ΕΠΙΣΤΗΜΟΝΙΚΑ ΧΡΟΝΙΚΑ – www.exronika.com

ORIGINAL ARTICLE

Emotions in patients in vegetative state

N. Sakellaridis [1], A. Petsanas [1], L. Sakellaridi [2]

[1] Department of Neurosurgery, Tzaneio General Hospital, Piraeus, Greece and [2] Department of Biology, University of Wageningen, Wageningen, Netherlands

ABSTRACT

We study 81 patients, all initially in vegetative state from severe brain injury. We treated them and followed them for at least one year after the injury or until death. We report their emotional responses, classified as those of human neonates, such as distress, disgust, fright, interest and pleasure. We also study the initially fleeting and later developed emotions of fear, surprise, sadness, anger, motor mimicry and smiling towards the caregiver. Our results indicate that the appearance to our patients of the five first initially present in the neonates emotions is statistically significant more frequent than that of the six later developed emotions and that patients who exhibit more emotions have a better prognosis. We discuss our results and review the pertinent literature.

Keywords: Vegetative state, emotions, neonates, prognosis

N. Sakellaridis, A. Petsanas, L. Sakellaridi. Emotions in patients in vegetative state. Scientific Chronicles 2019; 24(1): 62-71

eoi: ***http://eoi.citefactor.org/10.11212/exronika/2019.1.6***

INTRODUCTION

Patients in vegetative state are an important cause of disability after severe traumatic brain injury. Recent research has increased our knowledge for these patients. The use of techniques such as positron emission tomography (PET), functional magnetic resonance imaging, magnetoencephalography etc have allowed us to study the responses of these patients' central nervous system to external stimuli. The new concept of minimally conscious state [1] has been described.

It would be very important to know the individual prognosis of these patients. We know that patients in vegetative state after a

severe traumatic brain injury have a better prognosis than those from non-traumatic injuries [2]. Younger patients have a better chance of recovery than older patients. But, generally speaking, we know very little about prognostic factors [3].

Patients in vegetative state do not have emotions, because they do not have consciousness. They have emotional reactions, triggered by absolute physical stimulus thresholds and not by any attribution of meaning. Neonates possess only precursor emotions also. They also possess only reflex activities without consciousness. These precursor emotions in neonates have been better studied [4]. No comparative study of emotional reactions has been done in patients in vegetative state, who also function with reflex activities.

MATERIAL AND METHODS

We prospectively studied patients in persistent (>4 weeks duration) or permanent (>1 year) vegetative state, treated in our Hospital from 1.1.2008 to 30.6.2016.

We study distress, disgust, fright, interest and pleasure. We also study the initially fleeting and later developed emotions of fear, surprise, sadness, anger, motor mimicry and smiling towards the caregiver.

Distress manifests as crying. Disgust as nose wrinkling and has as underlying reflex gagging. Fright depends on Moro's reflex. The underlying reflex for interest is the orienting response. Pleasure emerges as smiling, even if delayed. Fleeting emotions can be seen even in sleeping, such as fear (widening of eyes and clenching fists), surprise (raised eyebrows), sadness (pouting mouth), anger (frowning), motor mimicry and smiling towards the caregiver (1).

We follow up the patients until at least one year after the brain injury or until death.

RESULTS

We have collected 81 patients with brain injury leading to vegetative state. The appearance or not of each emotion and their combination in individual patients is unpredictable. Their frequency of appearance is distress 38%, disgust 50%, fright 68%, interest 26%, and pleasure 36%; fear 14%, surprise 20%, sadness 36%, anger 18%, motor mimicry 22% and smiling towards the caregiver 40%.

By using the McNemar's test we have found that the appearance of the five first initially presented neonates' emotions is statistically significant more frequent at the $p<0,01$ level than that of the six later developed emotions (Table 1).

20 patients improved, 17 died and 44 remained in vegetative state.

Patients who exhibit more emotions have a better prognosis. These patients exhibited an average of 5,9 kinds of emotional responses vs. 2,9 for the rest, $p> 0,05$.

	yes	**no**	**total**
Number of emotions initially present in neonates	100	135	**235**
Number of emotions later present in neonates	66	216	**282**
total	**166**	**351**	**517**

Table 1. McNemar's test. X^2= ([x-y]-1)²/x+y= (135-66-1)²/135+66=4624/201=23. p<0,01

Due to the small number of improved patients at follow up, we can draw no conclusions if singular emotions or combinations of them have any prognostic significance.

Anyway, we have observed that interest and pleasure usually combine with smile towards the caregiver, while disgust and fright with sadness. Fear combines with fright, surprise, anger and motor mimicry with interest.

Neonates have coping mechanisms, such as sucking, which helps calmness. Such mechanisms were not observed in our vegetative patients.

DISCUSSION

Vegetative state is a disorder of consciousness. In this state patients with severe brain damage are in a state of partial arousal rather than true awareness. After four weeks in a vegetative state (VS), the patient is classified as in a persistent vegetative state. Permanent vegetative state occurs after 3 or 6 months in vegetative state after non-traumatic brain injury or one year in traumatic brain injury.

Vegetative state is one of the five main outcomes of Glascow Outcome Scale. It differs from coma: In coma patients lack both awareness and wakefulness. In VS patients have awoken from coma, but still have no awareness. In the vegetative state patients can open their eyelids occasionally and demonstrate sleep-wake cycles, but completely lack cognitive function.

Patients in VS are a very important medical, social and family problem. The effort needed to keep these patients in life is very high. If we could foresee the final outcome, that would be very important.

Clinical and radiological variables are not very helpful prognostic factors. We know

that younger patients do better than older ones [5], patients remaining longer in VS have worse prognosis than the others and VS from traumatic brain injury have a better prognosis than those from non-traumatic causes [2]. There are no clinical signs that allow us to decide which patients will recover [3]. Re-appearance with proper timing of spontaneous motility, eye tracking and oculo-cephalic reflex and disappearance of oral automatisms proved highly correlated to outcome and allowed early and reliable prognosis [6]. Lesions of the dorsolateral brainstem and corpus callosum have a worse prognosis [7].

The use of modern functional neuroimaging has given us better insight into this difficult problem. PET studies have shown the identification of residual cognitive function in persistent vegetative state. That is, an external stimulation, such as a painful stimulus, still activates "primary" sensory cortices in these patients but these areas are functionally disconnected from "higher order" associative areas needed for awareness [8]. In VS patients there are preserved and consistent responses in predicted regions of auditory cortex in response to intelligible speech stimuli, but functional connectivity to association cortices is severely damaged [9].

Somatosensory stimulation of VS patients, at intensities that elicited pain in controls, resulted in increased neuronal activity in primary somatosensory cortex, even if resting brain metabolism was severely impaired. However, this activation of primary cortex seems to be isolated and dissociated from higher-order associative cortices [10].

The purpose of our work was to study emotional reactions in patients in VS. These emotional reactions are not real emotions, because these patients do not have consciousness. A similar situation exists in human neonates. In terms of our systemic definition of emotion, strictly speaking, no fully functioning emotions are to be found in the neonates. They possess only precursor emotions [11] that can form the basis for interpersonal regulation to start. These precursor emotions are triggered by absolute physical stimulus thresholds and not by any attribution of meaning [12]. Expressive and body reactions are still not coordinated with the cause of an emotion and its situational context. In part, they are still reflex-like.

These precursor emotions of neonates have been well studied. We have decided to use this knowledge for studying emotional reactions in VS, despite other obvious differences.

Let us describe these precursor emotions:

The precursor emotions distress, disgust, and fright as well as interest and endogenous pleasure can be observed consistently in neonates [13].

1. Distress and crying. Distress is initially an emotion with no specific motive that is triggered by a deficit state, for example, a lack of food, physical integrity (hypothermia, pain, overstimulation), or external stimulation (body contact, sensory arousal

[14]. The typical expression and body reaction are initial motor unrest followed by an unfocused crying that slowly increases in volume plus a rectangular open mouth with closed eyes. The quality of crying initially contains no indication regarding the cause of the emotion. For the caregiver, it functions exclusively as a sign. Motor immaturity obliges the infant to draw the caregiver's attention to his or her need.

Accordingly, the caregiver perceives the infant's crying as a directed appeal for help. It triggers measurable psychophysiological arousal [15], an urge to seek the cause of the crying and remove it, as well as a number of intuitive actions designed to calm the infant [16]. Accordingly, an infant's cries serving as an appeal for help and the caregiver's feeling of having to respond to this appeal form a preadapted unit.

2. Disgust and nose wrinkling. Disgust can be triggered by a bitter or an acidic taste [17]. The underlying reflex is gagging [18]. The characteristic expressive reaction is to drop the lower lip, raise the upper lip, and wrinkle or screw up the nose—as elicited in spitting by opening the mouth and sticking out the tongue [19]. The intrapersonal function of this expression is instrumental and serves to eject unpleasant foodstuffs. However, caregivers may interpret the expression of disgust as a sign indicating, for example, that they should stop feeding or switch to another foodstuff.

3. Fright and starting. Fright particularly follows a loss of balance, but also other abrupt and strong stimulus changes such as a sudden noise. Its underlying form is the Moro reflex. Although Prechtl [20] assigns it no further instrumental function, it does possess a sign function for caregivers. In itself, fright is closer to a reflex in classification [21]. However, it serves as the starting point for the emotion of fear [11]. If an abrupt or strong stimulus change persists, as in, for example, a sudden dunking in water when bathing, it is joined by characteristic expressive reactions of fear, such as a widening of the eyes as a sign of sympathicotonia, an A-shaped mouth, and clenching fists [22]. Should overstimulation persist, the reaction will shift to crying as a sign for distress.

4. Interest. Interest can be viewed as a motive-specific emotion triggered by the novelty of an external stimulation. It serves the search for contingencies in the perception of the environment. This active exploration behavior is assigned an independent motivational basis, namely, that of curiosity [23]. Here as well, the "novelty" of stimulation is linked initially to physical stimulus properties, namely, ones that elicit marked sensory contingencies.

These particularly include the "speaking" and slowly moving face of a person holding the baby in his or her arms [24]. The underlying reflex for interest is the orienting response [25].

5. Pleasure and smiling. Whether neonates already possess the ability to react with the emotion of pleasure is a matter of some controversy. In contrast to the other precursor emotions addressed here, pleasure does not exhibit any coincidence between the

typical expression sign for the emotion—the smile—and an externally observable cause. In neonates, smiling occurs during REM sleep [26]. This led Fogel and Thelen [27] to conclude that smiling might still possess no function and not yet be associated systematically with motivation states. In contrast, Sroufe's tension modulation hypothesis [11] offers an explanation that can integrate existing theories and findings on smiling and laughing into one consistent theory.

Later developed emotions: The facial expressive reactions for precursor emotions are joined by a number of further facial expressions that babies exhibit predominantly during REM sleep.

These show similarities to the prototypical facial expressive reactions of surprise (raised eyebrows), sadness (pouting mouth), and anger (frowning), but are very fleeting. They develop a few weeks or months later.

Motor mimicry: When neonates are exposed to the crying of other neonates, they start to cry themselves.

Finally, recognizing the caregiver occurs in face-to-face interaction (social smiling).

CONCLUSIONS

There is a similarity between the emotions observed in the neonates and those observed in patients in vegetative state. Both rely heavily on reflex activities.

Neonates possess five basic precursor emotions and six fleeting ones, which develop later. Patients in vegetative state display all these precursor emotions in various combinations. So, they have no clear-cut one-way development of emotions, such as the one observed in neonates. Anyhow, they display the five basic emotions more frequently than the six fleeting ones.

Patients who exhibit more emotions have a better prognosis.

Some combinations of emotions are more frequent than others. These combinations are reasonable, if we take into account that patients in vegetative state had in the past intellectual and emotional development, which were almost lost, unlike the neonates, who never had such a development in the past, but have the potential to develop it in the future.

REFERENCES

1. Giacino JT, et al. (2002). The minimally conscious state: definition and diagnostic criteria. Neurology 58 (3): 349–353.

2. Jennett, B (2002). "Editorial: The vegetative state. The definition, diagnosis, prognosis and pathology of this state are discussed, together with the legal implications". British Medical Journal. 73 (4): 355–357.

3. R. Braakman W. B. Jennett J. M. Minderhoud. Prognosis of the posttraumatic vegetative state. Acta Neurochirurgica. March 1988, Volume 95, Issue 1–2, pp 49–52

4. M. Holodynski, W. Friedlmeier, Development of emotions and emotion regulation. Springer, New York, 2006, p. 89-127.

5. PVS, The Multi-Society Task Force on (1994-05-26). "Medical Aspects of the Persistent Vegetative State". New England Journal of Medicine. 330 (21): 1499.

6. G. Dolce, M. Quintieri, S. Serra et al.Clinical signs and early prognosis in vegetative state: A decisional tree, data-mining study. Brain Injury, Volume 22, 2008 - Issue 7-8

7. Andreas Kampfl, Erich Schmutzhard , Gerhard Franz et al, Prediction of recovery from post-traumatic vegetative state with cerebral magnetic-resonance imaging. Lancet, Volume 351, Issue 9118, 13 June 1998, Pages 1763-1767.

8. Dr Steven Laureys. Adrian M Owen, Nicholas D Schiff . Brain function in coma, vegetative state, and related disorders. Lancet Neurology, Volume 3, Issue 9, September 2004, Pages 537-546.

9. Melanie Boly, Marie-Elisabeth Faymonville, Philippe Peigneux et al. Auditory Processing in Severely Brain Injured Patients. Arch Neurol, Vol. 61, Feb 2004, p. 233-238.

10. S. Laureys, M. E. Faymonville, P. Peigneux et al. Cortical Processing of Noxious Somatosensory Stimuli in the Persistent Vegetative State. NeuroImage 17, 732–741 (2002).

11. Sroufe, L. A. (1996). Emotional development: The organization of emotional life in the early years. New York: Cambridge University Press.

12. Soussignan, R., & Schaal, B. (2005). Emotional processes in human newborns: A functionalist perspective. In J. Nadel & D. Muir (Eds.), Emotional development: Recent research advances (pp. 127–159). New York: Oxford University Press.

13. Izard, C. E. (1978). On the ontogenesis of emotions and emotion–cognition relationships in infancy. In M. Lewis&L. Rosenblum (Eds.), The development of affect (pp. 389–413). NewYork: Plenum.

14. Lester, B.M.(1984). Infant crying and the development of communication. In N. A.Fox&R. J.Davidson (Eds.), The psychobiology of affective development (pp. 231–258). Hillsdale, NJ: Erlbaum.

15. Boukydis, C. F. Z., Burgess, R. L. (1982). Adult physiological response to infant cries: Effects of temperament of infant, parental status, and gender. Child Development, 13, 1291–1298.

16. Papouˇsek, M. (1990). Affektive Verhaltensregulation des S¨auglings in der Eltern-Kind-Interaktion. In M. J. Pachler&H.-M. Straßburg (Eds.), Der unruhige S¨augling (pp. 203–221). L¨ubeck, Germany: Hansisches Verlagskontor.

17. Fox, N. A., & Davidson, R. J. (1984). Hemispheric substrates of affect: A developmental model. In N. A. Fox & R. J. Davidson (Eds.), The psychobiology of affective development (pp. 353–382). Hillsdale, NJ: Erlbaum.

18. Fridlund, A. J. (1994). Human facial expression. An evolutionary view. San Diego, CA: Academic Press.

19. Izard, C. E. (1979). The maximally discriminative facial movement coding system (MAX). Newark, DE: Instructional Resources Center University of Delaware.

20. Prechtl, H. F. R. (1993). Principles of early motor development in the human. In A. F. Kalverboer, B. Hopkins, & R. Geuze (Eds.), Motor development in early and later childhood (pp. 35–50). Cambridge, England: Cambridge University Press.

21. Ekman, P., Friesen, W. V., & Simons, R. C. (1985). Is the startle reaction an emotion? Journal of Personality and Social Psychology, 49, 1414–1426.

22. Papouˇsek, H., & Papouˇsek, M. (1999). Symbolbildung, Emotionsregulation und soziale Interaktion. In W. Friedlmeier & M. Holodynski (Eds.), Emotionale Entwicklung. Funktion, Regulation und soziokultureller Kontext von Emotionen (pp. 135–155). Heidelberg, Germany: Spektrum.

23. Hunt, J. M. (1965). Intrinsic motivation and its role in psychological development. In D. Levine (Ed.), Nebraska Symposium on Motivation (pp. 189–282). Lincoln, NE: University of Nebraska Press.

24. Langsdorf, P., Izard, C. E., Rayias, M., & Hembree, E. A. (1983). Interest expression, visual fixation, and heart rate changes in 2- to 8-month-old infants. Developmental Psychology, 19, 418–426.

25. Sokolov, E. N. (1963). Perception and the conditioned reflex. New York: Macmillan.

26. Emde, R. N., & Koenig, K. L. (1969). Neonatal smiling, frowning, and rapid eye movement states. Journal of the American Academy of Child Psychiatry, 8, 637–656.

27. Fogel, A., & Thelen, E. (1987). Development of early expressive and communicative action: Reinterpreting the evidence from a dynamic systems perspective. Developmental Psychology, 23, 747–761.

ΠΡΩΤΟΤΥΠΟ ΑΡΘΡΟ

Συναισθήματα ασθενών σε φυτική κατάσταση

Ν. Σακελλαρίδης[1], Α. Πετσανάς[1,] Λ. Σακελλαρίδη[2]

[1] Νευροχειρουργική Κλινική, ΓΝ Πειραιά «Τζάνειο», [2] Τμήμα Βιολογίας, Πανεπιστήμιο Wageningen, Ολλανδία

ΠΕΡΙΛΗΨΗ

Περιγράφουμε 81 ασθενείς μας σε φυτική κατάσταση από βαριά κρανιοεγκεφαλική κάκωση. Τους αντιμετωπίσαμε και παρακολουθήσαμε τουλάχιστον για ένα χρόνο μετά την κάκωση ή μέχρι τον θάνατό τους. Περιγράφουμε τις συναισθηματικές τους αντιδράσεις, ταξινομημένες όπως στα νεογνά, ως στενοχώρια, απέχθεια, τρόμος, ενδιαφέρον κι ευχαρίστηση. Επίσης, τις κάπως αργότερα αναπτυσσόμενες συναισθηματικές αντιδράσεις των νεογνών, όπως φόβος, έκπληξη, λύπη, θυμός, μιμητικότητα και χαμόγελο. Όλες οι αντιδράσεις μελετήθηκαν στους ασθενείς σε φυτική κατάσταση ανάλογα με την κλινική τους έκφραση στα νεογνά. Τα βασικά μας συμπεράσματα είναι ότι συνήθως εμφανίζονται πρώτα οι συναισθηματικές αντιδράσεις που εμφανίζονται πρώιμα και στα νεογνά. Επίσης, ότι περισσότερες συναισθηματικές αντιδράσεις συνοδεύονται από καλύτερη πρόγνωση.

Λέξεις ευρετηρίου: φυτική κατάσταση, συναισθήματα, νεογνά, πρόγνωση

Ν. Σακελλαρίδης, Α. Πετσανάς, Λ. Σακελλαρίδη. Συναισθήματα ασθενών σε φυτική κατάσταση. Επιστημονικά Χρονικά 2019; 24(1): 62-71

eoi: ***http://eoi.citefactor.org/10.11212/exronika/2019.1.6***

Συγγραφέας επικοινωνίας: **Νικόλαος Σακελλαρίδης,** E-mail: nicksac2@hotmail.com