NICU INFANTS & SNHL: EXPERIENCE OF A WESTERN SICILY TERTIARY CARE CENTRE

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ABSTRACT

Introduction*: The variability of symptoms and signs caused by central nervous system (CNS) lesions make multiple sclerosis difficult to recognize,Introduction: This study adds the evaluation of the independent etiologic factors that may play a role in the development of SNHL in a NICU population. We compared neonatal intensive care unit NICU infants with sensorineural hearing loss SNHL to age and gender matched normal hearing NICU controls.*

Materials and methods*: 284 consecutive NICU infants positive to the presence of risk indicators associated with permanent congenital, delayed-onset, or progressive hearing loss underwent to global audiological assessment. The following risk factors were researched, making a distinction between prenatal and perinatal risk factors: in the first group, family history of permanent childhood hearing impairment, consanguinity, pregnant maternal infection and drugs exposition during pregnancy; in the second group, premature birth, respiratory distress , hyperbilirubinemia requiring exchange tranfusion, very low birth weight, cranio-facial abnormality, perinatal infections, ototoxic drugs administration, acidosis, hyponatremia, head trauma.*

Results*: The analysis of the auditory deficit for infants according to numbers of risk factors showed mean values of: 78 + 28.08 dB nHL for infants positive to two risk factors; 75.71 + 30.30 dB nHL in cases positive to three risk factors; 96.66 + 34.46 dB nHL for four risk factors and 85 + 35 dB nHL in case of >5 risk factors.*

Conclusion*: NICU infants have greater chances of developing SNHL, because of the presence of multiple risk factors; in fact, as the number of coexisting risk factors increases, the prevalence rate of SNHL also increases (r=0.81).*

Keywords*: NICU, infants, risk factors hearing loss.*

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Introduction

Infants admitted to the neonatal intensive care unit (NICU), who represent the 4-8% of all births, have an increased risk of developing congenital sensorineural hearing loss (2 to 4 cases per 100 newborn infants)[1, 2]; multiple risk factors have been associated with sensorineural hearing loss (SNHL). Comparing SNHL incidence with that of other congenital pathologies routinely screened at birth like phenylketonuria (1:15000 newborns) and hypothyroidism (1:4500 newborns), permanent hearing loss appears more frequent especially among NICU population. Unlike children with normal hearing, those with hearing loss present more difficulty developing verbal skills (learning vocabulary, grammar, word order and idiomatic expressions), language, learning and speech. Hearing impairment influences also cognitive and affective development of infants making consequences in their interpersonal relationships[3-7].

The 2007 Position Statement from the Joint Committee on Infant Hearing (JCIH) confirmed that neonates who are in NICU for >5 days, or who have risk factors and a shorter stay, undergo hearing evaluation with Transient evoked otoacoustic emissions (TEOAEs) and (automated) auditory brainstem response (ABR) testing, that is recommended for screening because of the increased occurrence of SNHL and neural (auditory neuropathy/dyssynchrony) loss that are known to

cause long-term problems on language and speech development in this population[8].

Some authors have studied the presence of risk factors identified by the Joint Committee on Infants Hearing (JCIH) among NICU infants[1, 2, 9-14] but their studies concerned a relative small number of NICU infants, or did not have a control group of normal hearing infants. Risk factors that are commonly found among NICU infants are prolonged mechanical ventilation, asphyxia, low birth weight and ototoxic medication.

Because most of these risk factors are related to NICU admittance it is unclear which risk factors play an independent contributing role to SNHL. Only by comparison within the NICU population the risk factors specific to SNHL can be assessed.

The Department of Audiology of Palermo University represents the main speech and hearing third level centre in Western Sicily; it daily performs an audiological assessment to those infants at risk born in Western Sicily and transferred from NICUs to our specialized area[15-17]. Therefore this study adds the evaluation of the independent etiologic factors that may play a role in the development of SNHL in a NICU population[18-22]). We compared NICU infants with SNHL to age and gender matched normal hearing NICU controls.

Materials and methods

284 consecutive NICU infants positive to the presence of risk indicators associated with permanent congenital, delayed-onset, or progressive hearing loss underwent to global audiological assessment. After ethical Committee approval, the study protocol was fully explained to patients or their guardians, and written informed consent was obtained from each patient. The following risk factors were researched, making a distinction between prenatal and perinatal risk factors (JCIH): in the first group, family history of permanent childhood hearing impairment, consanguinity, pregnant maternal infection (TORCH) and drugs exposition during pregnancy; in the second group, premature birth (gestational age ≤36 weeks), respiratory distress (IRDS), hyperbilirubinemia requiring exchange tranfusion, very low birth weight (<1500 g, VLBW), cranio-facial abnormality (CFA) and syndromes associated to HI, perinatal infections like sepsis and meningitis, ototoxic drugs administration (furosemide, dexamethason, vancomycin, gentamycin and tobramycin), acidosis, hyponatremia, head trauma[8].

An experienced audiologist and otorhinolaryngologist examined the condition of the external auditory canal and tympanic membrane with otoscopy, and nose, throat, head and face in search of ear anomalies and syndromic features related to hearing impairment[23-29].

The audiological assessment was performed by the same qualified bio-medical staff and consisted of ABR, TEOAE and tympanometry measurement. ABR measurements were recorded in a soundproof room; all children were in natural sleep or in calm conditions throughout the assessment. Both ears were sequentially tested. AMPLAID mk22 auditory evoked potentials system was used for testing the infants. After adequate preparation of skin, recording silver electrodes were attached to upper forehead (recording electrode), the ipsilateral mastoid process (reference electrode) and contralateral mastoid process (ground electrode). Thus the Fpz-M1-M2 electrode montage was used for recording the ABR. The acoustic stimuli consisted of unfiltered full square wave pulses of 100 microseconds duration and with alternating polarity. The clicks were delivered monaurally by a hand-held TDH-49 headphone, at a rate of 21/sec. The analysis time was 15 milliseconds. The recording bandwidth for click threshold determination was 100-2500 Hz. The electrode and inter electrode impedance were ensured to be below 5 kHz and 2 kHz respectively. Each run consisted of summing the responses to 2000 clicks. Click stimuli were presented starting at a level of 90 dB nHL. With step sizes of 10 dB the level was decreased until no response was found. The response threshold was estimated by the lowest level at which a response was found.

An infant was considered to have passed the ABR test if a replicable wave V response (response present on at least two identical sound stimulation levels) was present at 30 dB nHL in both the ears while sensorineural hearing loss was defined as elevated ABR response thresholds (>40 dB) in one or both ears. Moreover, the absolute latencies and interpeak intervals as well as the response thresholds were recorded. Experienced clinical specialists interpreted the ABR response waves. The response latencies in milliseconds were obtained by establishing the peak of the wave and reading out the digitally displayed time. From the latency intensity curves the level of

conductive hearing loss was estimated. TEOAE and tympanometry measurement were used to confirm the diagnosis of conductive hearing loss when available. In particular, the first one was performed using the Otodynamics ILO 288 USB II system with the standard settings; the stimulus level was set to 84 dB SPL, a number of 260 averages was used. Tympanometry was performed through Amplaid 766, with a probe frequency of 220 Hz and an air pressure range of -400 to -100 mmH2O with automatic recording.

The parents of an infant with suspicion of hearing impairment were informed of the results of the initial test and received recommendations to return for a follow up evaluation after 3 weeks. Statistical analysis was conducted with Matlab® computer programme; χ^2 test, odds ratio (or) and/or exact test of Fisher test were used, following usual conditions of application. Significance was set at 0.05.

Results

Of 284 NICU infants examined 168 were males (59.15%) and 116 females (40.85%) with a male:female ratio = 1.45; the age of infants at first diagnostic ABR measurement, ranged from 4 to 20 weeks of life, with no statistical difference among the sex (t = 0.74; f.d. = 140; p = 0.26).

Audiologic evaluation revealed the presence of hearing loss in 34 children (16 male and 18 female) corresponding to 11.97% of the study group (Table 1).

RISK FACTOR	Cohort N°	NHL N°(%)*	SNHL N°(%)*	Odds ratio or	P-value	95% CI
Family history of HI	6	4(66.6)	2(33.3)	3.88	0.10	0.68-22.01
TORCH	15	11 (73.3)	4(26.6)	2.90	0.071	0.87-9.67
Drugs administration in pregnant	18	16 (88.8)	2(11.1)	0.91	0.90	0.20-4.16
Prematurity	88	72(81.8)	16(18.2)	2.20	0.030	1.06-4.55
IRDS	140	120(85.7)	20(16.6)	1.79	0.11	0.87-3.68
Hyperbilirubinemia	50	38(76)	12(24)	3.04	0.0039	1.39-6.66
VLBW	56	48(85.7)	8(14.3)	1.29	0.55	0.55-3.04
Perinatal infections	36	34(94.4)	2(5.5)	0.40	0.20	0.09-1.73
Ototoxic drugs	40	36(90)	4(10)	0.79	0.67	0.26-2.38
CFA and Syndromes associated to HI	22	22(100)	0(0)	-	-	-

*Percentage rate relative to total cohort

Table 1: Analisys of risk factors for SNHL among NICU newborns: logistic regression analisys, correlation coefficient b, P-value, odds ratio and 95% confidence limits.

There is no statistically significant difference in prevalence of SNHL among sex (χ^2 = 1.17, P = 0.25, or = 1.74). Out of 34 SNHL infants, 30 subjects (88.23%) were diagnosed with bilateral SNHL; a symmetric HL, defined by an inter-aural threshold difference < 30 dB, was evidenced in the 93.33% corresponding to 28 cases (82.35% of the total infants suffering from SNHL), while in the 5.88 % corresponding to 2 cases this sensorineural hearing loss was asymmetric (inter-aural threshold difference > 30 dB).

Finally, 4 infants (11.76%) were affected by unilateral SNHL, with a response threshold in the best hearing ear < 40 dB. Among the total ears suffering from SNHL, our study evidenced an hearing threshold mean value of 82.5 ± 30.37 dB HL (median 75 dB HL) for the left ears, of 81.25 ± 33.04 dB HL (median 70dB HL) for the right ears, of 81.87± 32.05 dB HL (median 70 dB HL) for both ears without any difference between left and right ears (t=0.18, f.d.=30, P=0.85). The ABR response thresholds were used also to determine the degree of SNHL; a moderate, defined as hearing threshold inferior to 70 dB nHL, hearing loss was identified in 52.94% of SNHL corresponding to 18 infants, severe hearing loss in 11.76% (4 cases) and profound hearing loss in 35.29% of cases (12 cases).

44 NICU infants (15.49%) resulted positive for a specific risk factor while 142 subjects (50%) were positive for 2 risk factors, 48 cases (16.90%) presented 3 risk factors, 34 (11.97%) infants demonstrated 4 risk factors while only in 16 case >5 risk factors were found.

Prevalence of prenatal risk factors was lower than that of perinatal risk factors (Table 1) even if TORCH infection resulted an independent risk factor for SNHL (or=2.90).

In the second group, that includes risk factors occurred from birth to the 28th day of life, respiratory distress and prematurity showed the highest prevalence, with 140 infants suffered from IRDS (49.29%) and 88 born preterm (30.98%). Lower percentage concerned other risk factors like hyperbilirubinemia requiring phototherapy, found in 50 newborns (17.60%), VLBW, that regarded 56 infants (19.71%), syndromes associated with HI and cranio -facial anomalies (CFA) which affected 22 children (7.74%)(Figure 1).

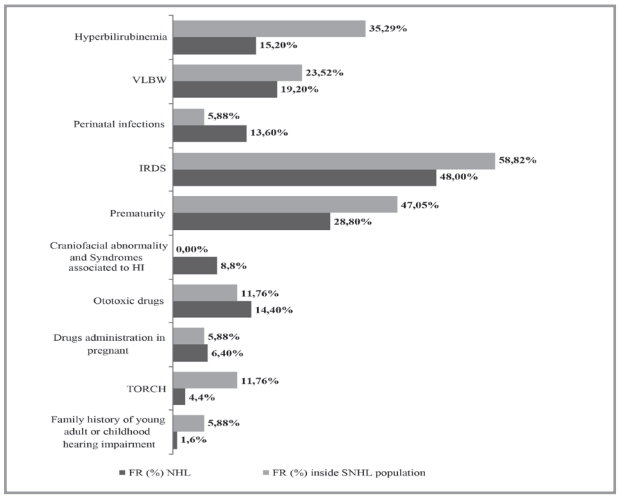

Figure 1: Figure 1: Incidence of risk factors in SNHL infants respect to NHL cohort.

The univariant analysis showed a statistically significant correlation between prematurity, hyperbilirubinemia and SNHL (P=0.03 with or=2.20 and P=0.0039 with or=3.04) with a SNHL prevalence respectively of 47.05% and 35.29% for infants with this risk factor (Table 1).

The study of the risk factors of the SNHL infant population demonstrated the presence of more risk factors in the 100%; moreover, as the number of coexisting risk factors increased, the percentage value of SNHL in infants also increases. In fact, among the 142 infants presenting two risk factors 16 were diagnosed with SNHL (11.26%), of the 48 infants with three risk factors 8 were deafness (16.6%); 6 infants (21.42%) among the 28 with four risk factors resulted deaf and 4 infants of the 12 (33.33%) positive to >5 risk factors was hearing impaired (r = 0.81).

The analysis of the auditory deficit for infants according to numbers of risk factors showed mean values of: 78 + 28.08 dB nHL for infants positive to two risk factors; 75.71 + 30.30 dB nHL in cases positive to three risk factors; 96.66 + 34.46 dB nHL for four risk factors and 85 + 35 dB nHL in case of >5 risk factors.

Discussion

In the general population, a newborn every 500-1000 births presents permanent hearing impairment (HI) greater than the incidence of other diseases routinely screened at birth[30-41]. Moreover, in certain 'higher risk' populations, this incidence could increase to 8-100 cases per 1000 infants. The importance of deafness for the public health comes from its tendency to cause sequelae and complications such as irreversible delay in speech and cognitive development. To prevent these complications, children especially who have certain risk factors for HI must be identified within three months of birth, with formal diagnosis and initiation of early intervention beginning before the 6th month of age. The goal of this report was to present the results of global audiological evaluation of 142 NICU infants for permanent congenital, delayed-onset, or progressive hearing loss, who were transferred to our Department, the main tertiary Speech and Hearing Center of Western Sicily, from all NICU centres of Western Sicily that decided to participate in the study from January 2010 to our days.

With a prevalence rate of 11.97% of SNHL, our percentage is higher than those reported by Coenraad (1.39%), Hille (3.1%) and Robertson (3.2%) and inferior to those evidenced by Davis and Parving (32.8%), Shiu et al. (30.9%) and Pitt (32%) (2, 9; 41-45). According to Dauman et al., the high variability in incidence of SNHL among newborns admitted to NICU reflects an heterogeneous distribution of different neonatal risk factors more or less involved in the development of SNHL[46-53].

In addition, another consideration should be made for NICU babies: these newborns, in fact, present often multiple risk factors, a condition that increases the probability of hearing impairment. Table 1 reports logistic regression analysis for each risk factors in our NICU cohort; results of a simultaneous multiple regression analysis of the variation in SNHL prevalence among NICU infants evidenced that the relative risk for SNHL increases by 21.24% in preterm infants and by 19.33% in newborns who suffered from hyperbilirubinemia when respiratory distress is concomitant with these risk factors respectively (Figure 2). Furthermore, in this cohort, we observed an higher risk of SNHL (99.66%) in case of coexistence of prematurity and hyperbilirubinemia.

Our study also underlined the role of gestational age and birth weight as risk factors for SNHL; specifically, among the 72 preterm infants, 58 (80.55%) presented extreme prematurity and of them 14 (corresponding to 24.13% subjects) were hearing impaired (χ^2=10.23; P=0.001). Among newborns with very low birth weight, it was evidenced a statistically difference between infants with weight < 1000g and those who weighed at birth≥1000g; in fact the SNHL prevalence

percentages inside the groups resulted of 14.28%, 5.26% and 33.33% for the total infants with VLBW, for newborns weighed between 1000g and 1500 g and for children with extremely low birth weight (<1000g) respectively (χ^2=3.93; P=0.04). These findings are explainable considering that the greater the severity of prematurity and the lower the birth weight, more probable is the coexistence of condition like severe birth asphyxia or assisted ventilation for ≥5 days that increase the risk of SNHL[54-65].

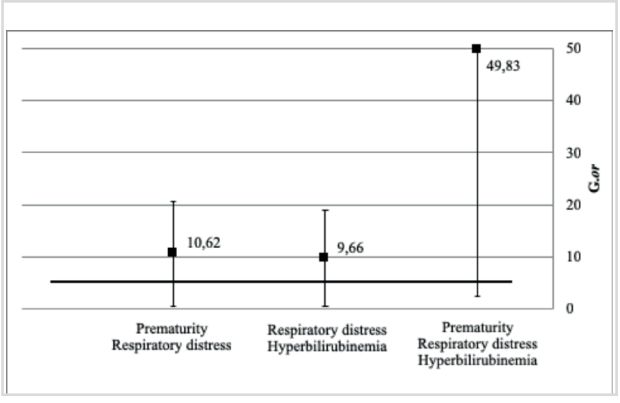

Figure 2: Global odds ratio (G.or) and 95% confidence intervals (CI) for joint effect of determinants among NICU population (P<0.001).

Conclusion

With an incidence of 11.97% of SNHL in infants at risk this study demonstrates the necessity to implement a Newborn Hearing Screening program in Western Sicily; with a mean hearing threshold of 82.5 ± 30.37 dB HL (median 75 dB HL), out of speech spectrum, it underlines the necessity of an early diagnosis before the 6th month of life to prevent sequelae and complications such as irreversible delay in speech and cognitive development. NICU infants have greater chances of developing SNHL, because of the presence of multiple risk factors; in fact, as the number of coexisting risk factors increases, the prevalence rate of SNHL also increases (r=0.81), particularly among extreme premature and infants with weight < 1000g (P=0.04).

References

1) Vohr BR, Widen JE, Cone-Wesson B, Sininger YS, Gorga MP, Folsom RC, et al. Identification of neonatal hearing impairment: characteristics of infants in the neonatal intensive care unit and well-baby nursery. Ear Hear. 2000; 21(5): 373-82.

2) Hille ET, van Straaten HI, Verkerk PH, Dutch NNHSWG. Prevalence and independent risk factors for hearing loss in NICU infants. Acta Paediatr. 2007; 96(8): 1155-8. http://dx.doi.org/10.1111/j.1651-2227.2007.00398.x

3) Rizzo S, Bentivegna D, Dispenza F, Mucia M, Plescia F, Salvago P, Sireci F, Martines F. Audiological risk factors and screening strategies in NICU infants In Martines F. Neonatal Intensive Care Units. Nova Science Publishers; 2017. 1-15.

4) Yoshinaga-Itano C, Coulter D, Thomson V. The Colorado Newborn Hearing Screening Project: effects on speech and language development for children with hearing loss. J Perinatol. 2000; 20(8 Pt 2): S132-7.

5) Plescia F, Lavanco G, Brancato A, Cannizzaro C, Dispenza F, Mucia, M, Passalacqua MI, Salvago P, Sireci F,Rizzo S, Cavallaro A. Pharmacological Therapy of Newborn Babies Admitted to the Neonatal Intensive Care Unit. In: Francesco Martines eds. Neonatal Intensive Care Units (NICUs): Clinical and Patient Perspectives, Levels of Care and Emerging Challenges. Chapter 6; Nova publisher; 2017. 1-15

6) Fortnum H, Davis, A, Butler, A, Stevens, J. Health service implications of changes in aetiology and referral patterns of hearing impaired children in Trent 1985-1993, Report to Trent Regional Health Authority. UK: Nottingham, MRC Institute of Hearing Research, 1996.

7) Martines F, Martines E, Ballacchino A, Salvago P. Speech perception outcomes after cochlear implantation in prelingually deaf infants: The Western Sicily experience. Int J Pediatr Otorhinolaryngol. 2013; 77(5): 707-13. http://dx.doi.org/10.1016/j.ijporl.2013.01.023

8) American Academy of Pediatrics JCoIH. Year 2007 position statement: Principles and guidelines for early hearing detection and intervention programs. Pediatrics. 2007; 120(4): 898-921. http://dx.doi.org/10.1542/peds.2007-2333

9) Sireci F, Ferrara S, Gargano R, Mucia M, Plescia F, Rizzo S, Salvago P, Martines F. Hearing loss in Neonatal Intensive Care Units (NICUs): follow-up surveillance In Martines F. Neonatal Intensive Care Units. Nova Science Publishers; 2017. 1-15.

10) Robertson CM, Howarth TM, Bork DL, Dinu IA. Permanent bilateral sensory and neural hearing loss of children after neonatal intensive care because of extreme prematurity: a thirty-year study. Pediatrics. 2009; 123(5): e797-807. http://dx.doi.org/10.1542/peds.2008-2531

11. Declau F, Boudewyns A, Van den Ende J, Peeters A, van den Heyning P. Etiologic and audiologic evaluations after universal neonatal hearing screening: analysis of 170 referred neonates. Pediatrics. 2008;121(6):1119-26. http://dx.doi.org/10.1542/peds.2007-1479

12) Nield TA, Schrier S, Ramos AD, Platzker AC, Warburton D. Unexpected hearing loss in high-risk infants. Pediatrics. 1986; 78(3): 417-22.

13) Salamy A, Eldredge L, Tooley WH. Neonatal status and hearing loss in high-risk infants. J Pediatr. 1989; 114(5): 847-52.

14) Borradori C, Fawer CL, Buclin T, Calame A. Risk factors of sensorineural hearing loss in preterm infants. Biol Neonate. 1997; 71(1): 1-10.

15) Borg E. Perinatal asphyxia, hypoxia, ischemia and hearing loss. An overview. Scand Audiol. 1997; 26(2): 77-91.
16) Martines F, Martines E, Mucia M, Sciacca V, Salvago P. Prelingual sensorineural hearing loss and infants at risk: Western Sicily report. Int J Pediatr Otorhinolaryngol. 2013;77(4):513-8. http://dx.doi.org/10.1016/j.ijporl.2012.12.023
17) Salvago P, Martines E, Martines F. Prevalence and risk factors for sensorineural hearing loss: Western Sicily overview. Eur Arch Otorhinolaryngol. 2013; 270(12): 3049-56. http://dx.doi.org/10.1007/s00405-013-2379-2
18) Galletti B, Freni F, Cammaroto G, Catalano N, Gangemi G, Galletti F. Vocal outcome after CO2 laser cordectomy performed on patients affected by early glottic carcinoma. J Voice. 2012 Nov; 26(6): 801-5.
19) Marseglia L, D'Angelo G, Impellizzeri P, Salvo V, Catalano N, Bruno R, Galletti C, Galletti B, Galletti F, Gitto E. Neonatal stridor and laryngeal cyst: Which comes first? Pediatr Int. 2017 Jan; 59(1): 115-117.
20) Canevari FR, Martines F, Sorrentino R, Nicolotti M, Sireci F. Pseudoaneurysm of superior thyroid artery following a transesophageal echocardiography: a case presentation. Euromediterranean Biomedical Journal 2017, 12(03): 010-012
21) Galletti B, Gazia F, Freni F, Sireci F, Galletti F. Endoscopic sinus surgery with and without computer assisted navigation: A retrospective study. Auris Nasus Larynx. 2018; 10.1016/j.anl.2018.11.004
22) Galletti B, Bruno R, Catalano N, Cammaroto G, Freni F. Follicular carcinoma on a radio-treated ectopic lingual thyroid. Chirurgia (Turin). 2016 June; 29(3): 88-91
23) Santoro R, Mannella VK, Freni F, Galletti F. Penetrating foreign body in the nasal floor through nasolacrimal duct. BMJ Case Rep. 2014 Jun 12; 2014
24) Sireci F, Nicolotti M, Battaglia P, Sorrentino R, Castelnuovo P, Canevari FR. Canine fossa puncture in endoscopic sinus surgery: report of two cases. Braz J Otorhinolaryngol. 2017 Sep - Oct;83(5):594-599. doi: 10.1016/j.bjorl.2017.03.001.
25) Martines F, Salvago P, Ferrara S, Messina G, Mucia M, Plescia F, Sireci F. Factors influencing the development of otitis media among Sicilian children affected by upper respiratory tract infections. Braz J Otorhinolaryngol. 2015 Jul 21. pii: S1808-8694(15)00091-9.
26) Galletti B, Santoro R, Mannella VK, Caminiti F, Bonanno L, De Salvo S, Cammaroto G, Galletti F. Olfactory event-related potentials: a new approach for the evaluation of olfaction in nasopharyngeal carcinoma patients treated with chemo-radiotherapy. J Laryngol Otol. 2016 May; 130(5): 453-61.
27) Ottaviano G, Maculan P, Borghetto G, Favero V, Galletti B, Savietto E, Scarpa B, Martini A, Stellini E, De Filippis C, Favero L. Nasal function before and after rapid maxillary expansion in children: A randomized, prospective, controlled study. Int J Pediatr Otorhinolaryngol. 2018 Dec; 115: 133-138.
28) Galletti C, Cammaroto G, Galletti F, Camps-Font O, Gay-Escoda C, Bara-Casaus JJ. Dental implants after the use of bichat's buccal fat pad for the sealing of oro-antral communications. A case report and literature review. J Clin Exp Dent. 2016 Dec 1; 8(5): e645-e649.
29) Cammaroto G, Montevecchi F, D'Agostino G, Zeccardo E, Bellini C, Galletti B, Shams M, Negm H, Vicini C. Tongue reduction for OSAHS: TORSs vs coblations, technologies vs techniques, apples vs oranges. Eur Arch Otorhinolaryngol. 2017 Feb; 274(2): 637-645. doi: 10.1007/s00405-016-4112-4.
30) Freni F, Galletti B, Galletti F, Dionigi G. Improved outcomes for papillary thyroid microcarcinoma care: active surveillance and case volume. Ther Adv Endocrinol Metab. 2018 Jul; 9(7): 185-186.
31) Sun H, Zanghì GN, Freni F, Dionigi G. Continuous and intermitted nerve monitoring in thyroid surgery: two complementary devices. Gland Surg. 2018 Aug; 7(Suppl 1): S80-S81
32) Cristofari E, Cuda D, Martini A, Forli F, Zanetti D, Di Lisi D, Marsella P, Marchioni D, Vincenti V, Aimoni C, Paludetti G, Barezzani MG, Leone CA, Quaranta N, Bianchedi M, Presutti L, Della Volpe A, Redaelli de Zinis LO, Cantore I, Frau GN, Orzan E, Galletti F, Vitale S, Raso F, Negri M, Trabalzini F, Livi W, Piccioni LO, Ricci G, Malerba P. A Multicenter Clinical Evaluation of Data Logging in Cochlear Implant Recipients Using Automated Scene Classification Technologies. Audiol Neurootol. 2017; 22(4-5): 226-235.
33) Ciodaro F, Mannella VK, Cammaroto G, Bonanno L, Galletti F, Galletti B. Oral gabapentin and intradermal injection of lidocaine: is there any role in the treatment of moderate/severe tinnitus? Eur Arch Otorhinolaryngol. 2015 Oct; 272(10): 2825-30.
34) Galletti B, Mannella VK, Santoro R, Rodriguez-Morales AJ, Freni F, Galletti C, Galletti F, Cascio A. Ear, nose and throat (ENT) involvement in zoonotic diseases: a systematic review. J Infect Dev Ctries. 2014 Jan 15;8(1):17-23. doi: 10.3855/jidc.4206.
35) Salvago P, Rizzo S, Bianco A, Martines F. Sudden sensorineural hearing loss: is there a relationship between routine haematological parameters and audiogramshapes? Int J Audiol. 2017 Mar;56(3):148-153.
36) Galletti F, Cammaroto G, Galletti B, Quartuccio N, Di Mauro F, Baldari S. Technetium-99m (^{99}mTc)-labelled sulesomab in the management of malignant external otitis: is there any role? Eur Arch Otorhinolaryngol. 2015 Jun;272(6): 1377-82.
37) Martines F, Ballacchino A, Sireci F, Mucia M, La Mattina E, Rizzo S, Salvago P. Audiologic profile of OSAS and simple snoring patients: the effect of chronic nocturnal intermittent hypoxia on auditory function. Eur Arch Otorhinolaryngol. 2016 Jun; 273(6): 1419-24.
38) Motta G, Motta S, Cassano P, Conticello S, Ferretti M, Galletti B, Garozzo A, Larotonda G, Mansi N, Mevio E, Motta G, Quaremba G, Serra A, Tarantino V, Tavormina P, Vicini C, Vigili MG, Testa D. Effects of guidelines on adeno-tonsillar surgery on the clinical behaviour of otorhinolaryngologists in Italy. BMC Ear Nose Throat Disord. 2013 Jan 7; 13: 1.
39) Meyer C, Witte J, Hildmann A, Hennecke KH, Schunck KU, Maul K, et al. Neonatal screening for hearing disorders in infants at risk: incidence, risk factors, and follow-up. Pediatrics. 1999;104(4 Pt 1): 900-4.
40) Mehl AL, Thomson V. Newborn hearing screening: the great omission. Pediatrics. 1998; 101(1): E4.

41) Ballacchino A, Mucia M, Cocuzza S, Ferrara S, Martines E, Salvago P, et al. Newborn Hearing Screening in Sicily: Lesson Learned. Acta Medica Mediterr. 2013; 29(4): 731-4.
42) Davis A, Parving A. Towards appropriate epidemiological data on childhood hearing disability: A comparative European study of birth cohorts 1982-88. J Audiol Med. 1994; 3(1): 35-47.
43) Shiu J, Purvis, M, Sutton, G. Detection of childhood hearing impairment in the Oxford Region. Report of the Regional audit project. Oxford, UK: Oxford University1996 Contract No.: I.
44) Pitt T. Management and outcome: children fitted with hearing aids in Ireland. Br J Audiol. 1995; 29(4): 199-207.
45) Coenraad S, Goedegebure A, Hoeve LJ. An initial overestimation of sensorineural hearing loss in NICU infants after failure on neonatal hearing screening. Int J Pediatr Otorhinolaryngol. 2011; 75(2): 159-62. http://dx.doi.org/10.1016/j.ijporl.2010.10.026
46) Dauman R, Roussey M, Belot V, Denoyelle F, Roman S, Gavilan-Cellie I, et al. Screening to detect permanent childhood hearing impairment in neonates transferred from the newborn nursery. Int J Pediatr Otorhinolaryngol. 2009; 73(3): 457-65. http://dx.doi.org/10.1016/j.ijporl.2008.12.001
47) Catalano N, Cammaroto G, Galletti B, Freni F, Nicita RA, Azielli C, Galletti F. The role of cVEMPs and vHIT in the evaluation of otosclerosis and its eventual vestibular impairment: preliminary findings. B-ENT. 2017; 13(1 Suppl 27): 31-36
48) Freni F, Mannella VK, Cammaroto G, Azielli C, Cappuccio C, Galletti F. Classic and reversal steps stapedotomy performed with CO2 laser: a comparative analysis. Eur Arch Otorhinolaryngol. 2014 May; 271(5): 981-6.
49) Martines F, Sireci F, Cannizzaro E, Costanzo R, Martines E, Mucia M, Plescia F, Salvago P. Clinical observations and risk factors for tinnitus in a Sicilian cohort. Eur Arch Otorhinolaryngol. 2015 Oct; 272(10): 2719-29.
50) Bruno R, Aversa T, Catena M, Valenzise M, Lombardo F, De Luca F, Wasniewska M. Even in the era of congenital hypothyroidism screening mild and subclinical sensorineural hearing loss remains a relatively common complication of severe congenital hypothyroidism. Hear Res. 2015 Sep; 327: 43-7.
51) Amorini M, Romeo P, Bruno R, Galletti F, Di Bella C, Longo P, Briuglia S, Salpietro C, Rigoli L. Prevalence of Deafness-Associated Connexin-26 (GJB2) and Connexin-30 (GJB6) Pathogenic Alleles in a Large Patient Cohort from Eastern Sicily. Ann Hum Genet. 2015 Sep; 79(5): 341-349.
52) Miroddi M, Bruno R, Galletti F, Calapai F, Navarra M, Gangemi S, Calapai G. Clinical pharmacology of melatonin in the treatment of tinnitus: a review. Eur J Clin Pharmacol. 2015 Mar; 71(3): 263-70.
53) Naro A, Leo A, Cannavò A, Buda A, Bruno R, Salviera C, Bramanti P, Calabrò RS. Audiomotor Integration in Minimally Conscious State: Proof of Concept! Neural Plast. 2015; 2015: 391349. doi: 10.1155/2015/391349.
54) Marlow ES, Hunt LP, Marlow N. Sensorineural hearing loss and prematurity. Arch Dis Child Fetal Neonatal Ed. 2000; 82(2): F141-4.
55) Leslie GI, Kalaw MB, Bowen JR, Arnold JD. Risk factors for sensorineural hearing loss in extremely premature infants. J Paediatr Child Health. 1995; 31(4): 312-6.
56) Naro A, Leo A, Bruno R, Cannavò A, Buda A, Manuli A, Bramanti A, Bramanti P, Calabrò RS. Reducing the rate of misdiagnosis in patients with chronic disorders of consciousness: Is there a place for audiovisual stimulation? Restor Neurol Neurosci. 2017; 35(5): 511-526.
57) Naro A, Bruno R, Leo A, Russo M, Salviera C, Bramanti A, Bramanti P, Calabrò RS. Twist and turn into chronic disorders of consciousness: Potential role of the auditory stapedial reflex. Restor Neurol Neurosci. 2017; 35(1): 77-85.
58) Leo A, Naro A, Cannavò A, Pisani LR, Bruno R, Salviera C, Bramanti P, Calabrò RS. Could autonomic system assessment be helpful in disorders of consciousness diagnosis? A neurophysiological study. Exp Brain Res. 2016 Aug; 234(8): 2189-99
59) Ciodaro F, Mannella VK, Nicita RA, Cammaroto G, Bruno R, Galletti B, Freni F, Galletti F. Therapeutic efficacy of the Galletti-Contrino manoeuvre for benign paroxysmal positional vertigo of vertical semicircular canals in overweight subjects. Eur Arch Otorhinolaryngol. 2018 Oct; 275(10): 2449-2455.
60) Naro A, Leo A, Cannavò A, Buda A, Bruno R, Salviera C, Bramanti P, Calabrò RS. Audiomotor Integration in Minimally Conscious State: Proof of Concept! Neural Plast. 2015; 2015: 391349
61) Mento C, Galletti F, Freni F, Longo P, Testini G, Rizzo A, Settineri S. The role of temperament in traumatic hearing loss: a single case study of a cochlear-implanted patient. Int J Adolesc Med Health. 2016 Feb; 28(1): 107-13.
62) De Salvo S, Bonanno L, Giorgianni R, Muscarà N, Freni F, Caminiti F, Milardi D, Bramanti P, Marino S. Functional MRI and laser-evoked potentials evaluation in Charcot-Marie-Tooth syndrome. Neurol Sci. 2018 Jul; 39(7):1185-1189.
63) Puccio G, Giuffré M, Piccione M, Piro E, Malerba V, Corsello G. Intrauterine growth pattern and birthweight discordance in twin pregnancies: a retrospective study. Ital J Pediatr. 2014 May 5; 40:43.
64) Viaggi CD, Cavani S, Pierluigi M, Antona V, Piro E, Corsello G, Mogni M, Piccione M, Malacarne Characterization of a complex rearrangement involving chromosomes 1, 4 and 8 by FISH and array-CGH.M. J Appl Genet. 2012 Aug; 53(3): 285-8
65) Galletti B, Gazia F, Freni F, Nicita RA, Bruno R, Galletti F. Chronic Otitis Media Associated with Cholesteatoma in a Case of the Say-Barber-Biesecker-Young-Simpson Variant of Ohdo Syndrome. Am J Case Rep 2019; 20: 175-178

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