MedCrave
Step into the World of Research

Advances in Ophthalmology & Visual System

Research Article

Open Access

CrossMark

Visual stimulation in the neonatal and pediatric intensive care

Abstract

Introduction: In the first months of life, children are strongly sensitive to conditions that interfere with visual development. There is evidence that impoverished developmental conditions can lead to delays in visual development. We focused on patients with prolonged hospitalization during their first months of life, whose delayed visual maturation may be consequence of a poorly visual environment at the hospital intensive care units. Our main purpose was to develop a visual stimulation kit that could be implemented in these situations in order to create a visual enriched environment.

Materials and methods: Creation of a reproductible visual stimulation kit using high contrast black-and-white patterns. Images were created through the software Adobe Illustrator® and impressed in plates with 30 x 30 cm and 15 x 15 cm in a material appropriated to the hospital ambient. An awareness session at the time of the kit's delivery was conducted and a booklet with important advices was created.

Results: The visual stimulation kit, intended to be applied to the surrounding environment of children until 8 months-old with prolonged hospitalizations (more than 1 month long) and children demonstrating lack of visual interaction, was created with two bigger plates destined to be placed in the lateral walls of the cribs and four smaller plates destined to be hanged in the supports surrounding the crib.

Discussion and conclusion: Stimulation through an environmental enrichment can modulate brain development and induce modification in the neural circuits. Simple high contrast black and white images are one of the main interventions to stimulate children's vision. Our main purpose with this project is to create a systematic guideline to be applied in children with prolonged hospitalizations in order to prevent the onset of a delayed visual maturation and sensitize healthcare providers, caregivers and parents to this aspect of the development.

Keywords: visual stimulation, intensive care units, sensory development, pediatrics, visual system

Volume 13 Issue 3 - 2023

Catarina Pestana Aguiar,[1] Liliana Cortez,[2] Patrícia Valério,[3] Pedro Pereira,[2] Catarina Paiva[2]

[1]Ophthalmology Department, Centro Hospitalar de Entre o Douro e Vouga, Portugal
[2]Ophthalmology Department, Centro Hospitalar Universitário de Coimbra, Portugal
[3]Centro de Apoio à Intervenção Precoce na Deficiência Visual – Associação Nacional de Intervenção Precoce, Portugal

Correspondence: Catarina Pestana Aguiar, MD, Ophthalmology Department, Centro Hospitalar de Entre o Douro e Vouga, Santa Maria da Feira, Portugal, Email catarina.pestana.aguiar@gmail.com

Received: November 22, 2023 | **Published:** December 11, 2023

Abbreviations: DVM, delayed visual maturation; ICU, intensive care units

Introduction

During the first six months of life, there is a rapid visual development that continues through the first decade. Full-term newborns may present visual fixation, but the ability to follow targets is usually only present at two months of age. Color discrimination and contrast sensitivity are present but poorly developed in newborns.[1] Eye contact is an important step for early parent-child interaction and the lack of eye contact or apparent visual behavior should alert parents and clinicians.[2] If infants do not present with visual fixation and tracking within the first two months of life, they may be referred to an ophthalmologist for evaluation of delayed visual maturation (DVM). These children may have other problems such as premature birth, systemic diseases or structural abnormalities of the eyes, but they may also be otherwise normal.[1] A detailed classification of DVM has been proposed by Uemura et al.[3] which separated these children in three groups: the first group included children without abnormalities; the second included those with developmental delay; and the third included those with ocular abnormalities.

In the first months of life, children are strongly sensitive to conditions that interfere with vision and visual development.[4] These conditions include not only the personal ones such as anatomic or organic alterations of the infant, but also the external ones such as the surrounding environment on which they develop – the main focus of our project. There is increasingly evidence that impoverished developmental conditions can lead to delays in sensory development, such as visual development.[5,6] The diminished sensorimotor stimulation leads to a marked delay in the development of the visual system not only in visual acuity but also in the visual cortical responses to the sensory input.[6]

In our work, we focused on a specific group of patients exposed to an impoverished environment: those with prolonged hospitalization during their first months of life, whose DVM may be the consequence of a poor visual stimulating environment at the hospital neonatal and pediatric intensive care units (ICU). Some of these children experience several months of hospitalization exposed to an impoverished, visually neutral environment, without any visual stimulation, during the critical period of visual development. It has been demonstrated that functional vision in children with DVM may be improved with visual stimulation therapy in the first months of life.[7] In this critical period, stimulation of vision can encourage brain plasticity and the recovery of impaired function.[8] Visual stimuli includes lights, bright colors and high contrast black-and-white patterns, used systematically and sequentially.[7] Our main purpose was to develop a visual stimulation kit that could be implemented in the different neonatal and pediatric ICU in Portugal in order to create a visual enriched environment for this type of hospitalizations, not only to prevent DVM but also to revert it when it is already present.

Materials and methods

Creation of a reproductible visual stimulation kit using high contrast black-and-white patterns. Images were created through the software Adobe Illustrator® and impressed in acrylic white material with the following dimensions: 30 x 30 cm and 15 x 15 cm. A material appropriated to the hospital ambient was chosen according to the following characteristics: a relatively light material that could be suspended in the hospital cribs and attachments; a resistant material so that the kit could last for years in the facilities; and a reusable material able to be disinfected and cleaned without damage to the printed images. An awareness session at the time of the kit's delivery was conducted and a booklet with important advices to parents and caregivers was created.

Results

A visual stimulation kit was created with two bigger plates destined to be placed in the lateral walls of the cribs (Figure 1) and four smaller plates destined to be hanged in the intravenous system support or other support surrounding the crib (Figure 2). The kit is intended to be applied to the surrounding environment of children with prolonged hospitalizations (more than 1 month long) and children demonstrating lack of visual interaction – no visual fixation or poor following. An example of the application of the visual stimulation kit is presented in Figure 3. At the time of the delivery of the kit, an awareness session was presented to the healthcare providers of this unit in order to sensitize them to the importance of not forgetting the visual aspects of the childrens' development and to instruct them on how to deal with this problematic and when to apply the kit.

Some important advices were given and intended to be transmitted to parents and caregivers as followed:

A. Usage of clothes and toys with bright or high contrast colors;

B. Stimulation of the infants' vision by presenting these toys to their field of vision;

C. Stimulation of the tracking movement by moving these toys in their field of vision.

A booklet was done to deliver to parents and caregivers with these and other practical devices (Figure 4).

Figure 1 Visual Stimulation Kit – 30 x 30 cm plates to hang in the later walls of the cribs.

Figure 2 Visual Stimulation Kit – 15 x 15 cm plates to hang around the crib.

Figure 3 Example of the visual stimulation kit application.

Figure 4 Booklet with advices to deliver to parents and caregivers.

Citation: Aguiar CP, Cortez L, Valério P, et al. Visual stimulation in the neonatal and pediatric intensive care. *Adv Ophthalmol Vis Syst.* 2023;13(3):96–99.
DOI: 10.15406/aovs.2023.13.00450

Discussion

The anatomic development of the eye and central visual pathways allow a rapid visual acuity, contrast sensitivity and color discrimination improvement. There is a maturation of the retina and photoreceptor, a myelination of the optic nerves and tracts and an increase in the cortical synaptic density that slows down after the six months of age.[2,4] Eye movement systems also develop rapidly in parallel with the other visual aspects so that the eyes are aligned in order to allow the development of binocularity and stereopsis. By three months of age, an integrated system of voluntary and reflexive eye movements allows normal alignment, fixation and tracking movements so that the infants are able to follow objects vertically and horizontally.[4] Therefore, the development of vision is part of a highly complex process of maturation in the eyes and the brain simultaneously and a continuous visual experience induces activity dependent tuning of synaptic connections.[8] The etiology of DVM has been extensively studied through various exams (flash, pattern, and sweep visual evoked potentials, preferential looking tests, electroretinograms, pupillometry, magnetic resonance imaging, and optokinetic nystagmus)[1] which were summarized in a lecture published in 2004 stating that the DVM resulted from abnormalities of the cortical areas that control visual attention.[9] Therefore, these patients might be unable to fix or follow despite having a normally functioning visual system and optic nerve.[10] The condition resolves when the child's vision recovers without intervention, and therefore DVM is only diagnosed retrospectively causing anxiety to parents and caregivers. The mean average time of recovery in DVM without any other abnormal feature is 6.7 months.[10]

An early environmental impoverishment can have an adverse influence on children development. Stimulation through an environmental enrichment can modulate brain development and induce modification in the neural circuits, since it acts on molecular factors involved in cerebral cortex development and plasticity (insulin-like growth-factor 1 – IGF-1; brain-derived neurotrophic factor – BDNF; and GABAergic transmission). A study has demonstrated that environmental impoverishment in pups lead to functional changes in the visual cortex that were accompanied by a significant reduction of IGF-1 protein associated with a decreased GAD67 expression and delayed myelination of nerve fibers.[6] It has also been demonstrated that patients with DVM that have some reaction to light, normal pupillary responses, no nystagmus and normal structural ocular features, have an excellent visual prognosis.[1] Alimovic et al.[8] showed that visual stimulation programs helped improving visual functions in babies. However, the critical period for visual stimulation always raises the question if improvement is due to the interventions itself or due to the maturation of the visual system. Nonetheless, studies suggest that this period includes the first eight months of life and that visual stimulation should start precociously to be effective.[11]

Visual stimulation is directed to children who hardly respond to normal visual impressions and it aims to stimulate the visual development through visual material.[11] Since the visual system of a newborn is not fully developed, visual contrast sensitivity is poor due physical factors affecting photon capture, such as eye size, photoreceptor density and high levels of noise in the neural transduction process.[12] Therefore, simple high contrast black and white images are one of the main interventions to stimulate their vision. In programs with this purpose typical stimuli are mobiles, lights, and high contrast or brightly colored materials. These stimuli are often presented above the crib or the bed or in a specific room. The goal is to improve visual functioning and, since visual stimulation is inherently reinforcing, elicit responses from the child such as fixation and following of moving targets. As a result of this process, there is the presumption that the anatomy, physiology and neural base of the visual system changes due to the increase branching of axons and dendrites, stimulating the origination of alternative neurological tracts and the restructuration of brain processes.[11] Specifically in our project, we decided to create a 2-dimensional red, black and white colored images and use them instead of 3-dimensional developmental play gyms already available because we wanted to create a simple, affordable and easily reproducible kit that could be implemented in the ICU environment without having to significantly alter the unit dynamics. The main limitation of our work was that we did not objectively compare the visual acuity and contrast sensitivity before and after the application of our visual stimulation kit. Moreover, only one kit was delivered given the short term follow up since the creation of the kit. A long term follow up should be done in order to evaluate the efficacy of this intervention with a higher number of cases. Our main purpose with this project is to create a systematic guideline to be applied in children with prolonged hospitalizations in order to prevent the onset of a DVM and, to accomplish that, we intend to expand the intervention to other ICU in Portugal.

Conclusion

Most studies published related to visual stimulation approach essentially interventions in patients with systemic or ocular disorders or in patients with cerebral visual impairment. The present intervention was mainly directed to patients we observe in our daily clinical practice without any of the mentioned disorders but in whom, after weeks of hospitalization, a visual inattention with poor eye contact is noted. These situations could be prevented with the appropriated visual stimulation during their stays at the hospital, an aspect that is most of the time forgotten. Our intervention was motivated by years of observations made in multiple children with DVM as a consequence of prolonged ICU hospitalization that rapidly resolved after proper directed visual stimulation. However, there is a lack of investigation in this specific field and more prospective studies are needed. With our project, we intend to avoid DVM in these children, providing a visually stimulating environment and establishing guidelines through the sensibilization of healthcare providers, caregivers and parents to the importance of visual stimulation.

Acknowledgments

We thank the designer Carolina Pestana Aguiar for the creation of the images to be printed in our Visual Stimulation Kit.

Conflicts of interest

The author declares that there are no conflicts of interest.

References

1. Azmeh R, Lueder GT. Delayed visual maturation in otherwise normal infants. *Graefes Arch Clin Exp Ophthalmol.* 2013;251(3):941–944.
2. Levinsen M, Børresen ML, Roos L, et al. Causes of poor eye contact in infants: a population-based study. *BMC Ophthalmol*. 2021;21(1):388.
3. Uemura Y, Oguchi Y, Katsumi O. Visual developmental delay. *Ophthalmic Genet.* 1981;1:49–58.
4. Mills MD. The eye in childhood. *Am Fam Physician*. 1999;60(3):907–916.
5. Eckerle JK, et al. Vision and hearing deficits and associations with parent-reported behavioral and developmental problems in international adoptees. *Matern Child Health J*. 2014;18(3):575–583.

6. Narducci R, Laura B, Gabriele S, et al. Early impoverished environment delays the maturation of cerebral cortex. *Sci Rep*. 2018;8(1):1187.

7. Tunay ZO, Ustunyurt Z, Idil A. Causes of severe visual impairment in infants and methods of management. *Eye*. 2021;35(4):1191–1197.

8. Alimovic S, Katusic A, Mejaski BV. Visual stimulations' critical period in infants with perinatal brain damage. *NeuroRehabilitation*. 2013;33(2):251–255.

9. Hoyt C. Constenbader lecture. Delayed visual maturation: the apparently blind infant. *J AAPOS.* 2004;8(3):215–219.

10. Lloyd A, Hadfield M. Average recovery time from delayed visual maturation. *Int Ophthalmol.* 2021;41(6):2241–2247.

11. Vervloed MPJ, Janssen N, Knoors H. Visual rehabilitation of children with visual impairments. *J Dev Behav Pediatr.* 2006;27(6):493–506.

12. Skoczenski AM, Norcia AM. Neural noise limitations on infant visual sensitivity. *Nature*. 1998;391(6668):697–700.

Citation: Aguiar CP, Cortez L, Valério P, et al. Visual stimulation in the neonatal and pediatric intensive care. *Adv Ophthalmol Vis Syst.* 2023;13(3):96–99. DOI: 10.15406/aovs.2023.13.00450