart et al 2007, Holmes et al 2011).
- Amblyopia recurrence is always a risk as you finish active phases of treatment, but tapering the treatment helps (Holmes et al 2004, Holmes et al 2007, Tacagni et al 2007).

- Consider translucent penalisation (e.g. a Bangerter Filter applied to the spectacle lens of the non-amblyopic eye) if visual acuity is better than 6/30 in the amblyopic eye and compliance seems likely (PEDIG et al 2010).

- Extra practitioner effort (for example: taking the time to explain amblyopia to parents and children, and providing reward stickers, a log book and an information sheet) significantly improves compliance with amblyopia therapy (Loudon et al 2006).

The MOTAS group has done the most thorough work to model amblyopia treatment dose (e.g. hours of patching) versus therapeutic response (e.g. VA improvement). The results provide evidence-based support for the concept of 'amblyopia treatment cycles', where one cycle = one week for every year of life. A four year old can achieve a two line improvement in VA in four weeks, while this takes six weeks for a six year old to achieve the same (Stewart et al 2007).

Opticlude (stick on skin) patch (left), and Patchmate (attach to glasses) patch (right) – sources unknown

Atropine penalization

Atropine is a non-selective muscarinic antagonist, long known to cause mydriasis and cycloplegia by disrupting parasympathetic innervation to the pupillary sphincter and ciliary body muscles. Both of these mechanisms and outcomes of ophthalmic atropine use degrade the retinal image for the duration of effect, particularly in a hyperopic eye. This degradation of retinal image means it can be used to penalize a non-amblyopic eye, giving some competitive advantage in cortical image processing to information coming from the amblyopic eye (Fricke 2014).

If a practitioner decides that atropine penalization of the non-amblyopic eye is the most appropriate way to treat amblyopia at some stage, and it is legal for them to do so in their jurisdiction, they should:

- Note contra-indications for atropine – Down Syndrome, spastic paralysis, brain damage, narrow anterior chamber angles, hypersensitivity to any of the ingredients.

- Prescribe 1% Atropine for somewhere between once daily and twice weekly use in the non-amblyopic eye.

- Provide a patient information handout including critical information about complications.

- Advise wearing sunglasses and a hat when outside

- Reiterate the family should contact you or a hospital emergency department immediately if the child shows signs of adverse reactions (local allergic reactions, dry mouth, facial flushing, headaches, ataxia, tachycardia, fever, irritability, low blood pressure or difficulty breathing).

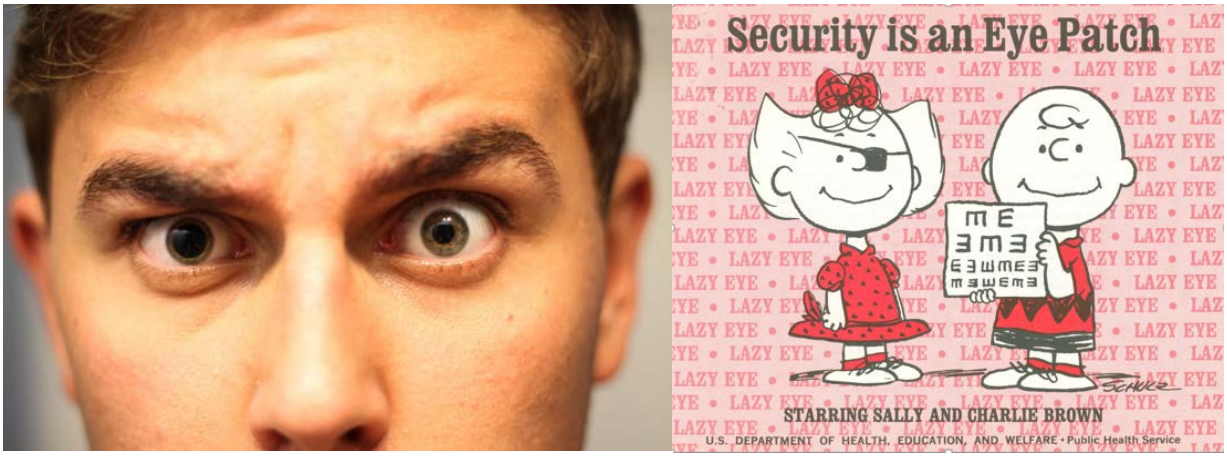
In a very small minority of cases (I have never encountered reactions requiring these responses), adverse reactions might need to be controlled in the short term via supportive treatments for high fevers and

dehydration or intramuscular physostigmine to counteract the muscarinic antagonist effect of atropine (in severe or life-threatening toxicity).

In a small minority of cases, adverse reactions need to be controlled in the longer term via: decreasing the dosage (for example to 'weekend only'; changing drug therapy to homatropine; or ceasing drug therapy entirely).

It is sensible to review after one week of atropine penalization to assess distance VA (although noting that treatment effect does not require reduced distance VA in the atropined eye, and that we do not expect improved VA in amblyopic eye at this stage), complications from atropine use, efficacy of atropine use (little to no pupil response to light, or accommodative response, in the non-amblyopic eye), and accommodation in the amblyopic eye (systemic absorption of atropine can lead to decreased accommodation in the eye that does not receive drops – consider a bifocal correction if this occurs).

It is then sensible to review after each amblyopia treatment cycle (in other words, a week for every year of the patient's life). The practitioner should have clear criteria for discharging from atropine penalization. For example: no improvement over two cycles, or continuous compliance for six months, or another therapy becomes indicated.



Atopine penalisation in an adult (left); Example of extra effort to achieve compliance – a patient handout from the US Department of Health, Education and Welfare 1965 (right)

STAGE 3 – TREAT ANY STRABISMUS

The third stage of amblyopia therapy involves treating any strabismus. The motor aspects of strabismus may require surgery, prism, an altered refractive correction, vision therapy, and/or a near addition. The sensory aspects of strabismus may require anti-suppression vision therapy (Birch et al 2004).

Refer to chapters on Strabismus for more details.

Antisuppression vision therapy (left) and stereo-training (right)

STAGE 4 – TREAT ANY OTHER IMPEDIMENTS TO EFFICIENT BINOCULAR VISION

The fourth and final stage of amblyopia therapy involves the removal of any other impediments to efficient binocular vision. This may require further alterations of refractive correction, a near addition, prism or vision therapy. Particularly, accommodative dysfunction in a previously amblyopic eye can lead to treatment regression. Note that active vision therapy to improve accommodation vergence skills is only likely to be useful once visual acuities are equal (or almost equal) – it will not replace the other amblyopia therapy stages.

Refer to chapters on accommodation vergence disorders for more details.

Fusional vergence vision therapy (left) and accommodation vision therapy (right)

AMBLYOPIA TREATMENT - PRACTICAL QUESTIONS

HOW MUCH OPAQUE PATCHING SHOULD BE DONE?

- One day of patching for each year of life, then one day rest
  - E.g. if the child is 4 years old: do 4 days patching then 1 rest day
  - One day of FULL-TIME patching means from waking until evening meal time
- One week of this routine for every year of life
  - E.g. if the child is 4 years old: do 4 weeks of patching routine
  - This is termed a "cycle" of amblyopia treatment

HOW MUCH OPAQUE PATCHING SHOULD BE DONE? UPDATE

- There was general consensus that successful amblyopia treatment REQUIRED full-time patching, until:
- PEDIG. A randomised trial of patching regimens for treatment of moderate amblyopia in children. Arch Ophthalmol 2003;121:603-611
  - Concluded that 2 hours of patching (1 of which had to involve concentrated near activity) each day had the same effect as full-time patching
- In response:
  - Vision Therapy Guidelines have been updated to reflect the new evidence. The new Guidelines give two options: **see Appendix 1 – Vision Therapy Guidelines for amblyopia**

WHEN DO I REVIEW THE PATIENT?

- After every cycle of treatment

WHAT RESPONSE SHOULD I EXPECT?

- VA can as much as double over the period of one cycle, but will asymptote towards the VA of the other eye

HOW LONG DO I CONTINUE WITH TREATMENT?

- If there is no response to therapy over the first 2 cycles of treatment, you should reconsider your diagnosis
  - Recheck for pathology
  - Recheck refraction
- If there is response to therapy, continue treatment for as long as there is improvement

WHEN DO I CEASE THERAPY AND WHEN DO I DISCHARGE THE PATIENT?

- Amblyopia may recur unless all sensory and motor skills are equalised between eyes
  - Consider your near retinoscopy result
  - Is the amblyogenic factor still there?
    - Residual strabismus

- Aniseikonia in anisometropia
- Maintenance therapy may be required (keep monitoring)

APPENDIX 1: VISION THERAPY GUIDELINES FOR AMBLYOPIA

1.1 OPAQUE OCCLUSION

Indications:

- Visual acuities of 6/12 or worse in one eye caused by amblyopia: thorough direct differential diagnosis of amblyopia (quantitative analysis of the amblyogenic factor, assessment of contour interaction, the ND filter test), AND diagnosis of exclusion to ensure absence of organic lesions (slit-lamp, keratometry, fundoscopy through dilated pupils) is imperative.

OR

- One line or more difference in visual acuity between eyes caused by amblyopia (thorough differential diagnosis as above is imperative).

AND

- Visual acuity has not improved with wear of the optimal refractive correction alone over the time of one cycle.[1]

Implementation:

Option 1: Full time occlusion (strongly consider this for all preschoolers as it gets fastest response)

- Aim to achieve at least 9 hours of occlusion (from waking until evening meal) per day, at least five days per week. Parents should use a logbook with incentives (e.g. stickers or stars building to some significant reward) to encourage compliance.

Option 2: Part time occlusion (strongly consider this for all school-age children as it achieves equal success over a six month period and is less invasive to the child's life)

- Two hours of patching per day, with or without one hour of concentrated near tasks under parental supervision. The PEDIG study (Arch Ophthalmol 2003;121:603-11) that first validated the use of part-time patching used 6 different near activities, each for 10 minutes. The near activities were Symbol fill-in, Symbol sequence, Word searches, Mazes, Lens flipper, and a Geography colouring workbook or Jewelry construction kit.

Both Options:

- Opticlude stick-on patches, PatchMate spectacle patch, or "pirate" black patches with elastic. These are used in conjunction with optimal refractive correction.
- Compliance is improved by providing instruction sheets, encouraging use of log sheets and reward systems, ringing the parents after 2-3 days of the therapy program.
- Review the child after every cycle. If vision is unresponsive[2] at review, consider compliance issues, re-examine for presence of organic lesions, and consider complicating factors such as eccentric fixation.

Discharge criteria:

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[1] One cycle = one week for every year of the child's life.

[2] Responsiveness to opaque occlusion: hope for acuity to double (improve three lines on a logMAR chart; for example 6/60 to 6/30) over one cycle in the initial phases, but in practice any improvement is encouraging.

- Continue opaque occlusion until there is no further improvement in vision over two cycles, or another form of therapy is indicated.

1.2 ATROPINE PENALISATION

Indications:

- Visual acuities of between 6/12 and 6/30 in one eye caused by amblyopia: thorough direct differential diagnosis of amblyopia (quantitative analysis of the amblyogenic factor, assessment of contour interaction, the ND filter test, etc), AND diagnosis of exclusion to ensure absence of organic lesions (slit-lamp, keratometry, fundoscopy through dilated pupils) is imperative.

OR

- One line or more difference in visual acuity between eyes caused by amblyopia (thorough differential diagnosis as above is imperative).

AND

- Visual acuity has not improved with wear of the optimal refractive correction alone over the time of one cycle.

AND

- There are no contra-indications to atropine (e.g. Down Syndrome, spastic paralysis, brain damage, narrow anterior chamber angles, hypersensitivity to any of the ingredients, keratoconus).

Implementation:

- Prescribe 1% Atropine for once daily, or twice weekly,[3] use (usually at bedtime) in the non-amblyopic eye (these guidelines assume optometrist is therapeutically-endorsed).
- Provide a patient information handout (e.g. ACO's "Patching for Lazy Eye 2") – include critical information about what the family should do in case of complications.
- The patient should be advised to wear sunglasses and a hat whenever outside during daylight hours for the duration of treatment.
- In particular, reiterate that the family should contact you or a hospital emergency department immediately if the child shows any signs of adverse reactions (local allergic reactions, dry mouth, facial flushing, headaches, ataxia, tachycardia, fever, irritability, low blood pressure or difficulty breathing). Adverse reactions can usually be controlled by decreasing the dosage (e.g. to 1 drop every second day), changing drug therapy to homatropine, or ceasing drug therapy entirely. In a minority of cases, supportive treatments to avoid high fevers and dehydration are required. Intramuscular physostigmine might be considered to counteract the muscarinic antagonist effect of atropine (in severe or life-threatening toxicity).
- Review after 1 week of treatment:
    - Assess distance VA, but note that the atropined eye does not necessarily experience or require reduced VA, and do NOT expect improved VA in amblyopic eye at this stage;
    - Assess for complications from atropine use;
    - Assess efficacy of atropine use (the non-amblyopic eye should show little to no pupil response to light, and little to no accommodation response),

[3]Weekend atropine and daily atropine achieve similar results (PEDIG, Ophthalmol 2004;111:2076-85)

    - Assess accommodation in the amblyopic eye (systemic absorption of atropine can lead to decreased accommodation in the eye that does not receive drops – consider a bifocal correction if this occurs)
- Review after a cycle of treatment (and ongoing reviews each cycle thereafter):
    - Assess distance visual acuity (the VA of the amblyopic eye should show some improvement at this review – although not a doubling of acuity).
    - Assess for complications from atropine use;
    - Assess efficacy of atropine use (the non-amblyopic eye should show little to no pupil response to light, and little to no accommodation response),
    - Assess accommodation in the amblyopic eye (systemic absorption of atropine can lead to decreased accommodation in the eye that does not receive drops – consider a bifocal correction if this occurs)
    - The patient should continue to wear their optimum optical correction for both eyes if there is a line or more improvement in the vision of the amblyopic eye in the cycle. The non-amblyopic eye should be changed to a plano lens after any cycle in which there has been less than 1 line improvement.
    - If VA remains unchanged over 2 cycles or equalises between eyes, cease therapy.
    - If treatment is unsuccessful, consider compliance issues, whether the non-amblyopic eye is penalised enough to stimulate the amblyopic eye, re-examine for presence of organic lesions and consider complicating factors such as eccentric fixation.
    - The PEDIG study (Arch Ophthalmol 2002;120:268-78) that first validated use of atropine in amblyopia therapy did not find improvement past 6 months of treatment.

Discharge criteria:

- Continue penalisation until there is no further improvement in vision over two cycles, or there has been continuous compliant treatment for 6 months, or another form of therapy is indicated.

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