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Term newborn at risk for Early Onset Neonatal Sepsis: clinical surveillance versus systematic paraclinical test

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Abstract

Introduction

Early onset neonatal sepsis is a rare but potentially lethal affection which is very often suspected. Previous national guidelines recommended the use of systematic paraclinic tests for healthy newborns with suspected infection. These guidelines have been updated in 2017 by the French Haute Autorité de Santé, and promote initial clinical monitoring taking into account the infectious risk level for term and near term born infants.

Objectives: To assess the impact of the new recommendations on antibiotic therapy prescription and on the outcomes of infants born from 36 weeks gestation.

Materials and methods

This study compared the management and the outcome of neonates born from 36 weeks gestation in the level III University Hospital of Nancy, according to their infectious risk level during two periods, before and after the update of national recommendations: from July 1st to December 31st 2017, versus July 1st to December 31st 2018. Data were retrospectively collected in the infants' file. This study compared mortality, the number of documented infections, the number of invasive tests, the number and length of hospitalization between the two periods.

Results

During the first period, among 1248 eligible newborn, 643 presented an infectious risk factor, versus 1152 newborn with 343 having an infectious risk factor during the second period. Antibiotic treatment was initiated for 18 newborns during the first period (1.4%) and 9 during the second (0.8%) ($p = 0.13$). The mean (SD) duration of the antibiotic treatment was longer in the first than in the second period: 6.3 +/- 2 days, vs 3.1 +/- 2.3 days ($p = 0.003$). There was no death related to neonatal infection. One thousand and fifty-two blood samples were done in the first period versus 51 in the second ($p < 0.01$). There was no documented infection. In the

first period, there were 18 newborns (1.4%) hospitalized for suspicion of infection versus 9 (0.8%) in the second (p = 0.13). The duration of hospitalization was 5.7+/- 1.7 days in the first period versus 5.2 +/- 3 days in the second (p = 0.33).

Conclusion

The application of the new guidelines enables a reduction of antibiotic exposure without additional risk.

Keywords: Early onset neonatal sepsis, Clinical management, term neonates, antibiotics.

1. Introduction

Early onset neonatal sepsis (EOS) is a rare but serious disease occurring within the first 72 hours of life. It is caused by bacterial pathogen transmitted to the infants during labor or delivery, identified in blood or cerebro-spinal fluid culture [1]. In term neonate, group B Streptococcus (GBS) is the most common etiologic agent [2].

The incidence is rare, estimated at 0.01 to 0.5/1000 newborn in France [3], but with potentially serious to lethal consequences. Term newborn's mortality is estimated at about twelve percent and higher for preterm neonate [4].

In France, guidelines for the management of suspected EOS were published in 2002 by the Agence Nationale d'Accréditation et d'Évaluation de la Santé [5]. Accordingly, many systematic blood and bacteriological tests used to be performed in newborns when an infection risk factor was identified. Several variations in practice were then observed and many asymptomatic newborns received unnecessary antibiotic therapy in intensive care units. Excessive antibiotic exposure is associated with consequences on the bacterial ecosystem of each newborn, the risk of promoting multidrug resistant bacteria, the separation of the mother-child dyad and the additional cost of hospitalization [6]. Thus, experts in neonatology and pediatric infectious disease of the Haute Autorité de Santé (HAS) have updated the recommendation in 2017 [7]. Recommendations for the management of neonates now consist mainly in close clinical monitoring defining specific risk levels.

The main objective of this study was to assess the impact of the new HAS recommendations on antibiotic therapy administration to infants born from 36 weeks gestation in every day practice.

The secondary objectives were to evaluate the compliance to the new guidelines, and then to compare, before and after using the new guidelines, the outcome of the infants: mortality, the

number of documented infections, the number of invasive tests, the number and length of hospitalization.

2. Methods and population

2.1. Type of study

This was an observational, retrospective comparative cohort study with a before-after design. The study was performed at the level III Maternity Hospital of the CHRU of Nancy (FRANCE), in three units of hospitalization: delivery room, postpartum and neonatology units.

2.2. Study design

During the first 6-month period, from July 1st to December 31st 2017, the previous ANAES guidelines were the gold standard [5]. This period was followed by a 6-month washout period to prevent a recruitment bias and allow for education of the caregivers about the new guidelines of the HAS [7]. Then, infants born from July 1st to December 31st 2018 were studied following the new HAS guidelines.

2.3. Inclusion/exclusion criteria

All inborn neonates from 36 weeks gestation (GA) were included. Outborns were excluded from this study.

2.4. First period: year 2017

Risk factors were classified in two groups, minors and majors, defining which exams to perform according to the ANAES guidelines.

Major risk factors were : suspicion of chorioamnionitis (not precisely defined), twin infected, maternal fever before or during labor ≥ 38°C, spontaneous prematurity ≤ 35 weeks gestation, prolonged rupture membrane ≥ 18 hours incomplete maternal GBS prophylaxis, history of GBS infection in previous pregnancy, vaginal or urinary GBS maternal colonization.

Minor risk factors were : prolonged rupture of membrane between 12 and 18 hours, spontaneous prematurity between 37 and 35 weeks gestation, fetal tachycardia, fetal cardiac rhythm abnormalities or unexplained bad neonatal adaptation, dyed or meconial amniotic fluid.

Biological and bacteriological samplings were systematic if one major risk factor or two minor risk factors were observed.

Infection was quoted “certain” when a bacteria was isolated in a blood sample or in the cerebrospinal fluid, associated with clinical signs.

Infection was quoted “probable” when there were clinical signs or biological abnormalities consistent with bacterial infection but no bacteria isolation. In that situation, neonates were hospitalized and received intravenous antibiotic therapy lasting at least 5 days.

When a pathogen was isolated in the gastric fluid, without any clinical or biological anomaly, the situation was quoted “colonization”.

2.5. Second period: year 2018

Management of EOS followed the HAS guidelines [7].

Risk factors were : GBS maternal colonization (vaginal or urinary), except in case of caesarian section out of labor and with intact membranes, history of neonatal GBS infection in a previous pregnancy, prolonged rupture of membranes longer than 12 hours, spontaneous birth before 37 SA, and maternal fever ≥ 38°C per partum and up to 2 hours after delivery.

When a risk factor for EOS was identified, newborns were classified according to the risk level and clinical management adjusted. There were 3 groups: A, B and C; A being the lowest risk and C the highest.

The group A included newborns whose mother received adequate antibiotic prophylaxis, for the following infectious risk factors: GBS maternal colonization (vaginal or urinary), except in case of caesarian section out of labor and with intact membranes, history of neonatal GBS

infection in a previous pregnancy, prolonged rupture of membranes longer than 12 hours, spontaneous birth before 37 SA.

The group B included newborns whose mother received inadequate antibiotic prophylaxis for previous risk factors, or those whose mother received adequate antibiotic therapy in the context of maternal fever ≥ 38°C per partum and up to 2 hours after delivery.

The group C included newborns whose mother received inadequate antibiotic therapy in context of maternal fever.

Antibiotic prophylaxis is considered adequate when given intravenously, with an initial dose of two grams, at least four hours before delivery, using penicillin G, ampicillin, amoxicillin or cefazolin.

The midwife in the delivery room had to evaluate the group and to indicate this group into the files of mother and newborn. A systematic program of clinical monitoring was then conducted by midwives and nurses, according to the group.

A pediatrician was soughed to guide in the adequate unit all newborn classified in group C.

In group A, the usual simple clinical monitoring was realized in post-natal unit. There was no discharge before 48 hours of life.

In group B, a standardized grid was used, based on possible clinical signs of neonatal infection during 48 hours: checked every 4 hours during day 1 and every 6 hours during day 2 (annex I). The grid was filed by the midwife or paramedic in charge of the mother and her child in post-natal unit, both previously trained for taking care of newborns at risk for EOS. This grid had to be added to the medical file.

In group C, the same standardized grid as in group B was necessary, with the same modalities. In this group, infants had a systematic clinical examination by a pediatrician between 6 and 12 hours of life.

2.6. Data collection

Inclusions were retrospective and data related to the neonatal period were collected from the medical files of the mothers and infants. The data were anonymized.

2.7. Statistics

Descriptive data were presented as median values and interquartile ranges and/or mean with standard deviation. Comparison between groups was performed by bivariate analysis with Mann and Whitney U test for the continuous variables and Chi 2 test for the discontinuous variables. A p value below 0.05 was chosen to indicate statistical significance. Statistical analyses were performed using SYSTAT 13 software (2009; Systat Software Inc., San Jose, California, USA).

2.8. Ethics

This retrospective observational study was performed in accordance with the methodology MR003, developed by the French commission of data protection and approved in the CHRU of Nancy. Parents were systematically informed and provided written consent for the possible use of medical information about their children at the time of birth.

3. Results

3.1. Descriptive analysis of the population

During the first period of the study 1248 newborns were evaluated; 643 (51% of births) had risk factors for EOS. Median (min ; max) GA was 39 weeks (36 ; 42) weeks; 50.4% of these infants were males. One hundred and twenty-three mothers presented with GBS colonization (9.8%).

During the second period, 1152 newborns were evaluated; 343 (29% of births) had risk factors. Median GA was 39 (36 ; 42), and 58.1% were males. Among the 343 newborns

presenting risk factors, 165 were in group A, 153 in group B, and 25 in the group C. One hundred and twenty-three mothers presented with GBS colonization (10.6 %).

Caesarian section was performed for 11.7% of births during the first period, and 9.9 % of births during the second period.

3.2. Postnatal antibiotic therapy

Antibiotic treatment was initiated for 18 newborns during the first period (1.4%), and nine during the second period (0.8%) (p = 0.13). The mean (SD) duration of antibiotics was higher in first period comparing to the second period: 6.3 +/- 2 days (p = 0.003), vs 3.1 +/- 2.3 days.

3.3. Compliance to guidelines (HAS)

3.3.1. Compliance to ranking

The classification of the risk level was inappropriate for 28 newborns. Among them, 22 were not classified at all, whereas they presented risk factors for EOS (1.9% of the total population). Eleven of 28 (39%) belonged to group A, 9 to group B (32%) and 2 to group C (7.1%). Group error was observed for 6 newborns (1.7 % of the population with risk factors). Sixteen infants with classification error were hospitalized in the neonatal intensive care unit (NICU) for other reasons.

3.3.2. Compliance to postnatal surveillance

A grid of monitoring was used, as required in group B and C, for 146 files (82% of those expected). All of the required items was noted in 129 cases (88.3%). Reasons for inappropriate monitoring were: 12 of them changed of group after initial decision (27.5%), 2 infants were directly hospitalized at birth (5%), no risk level was noted on the grid in 6 cases (15%), no traceability of paramedic visits was realized in 11 cases (27.5%) and there was an unknown reason in 10 cases (25%).

Systematic pediatric exam in group C infants was performed to 18 newborns (82% of newborns classified in group C). The medical exam was not performed for three infants, the last one being watched according to the older protocol.

Nine newborns were examined by a pediatrician for clinical signs, four of them had at least one blood sample to search for biological sign of infection (CRP) after this exam and none was hospitalized after it.

3.4. Comparative analysis

3.4.1. Mortality

There was no mortality related to EOS, during the study period.

3.4.2. Number and duration of hospitalization for suspected EOS

There were more newborns hospitalized for suspicion of infection in the first than in the second period (18 (1.4%) vs 9 (0.8%) $p = 0.13$).

The duration of hospitalization was slightly longer in the first than in the second period (5.7+/- 1.7 days versus 5.2 +/- 3 days, $p = 0.33$).

3.4.3. Documented EOS

Eleven newborns had probable infection and 123 newborns had colonization in the first period of the study. There was no documented infection during the second period of the study.

3.4.4. Invasive tests

One thousand and fifty-two blood samples were done in the first period versus 51 in the second period ($p < 0.01$). During the first period, 332 newborns (26.6% of all newborns) had at least one blood sample vs. 15 newborns (1.3% of all newborns) ($p < 0.05$) during the second period.

With regards to blood culture, 25 were realized in the first period, and 9 in the second period ($p = 0.29$). Gastric fluid examination was realized for 622 newborns in 2017 (96.7%) and for 1 newborn in 2018 (0.3%) ($p < 0.05$).

4. Discussion

This observational study conducted for newborns from 36 weeks gestation confirms that the clinical surveillance of neonates at risk for EOS according to the new HAS guidelines is appropriate. These recommendations result in lower duration of antibiotics, a trend to lower prescription of antibiotics and much lower unnecessary invasive tests.

The difference between the number of antibiotics prescriptions is not significant between the 2 periods. This may be related to a too small population because of the low prevalence of EOS in that population. Also, we observed no difference in mortality, which indicates that the monitoring seems safe in the studied population.

Of note, with the changes in risk factor definition, the population of neonates at risk for EOS appears to be different between the 2 periods (643 vs 344 neonates). With regards to previous studies, the number of neonates with risk factors, before using new guidelines, was already low [8]. With more specific risk factors [9], as defined in the new HAS guidelines, the population at risk requiring thorough clinical monitoring has decreased widely.

During the second period, we noted classification errors for 28 newborns (2.4%). The majority was the absence of ranking for 22 patients (1.9%). This could have potential dramatic consequences as clinical surveillance is the only way to detect sick newborns. However, half of the neonates concerned with ranking problem were actually hospitalized in a neonatal unit immediately after birth, which explain the lack of ranking as they were already continuously monitored. Therefore, the clinical surveillance, as proposed in the recommendations, is mandatory and needs to be reinforced to improve the nurses' clinical surveillance.

We noted a lot of neonates in group B, which suggests inappropriate antibiotic therapy before labor. This involves higher risk of infection and overload of work in the following 48 hours,

to supervise the infant with the grid. We have to insist on the importance of this prophylaxis at the obstetricians' level [10, 11].

The grid is adapted to the multiple unspecific signs of infection. It was easily adopted by the healthcare givers involved in the clinical monitoring. The grid was well filled except for some exams missing at some time points. Again, some exams were also missing when children were hospitalized in a neonatal unit. The computerization of this grid would probably lead to a more rigorous filling and avoid lack of information that was observed during the study.

Pediatric exam for group C neonates was mostly realized as requested in the recommendations. The only cases of missing medical exam were symptomatic newborns hospitalized and treated early after birth. However, this systematic clinical exam has to be done between 6 and 12 hours of life which confers little flexibility in terms of organization, including on-call periods.

As expected, the number and duration of hospitalizations had a trend to be less important thanks to the change of practice. This should reduce the rate of mother-to-child separation and promote breastfeeding.

In our population, the rate of antibiotic therapy was 1.4% in the first period and 0.8% in the second period which is consistent with the literature. Cantoni, in his prospective study in 2013, compared two periods [12]. In the first one, a biological exam was done to every asymptomatic newborn after the Centers of Disease Control and Prevention's (CDC) recommendations risk factors (blood count and blood culture). In the second period, only a clinical exam was done until 48 hours of life. The rate of antibiotic therapy in the first period was 1.2% vs 0.5% in the second period ($p < 0,01$). Moreover, several studies showed that asymptomatic term newborn at risk for infection can be monitored with clinical criteria. In those studies, no infection was found in asymptomatic newborn [13-15]. Antibiotics early in life have long term side effects that are well described. They disturb the microbiota colonizing

the neonate and might be associated with important health problems and self-immune pathologies such as eczema and allergies [16, 17]. Thus, indications of antibiotic treatment have to be as specific as possible. When reasonably administered, the probabilistic antibiotic treatment has to target the most common germ responsible for newborn infections which is GBS. In addition, antibiotic treatment has to be as short as possible. Indeed, reducing neonatal exposure to antibiotic could reduce bacterial selection pressure [18]. The bacterial selection pressure is responsible for emergence of bacteria resistant to antibiotics, especially gram-negative pathogens [19, 20]. Thus, appropriate antibiotic prescription is indeed a public health problem and an ecological medical unit problem.

Maintaining an appropriate compliance to the recommendations is a challenge because of the low prevalence of EOS [3]. With no EOS documented up till now in our population with risk factors, care givers could minimize the importance of strict monitoring. All the staff involved in the surveillance of neonates has to stay vigilant.

Many clinical signs for EOS are not specific and can be observed in non-infectious situation. Therefore, following the grid, which also take into account the evolution, is mandatory.

As expected, the number of additional exams was significantly reduced in the second period. In Sikias's study in 2013, 54% babies had a bacteriological gastric sample at birth and 25% had a blood sample [8]. In our study, 50% of all newborns of the first period had a bacteriological gastric sample at birth and 26.6 % had at least one blood sample. With the new recommendations, the only babies requiring blood sampling are those presenting suspect clinical signs of EOS. No gastric sampling is performed anymore, as recommended.

Our study has strength and limitations. When starting new recommendations, we chose to apply them to newborns from 36+0 weeks gestation, and not from 34+0 weeks gestation [7]. We wanted to evaluate the safety and feasibility of the guidelines first, before involving late premature infants. Indeed, preterm population is twice more at risk for EOS and is more

vulnerable than term population [21]. In addition, in our maternity hospital 34 to 36 weeks gestation infants are mostly hospitalized and monitored for a few days in a Neonatology Unit which is different from term infants. This is a retrospective study, and data were collected on files. Some informations are missing due to a lack of transcription. However, strength is the number of patients included in each cohort with a before-after design and a washout period allowing good representativeness of the study.

For the future, new diagnostic tools are developed: GBS DNA-based real time PCR is available [22, 23] to detect a GBS vaginal colonization during labor, which could help for a better screening of the infectious risk. It has a good negative predictive value (NPV) of 92% and could have an impact on intrapartum antibiotic prophylaxis (IAP) because 10% of prenatally GBS-negative women were positive during labor and missed IAP and 50% of prenatally GBS-positive women were negative during labor and received IAP [23].

In the same time, use for more specific biomarkers is studied, as PCT dosed on cord blood [24, 25]. Those complementary strategies might be additional tolls in the future, to enhance the clinical exam sensibility.

5. Conclusion

Our study confirms that clinical surveillance of neonates over 36 weeks gestation at risk for EOS, according to new guidelines, is safe and associated with lower invasive biological tests and lower duration of antibiotics. However, the unspecific character of the clinical signs of EOS implies the greatest attention of all the medical and paramedical staff. New diagnostic tolls are developed that might enhance the clinical exam sensibility.

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Annex 1

GRILLE DE SURVEILLANCE CLINIQUE POUR EVALUATION DES NOUVEAU-NES A RISQUE D'INFECTION NEONATALE BACTERIENNE PRECOCE(INBP)

A remplir par l'auxiliaire puériculture ou sage-femme ou infirmière
Si signe absent : mettre 0. Si signe présent : mettre 1 croix, et appel du pédiatre.

Groupe à risque

INBP :

Etiquette enfant
Date et heure de naissance : **Chambre maman** :

Heure précise	H4=	H8=	H12=	H16=	H20=	H24=	H30=	H36=	H42=	H48=
Nom de soignante										
Température : < 36 ou >37.9°C										
Fréquence cardiaque: au calme < 80 ou >160 bpm										
Signes respiratoires										
Tirage										
FR >60 /mn										
Geignement										
Apnée										
Cyanose										
Signes hémodynamiques										
Teint pâle ou gris										
Marbrures										
Signes généraux										
Somnolence, irritabilité, hypotonie										
Vomissements ou refus de boire										
Appel du pédiatre Nom du pédiatre										

Prévenir le pédiatre

- Si une croix est cochée dans une case
- devant tout signe clinique ou tout changement de comportement du NN

- *jours ouvrables appeler un pédiatre de maternité sur leur Bip ou 21506*
- *la nuit, W end et jours fériés, appeler la réanimation : poste 43635, 44456 ou 44609.*