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Implementation of epidural analgesia for labor: is the standard of effective analgesia reachable in all women? An audit of two years

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Abstract. – BACKGROUND: Social and cultural factors combined with little information may prevent the diffusion of epidural analgesia for pain relief during childbirth. The present study was launched contemporarily to the implementation of analgesia for labor in our Department in order to perform a 2 years audit on its use. The goal is to evaluate the epidural acceptance and penetration into hospital practice by women and care givers and safety and efficacy during childbirth.

PATIENTS AND METHODS: This audit cycle measured epidural analgesia performance against 4 standards: (1) Implementation of epidural analgesia for labor to all patients; (2) Acceptance and good satisfaction level reported by patients and caregivers. (3) Effectiveness of labor analgesia; (4) No maternal or fetal side effects.

RESULTS: During the audit period epidural analgesia increased from 15.5% of all labors in the first trimester of the study to 51% in the last trimester ($p < 0.005$). Satisfaction levels reported by patients and care givers were good. A hierarchical clustering analysis identified two clusters based on VAS (Visual Analogue Scale) time course: in 226 patients (cluster 1) VAS decreased from 8.5±1.4 before to 4.1±1.3 after epidural analgesia; in 1002 patients (cluster 2) VAS decreased from 8.12±1.7 before (NS vs cluster 1), to 0.76±0.79 after ($p < 0.001$ vs before and vs cluster 2 after). No other differences between clusters were observed.

CONCLUSIONS: Present audit shows that the process of implementation of labor analgesia was quick, successful and safe, notwestanding the identification of one cluster of women with suboptimal response to epidural analgesia that need to be further studies, overall pregnant womens'adhesion to labor analgesia was satisfactory.

Key Words:
Implementation, Epidural analgesia, Neuraxial analgesia, Audit, Labor, Childbirth pain, Cluster analysis, VAS.

Abbreviations

EA = Epidural Analgesia
BP = blood pressure
HR = heart rate
SaO_2 = arterial oxygen saturation

Introduction

"*In dolore paries filios*", "In pain you will bring forth children" (Gen. 3-16). The biblical citation confirms the association between labor and pain, an unchanged conviction until the era of obstetric anesthesia began with the first administrations of ether or chloroform during childbirth (Snow, 1853)[1-2]. Nowadays, there is worldwide agreement that pain, when unrelieved, may have adverse effects on the course of labor and maternal and fetal wellbeing[3,4]. Pain relief during labor is safe and helpful and Epidural Analgesia (EA) is the only available consistently effective technique of pain control[5]. A joint statement by the American Society of Anesthesiologists and the American College of Obstetricians and Gynecologists[6] asserts that maternal request is a sufficient medical indication for pain relief during childbirth and that pain management should be provided whenever medically indicated[7]. Nevertheless, social and cultural factors combined with little information still may prevent the diffusion of EA. Moreover, organizational deficiencies in the health system and local management may further delay its implementation into standards of care[8] in Obstetric Departments[9,10]. In our Department since February 2009 we have proposed EA to all pregnant women in accordance to a region-

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al project, included in the National Essential Levels of Assistance. The present study was launched contemporarily to the implementation of analgesia for labor in our Department in order to perform a two-years audit on its use. The goal was to evaluate the epidural acceptance and implementation into hospital by women and care givers and to evaluate safety and efficacy during childbirth.

Patients and Methods

This study protocol was approved by the local Ethics Committee. From February 2009 to February 2011 a prospective audit of pregnant women undergoing EA was carried out in our University Hospital. On the 36th-38th gestation week, every pregnant woman underwent a medical examination by a staff anesthesiologist and a preliminary written consent was obtained. After the admission, all patients were approached by a resident anesthesiologist, their compliance with inclusion criteria [ASA 1 or 2, ≥ 36 weeks of gestation, cervical dilatation > 5 cm, baseline VAS (Visual Analogue Scale) score > 5 (scale 1:10)] and exclusion criteria (inability or unwillingness to give informed consent, any contraindication for EA or allergy to study drugs) was checked, and the request finalized. Baseline measurements of pain, blood pressure (BP), heart rate (HR), arterial oxygen saturation (SaO_2) were taken. After epidural catheter insertion, a main dose of fentanyl (100 γ) and levobupivacaine (0.0625%) diluted with isotonic sodium chloride solution to a volume of 15-20 ml was injected. Additional doses were administered at hourly intervals on request. Two hours after childbirth, the epidural catheter was removed. EA's primary endpoint was the decrease in VAS pain score at 30 min. If analgesia was inadequate, a 'rescue' bolus was administered and repeated up to two times at 15 min intervals if required, or as a last resort the catheter was repositioned. In all patient the following outcomes were recorded on a dedicated database: demographics, number of pregnancy, spontaneous or induced labor, pain intensity by means of a 10 point VAS scale, maternal and fetal HR, mean BP, Apgar at 1' and 5', switch to cesarean section or need for instrumental delivery in addition to continuous cardiotocography. A proforma (available on request) was designed to collect relevant data from clinical notes of EA users across the audit cycle to measure performance against our standards: 1st Implementation of epidural analgesia for labor to all patients; 2nd Acceptance and good satisfaction level reported by patients and caregivers; 3rd Effectiveness of labor analgesia; 4th No maternal or fetal side effects.

Statistical Analysis

Data are reported as mean ± standard deviation (SD) or 95% confidence limits, as appropriate. Demographics were analyzed with χ^2 or Fisher exact test for categorical data, nonpaired, two-tailed Student's *t*-test for continuous data, and with Mann-Whitney U-test for non-parametric data. Cluster analysis was used to categorize patients: first a joining analysis (tree/hierarchical clustering) was performed to evaluate how many "natural" clusters were formed by our patients, afterwards the *k*-mean clustering method was applied on the basis of this number of clusters to assign observations to each cluster. Cluster analysis was conducted using % VAS scores reduction after the first epidural administration such that the clusters that emerged were distinct in terms of analgesic response. The next step was to use repeated measures one-way ANOVA to examine whether clusters were significantly different in terms of age, parity, numbers of instrumental deliveries or switches to caesarean section, children Apgar score at 1' and 5'. $p < 0.05$ was the minimal value accepted as statistically significant. All statistical calculation were performing using StatSoft, Inc. (2010), STATISTICA (data analysis software system), version 8.0. www.statsoft.com.

Results

Patients demographic data are reported in Table I. During the 24 months of this study there were 5710 labors: 3618 vaginal deliveries (63%) and 2092 cesarean sections (37%). EA were 1236 (22% of all labors). In 96 patients (7.7% of EA) a switch to cesarean section was indicated because of not reassuring cardiotocogram, dystocia, uterine hypertonus or prolonged and repeated decelerations. In 45 patients (3.6% of EA) instrumental delivery was performed after fetus progression failure or maternal fatigue, dystocia, inefficient pushing, shortness of the umbilical cord, or umbilical cord wrapped around the neck. No maternal or fetal hemodynamic complications were recorded. Our audit cycle included 1236 patients undergoing

Table I. Patients demographical characteristics of women undergoing analgesia for labor.

Number of pregnant women	1236
Age (years ± SD)	30.21 ± 5.4
Primiparous:	
Number	935
Age (years ± SD)	29.5 ± 5.3
Spontaneous Labor (N)	655
Induced Labor (N)	210
Pluriparous:	
Number	265
Age (years ± SD)	32.8 ± 5.3
Spontaneous Labor (N)	190
Induced Labor (N)	52
HR (Maternal – Pre 1st admin) bpm	86.6 ± 11.3
HR (Maternal – Post 1st admin) bpm	85 ± 29.8
HR (Fetal – Pre 1st admin) bpm	137.3 ± 12
HR (Fetal – Post 1st admin) bpm	133.4 ± 12
mBP (pre)	94.05 ± 9
mBP (post 1st administration) mmHg	91.2 ± 9
VAS (pre)	8 ± 2
VAS (post 1st administration)	1.9 ± 1.9
APGAR 1'	8 ± 0.6
APGAR 5'	9 ± 0.4
Cesarean section (N)	96
Strumental (N)	45

Values are means ± SD or number as appropriate:VAS: Visual Analog Score Bishop' score: Prelabor scoring system to assist in predicting wheter induction of labor will be required.

EA during the two years of this study; moreover, 32 completed set of questions were obtained by gynecologists (n. 17) and midwifes (n. 15) to evaluate their satisfaction level. In the following, our results are compared to the four standards of care stated previously.

Standard 1st: We proposed EA to all pregnant since February 2009. Overall 1236 patients choose EA: this is the first important result. In fact, the percentage of EA acceptance gradually increased from 15.5% of all vaginal deliveries in the first trimester of the study to 51% in the last trimester ($p < 0.005$; Figure 1), while the percentage of cesarean section decreased from 38% to 35%.

Standard 2nd: Satisfaction level reported by patients, gynecologists, and midwifes was very good (Table II). The EA was suggested to all patients and operators found positive differences during and post childbirth compared with women not accepting EA (Table II). Moreover, all midwifes agreed with the importance of the role of the anesthesiologist to give information to pregnant women, because of the absence of social and cultural awareness of EA.

Standard 3rd: Overall the first VAS recorded before any epidural administration was 8±2 and it decreased to 1.9±1.9 after the first administration ($p < 0.001$). However, the hierarchical clustering analysis identified two clusters based on the identification of pain perception after the first epidural administration (Table III, Figure 2). The k-mean cluster analysis allowed us to identify members of each cluster for the subsequent ANOVA, which confirmed a significant difference in mean VAS time course between the clusters (Figure 3). In 226 patients (Cluster 1) VAS decreased from 8.5±1.4 before the first epidural administration to 4.1±1.3 afterwards ($p < 0.001$), while in 1002 patients (Cluster 2) VAS was 8.12±1.7 before (NS vs Cluster 1) and decreased to 0.76±0.79 after ($p < 0.001$ vs before and vs Cluster 1 after). Eight patients were excluded from the analysis because their data were incomplete. Moreover, in all patients of Cluster 1 VAS after the first epidural administration was > 3. In total, 168 women gave birth after the first epidural drug administration. The remaining 1060 patients (209 from cluster 1 and 851 from cluster 2) underwent on average 2.8±1.3 additional epidural administrations; these patients had the same response to EA: residual pain after the 2nd epidural administration (VAS%) was always higher in cluster 1 patients (Table III) ($p < 0.001$ vs cluster 2 recorded at same time). No differences between clusters were observed with regards to other data recorded.

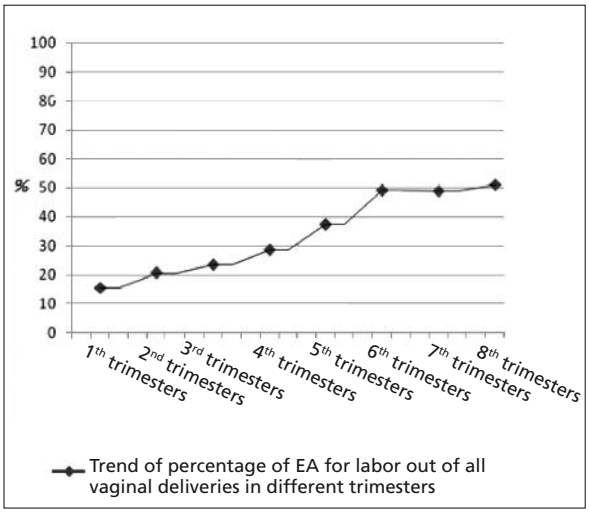

Figure 1. Percentage of analgesia for labor. The figure show the trends of childbirth analgesia numbers out of all vaginal deliveries in the different trimesters of the study.

Table II. Set of questions – results of obstetricians and gynecologists.

	Midwifes	Gynecologists
Number	15	17
Satisfaction level reported about EA [score: 1 to 10]	9 ± 1.4	
Do you recommend EA to all patients?		
Yes	12	15
Sometimes	2	2
No	1	0
Did you notice a positive difference during partum with EA		
Yes	13	15
Sometimes	2	2
No	1	0
Did you notice a positive difference in postpartum with EA		
Yes	7	8
Sometimes	4	7
No	4	2
Is usefulness for pregnant the colloquium with anesthesiologist? (O*nly midwifes*)		
Yes	11	NA
No	4	NA

Standard 4th: Children APGAR was 8±0.6 at 1' and 9±0.4 at 5' (NS). We found rare complications: headaches occurred in 0.5% of cases 24-48 hours after birth, and itching (facial or generalized but transient). We didn't find other common complications described in the literature[1].

Discussion

The main result of the present audit is that EA was proposed to all patients, with a good acceptance and penetration into hospital practice and positive feedback from parturients, gynecologists and midwifes in absence of side effects (*standard 1, 2, 4*). This is an important result because in the literature it has been widely underlined that implementing labor analgesia *ex novo* can present some difficulties due more to cultural factors than to organizational changes[12,13]. Cammu et al[14] showed that labor, cesarean section, instrumental delivery, and EA frequencies were inversely related to the level of maternal education. Moreover, the choice of labor analgesia also includes the choice of the method: immersion in water, relaxation, acupuncture, massage, local nerve blocks or non-opioid drugs, hypnosis, biofeedback, sterile water injection, aromatherapy, and

Table III. Demographic and clinical data of the two cluster identified.

Data	Cluster 1	Cluster 2	Significance
Age (years)	30.8 ± 5.3	29.9 ± 5.3	NS
Admnistration No	2.9 ± 1.2	2.7 ± 1.2	NS
Bishop	7.2 ± 1.7	7.2 ± 1.5	NS
VAS1	8.5 ± 1.4	8.1 ± 1.6	NS
VAS after 1st administration	4.1 ± 1.3	0.7 ± 0.7	$p < 0.001$
VAS2 (%)	31.3 ± 23.2	17.7 ± 18.5	$p < 0.001$
VAS3 (%)	25.9 ± 25.1	18.4 ± 19.1	$p < 0.001$
Labor duration (min)	190.6 ± 126.8	213.6 ± 143.5	NS
HR fetal (bpm)	99.4 ± 9.3	100.2 ± 36	NS
APGAR 1 (mean ± ST)	7.9 ± 0.7	7.8 ± 0.7	NS
APGAR 5 (mean ± ST)	8.8 ± 0.4	8.8 ± 0.4	NS

VAS 1: Visual Analogue Scale at first administration; VAS 2 (%): VAS at second administration (mean and ST); VAS 1 (%): VAS at third administration (mean and ST). Bishop' score: Prelabor scoring system to assist in predicting wheter induction of labor will be required.

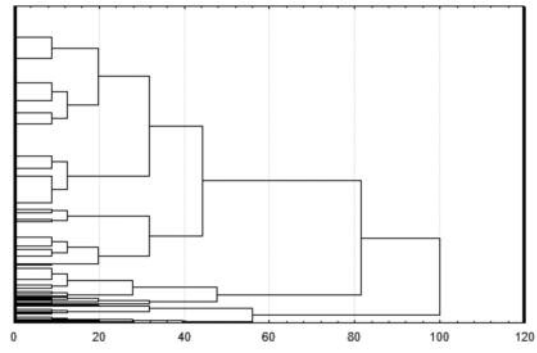

Figure 2. Clustering of patients. The figure shows the dendrogram of hierarchical agglomerate clustering: y-axis = cases (Each row on the y-axis represent 1 patient, because of the limited resolution of the dendrogram, cases were not labeled); x-axis = distance linkage (dlink) between patient clusters standardized against the maximal distance (dmax). Highly correlated clusters are nearer to the left side of the dendrogram, less correlated clusters are more distant from the left axis. As they move right in the dendrogram, clusters get bigger: each vertical line represent a merge, the x-coordinate of the vertical line represents the similarity of clusters that were merged. By moving up from the left layer to the right node, the dendrogram allows to reconstruct the history of merges that resulted in the depicted clustering.

parenteral opioids have all been proposed[15]. However, these alternative methods are less effective than EA, which remains the most common method of pain relief used during labor[16-17].

In many countries today, the availability of regional analgesia for labour is considered a reflection of standard obstetric care. According to the 2001 survey, the epidural acceptance is up to 60% in the major maternity centres of the America: 95.2% of labors in the USA and 90.6% in Canada[17,18].

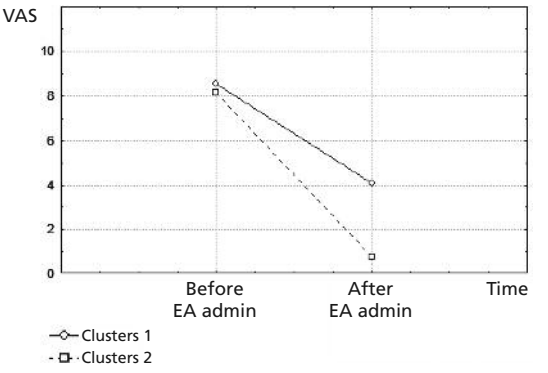

Figure 3. VAS Time Course. The figure shows the VAS time course before and after the first epidural administration in the two clusters.

The National Health Services Maternity Statistics of 2005-2006 in the UK reported that one-third of the parturients chose epidural analgesia[18]. In our Hospital to improve EA, we changed our Department organization: 18 physicians and residents followed the obstetrics service day and night. The positive feedback from parturients was encouraging, as confirmed by the progressive increase of childbirth analgesia performed throughout the audit period (Figure 1). Selection of patients who are likely to benefit from EA, strict precautions, optimal technique, close monitoring, and assistance from an acute pain team have reduced the occurrence and consequences of serious complications[19].

With regards to standard 3, we detected the presence of 2 different clusters, based on the values of VAS recorded after EA administration. While 80% of patients showed a good answer to EA with reduction of VAS ≥ 90% (Cluster 1), the remaining 20% in Cluster 2 showed suboptimal pain control, with a VAS always > 3. Interestingly, the same answer to analgesic drugs was observed in these patients when undergoing 2 or more EA administrations. Since no other difference was found between the clusters we propose a few hypotheses to explain this point: (1) Technical factors related with epidural catheter positioning may influence block success: a far lateral catheter position is a more common cause of asymmetric block[20] because posterior midline structures play a role in impeding the distribution of injectate. We cannot specify if this was a problem for our cluster 1 patients because we couldn't control the catheter tip position at RMN, however our data are comparable with literature that reports a 27% failure rate for incorrect positioning[21]; (2) the main determinant of epidural action is the dose of local anesthetic, with injected volume playing a minor role[22]. Pharmacodynamics studies found that adequate analgesia may be achieved with minimal drug doses in order to reach minimal risks[23] as we use in our protocol. However, data in literature report 30% of patients who present a suboptimal response to EA with such low doses[24]; (3) Intravenous oxytocin infusion is often used as a treatment for dystocia together with amniotomy, and its administration is started immediately after dystocia is identified[24]. In the literature there is controversy over whether women receiving an oxytocin would report higher levels of pain and discomfort

during childbirth[25] and whether EA would prolong labor duration[26,27] and interfere with oxytocin requirement[28]. In our patients there was no differences in oxytocin augmentation rate nor in labor duration, but our data are in agreement with recent literature that widely demonstrates how there is no significant pain difference between women in spontaneous labor with EA and administration of oxytocin and women receiving a placebo[29,30]. Consequently, there are repercussions at each stage of childbirth, but not in its total duration; (4) Inter-individual difference in pain responses and in reporting of pain has been linked to genetic factors that may affect opioid efficacy[31]. Experimental data suggest that from 30 to 76%[32] of the variance in pain response is explained by genetic factors. In addition, gender is an important factor, as well: women typically report greater pain than men[33]. We recently demonstrated[34] that one of the most widespread single-nucleotide-polymorphism in the μ-1 opioid receptor gene, an exchange of the nucleotide adenine with guanine at position 118 (118A > G), with a prevalence in the Caucasian population of up to 16.5%[35], is associated with a decrease in the analgesic effect of opioids and affects postoperative pain response both in hetero- and homozygous carriers. The present study was not designed to investigate genetic factors influencing pain response, however, it seems likely that such innate factors may have played a role in the cluster of patients with a suboptimal response to EA.

Conclusions

As a result of the superior analgesia and maternal-fetal benefits afforded by neuraxial techniques and their improved safety, use of neuraxial labour analgesia has progressively increased. The process of implementation of this new procedures was quick, successful and safe as the present audit shows: pregnant womens' adhesion to labor analgesia increased significantly throughout the audit period, notwithstanding the presence of one cluster of women with suboptimal response to epidural analgesia, that need to be further studied but probably related to the occurrence of technical problems, analgesic drugs doses and/or interindividual pain threshold differences.

A re-audit is needed to better appraise the cluster with suboptimal response to analgesia and to evaluate how deep the labor analgesia practice penetrated into the standards of care. However, this work highlights the good results of EA and the good response at his gradual introduction in our Hospital. EA was a safe and efficacious method for pain relief during childbirth; moreover, with its implementation both gynecologists and midwifes became aware of how much pain, when unrelieved, can have adverse effects on the course of labor as well as on the fetal wellbeing[36]. This caused their activity to change and increased quality, safety, and efficacy. We can start to consider this type of analgesia applicable, effective, and acceptable, despite the risks that are always inherent in medicine. The introduction of new analgesia modality is difficult. However, positive results can change its acceptance among women and standard protocols for anesthesiologists, gynecologists, and midwifes.

Declaration of Interest

None of the Authors has a financial interest in any of the drugs, devices, or products mentioned in this article.

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