

Organisation of obstetric services for very preterm births in Europe: results from the MOSAIC project.

Béatrice Blondel, Emile Papiernik, D. Delmas, W. Künzel, T. Weber, R. F. Maier, L. Kollée, Jennifer Zeitlin

► **To cite this version:**

Béatrice Blondel, Emile Papiernik, D. Delmas, W. Künzel, T. Weber, et al.. Organisation of obstetric services for very preterm births in Europe: results from the MOSAIC project.: Models of regionalisation in Europe for very preterm births. *BJOG An International Journal of Obstetrics and Gynaecology*, 2009, 116 (10), pp.1364-72. <10.1111/j.1471-0528.2009.02239.x>. <inserm-00462793>

HAL Id: inserm-00462793

<http://www.hal.inserm.fr/inserm-00462793>

Submitted on 17 Jun 2010

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Organisation of obstetric services for very preterm births in Europe: results from the MOSAIC project

Béatrice Blondel^{1*}, Emile Papiernik³, D. Delmas¹, W. Künzel⁴, T. Weber⁵, R. F. Maier⁶, L. Kollée⁷, Jennifer Zeitlin^{1,2}, the Mosaic Research Group

¹ *Recherches épidémiologiques en santé périnatale et santé des femmes et des enfants INSERM : U953, Université Paris Descartes, Université Pierre et Marie Curie - Paris VI, Université Paris Sud - Paris XI, FR*

² *Recherches épidémiologiques en santé périnatale et santé des femmes INSERM : U149, INSERM : IFR69, Université Pierre et Marie Curie - Paris VI, Centre de Recherche Inserm 16, Avenue Paul Vaillant-Couturier 94807 VILLEJUIF CEDEX,FR*

³ *Maternité Port-Royal Université Paris Descartes, 123 bd de Port Royal 75679 Paris cedex 14,FR*

⁴ *Department of Obstetrics and Gynaecology CHU Giessen, DE*

⁵ *Department of Obstetrics Hvidovre University Hospital, DK*

⁶ *Department of Neonatology CHU Marburg, DE*

⁷ *University Children's Hospital Radboud University Nijmegen Medical Centre, NL*

* Correspondence should be addressed to: Béatrice Blondel <beatrice.blondel@inserm.fr >

Abstract

Objective

To study the impact of the organisation of obstetric services on the regionalisation of care for very preterm births.

Design

Cohort study.

Setting

10 European regions covering 490 000 live births.

Population

All children born in 2003 between 24 and 31 weeks of gestation

Method

The rate of specialised maternity units per 10,000 total births, the proportion of total births in specialised units and the proportion of very preterm births by referral status in specialised units were compared.

Main outcome measure

Birth in a specialised maternity unit (level III unit or unit with a large neonatal unit (at least 50 annual very preterm admissions)).

Results

The organisation of obstetric care varied in these regions with respect to the supply of level III units (from 2.3 per 10 000 births in the Portuguese region to 0.2 in the Polish region), their characteristics (annual number of deliveries, 24 hour presence of a trained obstetrician) and the proportion of all births (term and preterm) that occur in these units. The proportion of very preterm births in level III units ranged from 93% to 63% in the regions. Different approaches were used to obtain a high level of regionalisation: high proportions of total deliveries in specialised units, high proportions of in utero transfers or high proportions of high risk women who were referred to a specialised unit during pregnancy.

Conclusion

Consensus does not exist on the optimal characteristics of specialised units but regionalisation may be achieved in different models of organisation of obstetric services.

MESH Keywords Europe ; Female ; Hospitals, Maternity ; organization & administration ; statistics & numerical data ; Humans ; Infant, Newborn ; Infant, Premature ; Infant, Premature, Diseases ; therapy ; Maternal Health Services ; organization & administration ; statistics & numerical data ; Perinatal Care ; organization & administration ; Pregnancy ; Pregnancy Outcome ; Premature Birth ; therapy ; Residence Characteristics

Author Keywords very preterm birth, regionalisation, in utero transfer

Introduction

Health planners and care givers seek continuously to optimise the organisation of services for women and newborns, to guarantee their medical safety, refer them according to their level of risk and promote access to these services. Numerous studies show the benefits of regionalising care for very preterm births and concentrating a high proportion of these deliveries in level-III maternity units^{1–6}. Regionalisation began in the early 1970s in the United States⁷; modifications have followed its initial development, and several states have taken steps towards deregionalisation since then^{8–10}. In Europe, regionalisation of perinatal care was implemented more progressively, beginning in the mid-1970s in several Scandinavian countries but not until the mid-1990s in many other countries, including Denmark, France and Poland^{11–12}.

While there is an enormous variety in the organization of care for very preterm babies in Europe, due to the combination of the diversity of health care systems between countries and the staggered implementation of regionalisation policies^{13–14}, all health systems share the same challenge: to ensure that women who will deliver very preterm - approximately 1% of all pregnant women - do so in an appropriate maternity unit. Achieving this goal may depend on the general organisation of obstetric care⁷.

European countries have adopted different models of organisation for the overall population, in terms, for example, of the number and size of maternity units and whether they are associated with specialised neonatology departments^{14–15}. At one extreme, the closure of small maternity units and the centralisation of all births in large units offering specialised neonatal services guarantee that high risk newborns will be born in an appropriate place¹⁶. In contrast, where there is a large supply of maternity units with differing levels of specialisation, the organisation of a referral network between hospitals will be necessary for ensuring that women at highest risk deliver in the specialised units.

One of the difficulties with the comparison of the organisation of care for very preterm babies is the variability in definitions of specialised units. Most studies assessing regionalisation and specialisation of care for very preterm babies have based their analyses on the classification of hospitals according to levels of care. This classification differs from country to country^{7,17,18}. Moreover it is defined essentially on criteria for neonatal care¹⁸ and may therefore correspond to very different situations in terms of specialisation in obstetrics.

We hypothesized that the organisation of maternity care, both with respect to the definition of units specialising in the care of very preterm babies, and the general organisation of obstetric services for all pregnant women has an impact on a health system's capacity to ensure that a high proportion of very preterm deliveries occur in specialised maternity units. To test this hypothesis, we compared the place of birth of very preterm babies in 10 European health systems using a population based cohort study conducted in 2003¹⁹. Regions represented different organisational models of perinatal care, based on the results of a previous European collaboration¹⁴.

Population and method

The MOSAIC study included all stillbirths and live births from 22⁺⁰ weeks to 31⁺⁶ weeks of gestation in 10 areas in 9 European countries in 2003. The study regions were: Flanders in Belgium, the Eastern Region of Denmark, 6 of 8 districts in the Ile-de-France region of France, Hesse in Germany, Lazio in Italy, the Central and Eastern region of the Netherlands, Wielkopolska and Lubuskie in Poland, the Northern region of Portugal, and the Northern region and the former Trent region of the UK. Each MOSAIC region covered between 30,000 and 65,000 live births in 2003, with the exception of the larger French region (135,000 births). These regions correspond to the catchment areas of regional perinatal centres and in most cases correspond to administrative regions as well.

The study was carried out on all births occurring from 1 January to 31 December 2003 with the exception of the Ile-de-France region where births were included from 1 February to 31 August 2003. Gestational age was based on the best obstetrical assessment, using information on last menstrual period and ultrasound measures. Ultrasound scans for dating pregnancies are part of routine antenatal care in the regions participating in MOSAIC. Inclusions in the MOSAIC cohort were cross-checked with birth registers in each maternity unit to ensure completeness. Ethics approval was sought for the collection of this data as required in each of the regions. Two data sources were used. Data on births were abstracted from records in the neonatal units for babies admitted to neonatal care. For stillbirths and babies dying before admission to a neonatal unit, the questionnaires were filled in from obstetric records.

Data on the characteristics of the maternity units (level, total number of deliveries, staffing) were collected through a questionnaire filled in by each unit. 426 maternity units out of 434 filled in a questionnaire. Maternity characteristics were known for all level III departments and for all hospital births before 32 weeks, except 32 children in Ile de France and one child in Denmark.

This study used a sub-sample of the total cohort that included all births between 24 and 31 weeks of gestation, after excluding fetal deaths before labour. Babies delivered before 24 weeks of gestation were excluded because they were generally considered below the limit of viability in the MOSAIC regions and recommendations may have differed with respect to the transfer of pregnant women to level III maternity units for delivery at this stage of gestation. Furthermore, despite attempts to insure completeness in the 10 regions, some live

births at 22 and 23 weeks may not have been included if the birth occurred outside of an obstetric ward or if some babies with signs of life were recorded as stillbirths.

Maternity units were classified according to the availability and specialisation of neonatal care in the same hospital. Two criteria were used: level of care and the size of the neonatal unit on site. We distinguished level III units vs level I or II units, using local classifications. At the time of the survey, the participating regions did not all recommend birth in level III units for all babies born before 32 weeks. Level III units were not defined in Trent. In Denmark, the guidelines for delivery in a level III hospital concerned only births before 28 weeks¹² and in the Netherlands those before 30 weeks¹⁸. Finally in the Netherlands obstetricians and neonatologists were very selective in providing intensive care to babies born before 26 weeks. The size of the neonatal units was measured by the annual number of primary admissions of newborns under 32 weeks, defined as admission to the first unit where a baby spent his or her first 48 consecutive hours. This information was obtained from the cohort study in each participating region. For France, the cohort study continued for a 7 month period and observed admissions over this period were extrapolated to estimate total annual admissions. We defined a large neonatal unit as a unit which had at least 50 annual admissions of newborns between 22 and 31 weeks¹⁸.

We defined regionalisation of care as the delivery of very preterm newborns in a specialised unit (level III or maternity unit associated with a large neonatal unit on site).

The description of obstetric units was based on the number of annual deliveries, the staffing in obstetrics and the availability of an adult intensive care unit on the same site. The number of deliveries included all women who had a live birth or stillbirth from 22 weeks of gestation onwards in 2002. For the staffing, we took into account the presence of at least one trained obstetrician 24 hours a day and seven days a week in the maternity unit.

In the analysis we first described all maternity units, level III units and those associated with a large neonatal unit, in each region. We also calculated the number of maternity units per 10 000 births for these three types of units. We then compared the place of birth for very preterm births in each region, according to the specialisation of the units and gestational age.

To understand how regionalisation was achieved in each study region, we first compared the proportion of very preterm births in specialised units with the proportion of all births (term and preterm) in these units. We assumed that regardless of existing recommendations regarding regionalisation of care, the proportion of very preterm births would be at least as high as the proportion of all births in these units. We also assessed the proportion of babies transferred in utero versus those whose mothers were booked directly in the unit for delivery (without in utero transfer). Maternal transfer or transfer in utero was defined for this study as transfer from one hospital to another for delivery.

Finally, to assess the relation between the supply of specialised units and the proportion of births in these units, we calculated rank correlation coefficients between the proportion of very preterm births in level III units on the one hand, and the rate of level III units per 10,000 births and the proportion of total births in level III units on the other hand. Similar computations were done for maternity units with large neonatal units.

Results

In all, 426 maternity units were included in the study (Table 1). Their size varied markedly between the MOSAIC regions. Maternity units rarely carried out more than 2000 deliveries in the regions in Belgium, Germany, Italy, the Netherlands and Poland. In contrast, about three-quarters of all maternity units were this size in Trent. There was a trained obstetrician on site 24 hours a day in one quarter or less of the maternity units in the study regions in Belgium, the Netherlands and Trent.

Fifty-seven maternity units were classified as level III and they represented between 2 and 44% of all units depending on the region (Trent is not included in this analysis, as explained in methods). Almost all of these maternity units had an adult intensive care unit on-site. However, the presence of a trained obstetrician on-site 24 hours a day varied greatly; it was less common in the Belgian region (25% of units) and was not found in the two level III units in the Dutch region. These level III units were also very different in size with fewer than 2000 deliveries a year in most of those in the Belgian, German, Italian and Dutch regions.

There were fewer specialised units when the classification was based on the size of the neonatal unit and the difference between these two classifications was greatest for the German, Italian and Portuguese regions. These units, however, are not more homogeneous with respect to size or the presence of a trained obstetrician on-site.

Table 2 presents the number of maternity units with respect to the total number of births in each region. The supply of total maternity units varied from 5.5 per 10 000 births or less in the study regions in Denmark, France, Portugal and UK, to more than 10 in those in Belgium, Germany, Italy and Poland. The supply of level III units was less than 1 per 10 000 births in the Danish, French, Dutch and Polish regions, whereas it was much higher in the regions from Germany, Italy and Portugal. The variation in supply was less marked for

maternity units associated with larger neonatal intensive care units, but there were still differences between regions with rates over 1 per 10 000 in Hesse (Germany) and UK North versus less than 0.5 per 10 000 in the Italian and Polish regions.

The percentage of infants 24–31 weeks of gestation delivered in level III maternity units ranged from 63–64% in the Danish and Polish regions to over 80% in the regions from Belgium, Germany, Italy and Portugal (Table 3). This proportion did not vary greatly by gestational age group in Flanders, Hesse, Lazio or the Polish and Portuguese regions. In Denmark, the percentage born in level III decreased with increasing gestation. In France and the Netherlands, the rates of births in level III were highest between 28 and 29 weeks and lower both before and after. In UK North, the group of babies born at 30–31 weeks was less likely to be delivered in level III.

A smaller percentage (64%) of very preterm infants was delivered in a maternity unit with a large neonatal intensive care unit and the percentage was lower than 50% in the Lazio region and Northern region of Portugal. The trends with gestational age were similar to those for level of care. In the Portuguese region the rate of births in a maternity unit with a large neonatal unit was higher in babies born at 24–27 weeks than in babies born later.

Table 4 describes the percentage of all births and births between 24 and 31 weeks in these specialised units by whether they were transferred in utero. Overall, the proportion of all births in level III was much lower than the proportion of births between 24 and 31 weeks without previous in utero transfer. However this difference was not marked in Portugal and the UK North. Most mothers delivering very preterm babies in level III were not transferred there for delivery, except in the French and Dutch regions. The same patterns were observed when we analysed births in hospitals with large neonatal unit on site. The Trent region followed the same pattern as the UK North region.

We found a significant relation between the rate of level III units per 10,000 births in each region and the proportion of births between 24 and 31 weeks in these units (Spearman's coefficient = 0.86; $p < 0.01$), but there was no relation between the proportion of all births in level III units and the proportion of very preterm births in these units (Spearman's coefficient = 0.60; $p > 0.05$). No associations were found in similar computations for maternity units associated with large neonatal units.

Discussion

We found large variations in the supply of specialised maternity units and their organisational characteristics (number of deliveries, size of the associated neonatal unit and presence of trained obstetricians) between European regions. The proportion of very preterm deliveries in specialised maternity units varied between regions. Different strategies were used to achieve a high proportion of deliveries in specialised units, including the concentration of all births in these units, in utero transfer and direct referral of high risk pregnancy women.

This study included only ten regions and this limited our ability to test the impact of specific aspects of the organisation of care on the place of delivery for very preterm babies. Furthermore, while ecological correlations revealed a positive association between the supply of specialised maternity units and the proportion of births in these units, this method does not guarantee that, in each region, supply has a direct impact on the place of birth of high risk newborns.

There is no common definition based on obstetric criteria that would make it possible to classify maternity units in different countries according to their specialisation for management of mothers and children in very preterm deliveries. In the regions studied, conditions or requirements fixed for obstetrical services are rare, and when they exist, they are mainly based on size: 1500 deliveries a year in Italy, 3000 in Portugal, or a minimum number of beds for women at high risk in Belgium and the Netherlands. The units are actually classified according to the presence and level of specialisation of the nearby neonatology department. For this study we used the classification of levels of care as applied in each country, which make it possible to evaluate rates of regionalisation as it is recommended in each country. In a previous analysis of neonatal units in the MOSAIC regions, we found large variations in volume of activity, personnel, procedures and equipment between level III units¹⁸. Consequently, we also used the admission of at least 50 very preterm babies per year to the neonatology department, to establish comparisons with a more homogeneous definition. This criterion, higher NICU volume, reflects the experience acquired by medical teams in the management of these children and has been associated with better neonatal outcomes in several contexts^{20–21}.

Each study region has made very different choices in its organisation of obstetric services, relative to the number of departments, their size, and the permanent presence of a trained obstetrician. In the United Kingdom the restructuring of services in very large perinatal centres has led to the concentration of births in large maternity units¹⁵. In Portugal, the reform of perinatal care that began in the early 1990s led to the closing of the smallest maternity units -- with a cut-off point of 1500 deliveries a year²². In contrast, in the study regions of Germany, Italy and Poland, there were many maternity units and very few large units. Different choices were also made in the organisation of services for mothers and children at very high risk, except for on site adult intensive care units which are found in almost all specialised units. Furthermore, it appears that the organisation of specialised maternity units does not always differ from that of other

maternity units in the same region. For example, specialised units were not very different in characteristics from non-specialised maternity units in relation to their number of annual deliveries (the regions from Belgium, Germany and the Netherlands) and whether there was continuous on-site presence of an obstetrician (regions in Belgium, the Netherlands and the UK).

These objective criteria used to assess specialisation and experience, such as the annual number of deliveries and continuous on site presence of a trained obstetrician may reflect different situations depending on the context, however. In a maternity unit with a low volume of deliveries, medical teams may nonetheless obtain a high level of experience in the care of high risk pregnancies if these pregnancies represent a large proportion of its overall caseload, as may be the case in the Netherlands where neonatal intensive care is concentrated in large neonatal units¹⁸ located in maternity units with a relatively low annual number of total deliveries. The qualifications of the obstetricians in training may also differ and obstetrics call duty may be covered by a physician still in training but who has reached a set level of experience, such as in Flanders²³.

Analysis of the situation for all children born at 24–31 weeks shows that the proportion born in a level III maternity ward differs clearly between regions from 63% to 93%. This variability may be due to specific national policies or failure to achieve regionalisation despite policy guidelines promoting it. Policies explicitly limit interventions for extremely preterm babies in the Netherlands. In Denmark, regionalisation is only recommended for babies up to 28 weeks and in the Netherlands the limit is to 30 weeks. These variations partially explain lower proportions of deliveries in level III units at 24–31 weeks in these countries. The debate on the optimal organisation of care for these babies continues. Since our study in 2003, regionalisation of care was set up in Trent with a neonatal network^{24–25}. The conditions of operation for the most specialised perinatal centres were reinforced in Germany in 2007 and more active intervention for births before 26 weeks, including in utero transfer, was recommended in the Netherlands²⁶.

Given differences in the consensus on where extremely preterm babies or babies 30 and 31 weeks of gestation should be born, comparisons of births at 28–29 weeks of gestation are a better test of the capacity of each system to achieve regionalisation because policies target this group in each country, with the exception of Denmark (where the subgroup of interest is deliveries <28 weeks) and excluding Trent (which had no defined level III units in 2003). With the exception of Poland (69%) and UK North (79%), regionalisation rates for babies 28–29 weeks of gestation (24–27 weeks in Denmark) varied from 83 to 96%. These rates are high and comparable to those from other health systems where regionalisation policies are implemented. In Finland in 2000–2003 between 82 and 91% of babies 26 to 29 weeks of gestation were born in level III units²⁷. In California in 2000, 79% of low birthweight babies were born in level III units²⁰. An analysis of US data from 1989 to 1998 in three states where regionalisation policies were implemented found that rates of low birthweight births in level III ranged from 78 to 88%²⁸. What the target rate of regionalisation should be remains unspecified, however. The US Health People 2010 initiative, for instance, set a goal of 90%²⁹. Transfer is not possible in all cases as there are contraindications, such as maternal haemorrhage and imminent delivery, and these are found to be risk factors for non-delivery in level III units³⁰.

In our study variations between regions in the proportion of births in specialised units are accentuated for births in hospitals with a large neonatology department even when comparisons are limited to severe cases, such as children born at a gestational age of 28–29 weeks (24–27 weeks in Denmark): in this age group, the percentages of children born in these maternity units vary from 88% in the Netherlands to 41% in Italy. These important differences in management, including for the most preterm babies, may have an effect on their survival, health status at discharge and later development. An article on this topic is currently being drafted using this database.

We found as many other studies have that the availability of specialised hospitals and intensive care resources for very preterm newborns varies by geographic areas^{14,17,31,32} in and between countries. We observed a strong relation between the density of level III maternity units and the percentage of births in these maternity units in the 9 regions that classify hospitals by levels. Availability of nearby services can facilitate regionalisation; accordingly the percentage of very preterm births in level III maternity units is higher for mothers living in a county with a hospital providing subspecialty perinatal care^{33,34}. Other factors may also play a role; these include the population's socioeconomic situation^{30,33}, medical density, and the supply of beds. In several regions, in particular the Portuguese region, the lack of beds in the most specialised neonatology units has been an obstacle to regionalisation or has led to an abnormally high rate of in utero transfers.

The capacity of specialised maternity units to admit women at all levels of risk is a factor that makes regionalisation easier in some regions. Given the distribution of all births in the level III units, we could thus expect more than 40% of very preterm births in level III hospitals in Lazio, the Portuguese region and in the UK North region. Moreover, in Trent, it was possible to expect nearly half of all very preterm births to take place in a hospital with a large neonatology department, in the absence of a regionalisation policy. Nonetheless, we found no significant association between the proportion of total births in level III facilities and the proportion of very preterm births in them. In fact regions appeared to follow different strategies to maximise their proportion of very preterm deliveries in level III units. One approach was to directly refer pregnant women to these units, meaning referral of women at high risk to level III maternity wards, during pregnancy, before their condition worsens and they are hospitalised. This is the case in regions where the percentage of very preterm births in level III units, without in utero transfers, was higher than the percentage of total births in these units and in particular in the regions of Denmark, Germany, Italy and Poland. Another strategy was frequent recourse to in utero transfer, as in Ile de France. Both direct referral

and in utero transfer were observed in Flanders and the Dutch region. Finally, in the Portuguese region and UK Northern region, regionalisation reflected both a high proportion of total births in level III and a reliance on in utero transfer. These patterns also apply in the four regions with a high percentage (> 70%) of very preterm babies born in maternity wards associated with large neonatal units: Flanders, Ile de France, the Netherlands region and the UK North region.

Conclusion

Our study suggests that a high proportion of very preterm births in specialised units, can be achieved through extremely varied forms of organisation of obstetric services. A high rate is equally compatible with a high concentration of total births in a small number of maternity units and with a more varied supply, including large and small units. A high level of regionalisation can therefore be reached without calling into question an entire perinatal health care system, and in particular the existence of smaller maternity units. However, other criteria may distinguish between these models, including quality criteria, such as the medical management of obstetric emergencies, the costs attached to each type of organisation³⁵ and the opinion of women and of caregivers. A complete assessment would need to include very preterm births (or women at high risk of preterm delivery), as well as all births. For instance, while, a model of organisation with a high concentration of births in large maternity units can facilitate the regionalisation of care, it may not be easily acceptable to future parents and caregivers for low-risk pregnancies.

Acknowledgements:

The authors would like to acknowledge the assistance of the personnel in the maternity and neonatal units in the regions participating in the MOSAIC project.

FUNDING

This project was partially funded by a grant from the European Commission Research Directorate (QLG4-CT-2001-01907) and coordinated by Assistance Publique-Hôpitaux de Paris.

The MOSAIC Research Group

Belgium, Flanders (E. Martens, G. Martens, P. Van Reempts); Denmark, Eastern Denmark (K. Boerch, T. Weber, B. Peitersen); France, Ile-de-France (G. Bréart, JL Chabernaud, D. Delmas, PH. Jarreau, E. Papiernik); Germany, Hesse (L. Gortner, W. Künzel, R. Maier, B. Misselwitz, S. Schmidt); Italy, Lazio (R. Agostino, D. Di Lallo, R. Paesano); Netherlands, Eastern & Central (L. den Ouden, L. Kollée, G. Visser, J. Gerrits, R. de Heus); Poland, Wielkopolska & Lubuskie (G. Breborowicz, J. Gadzinowski, J. Mazela); Portugal, Northern Region (H. Barros, I. Campos, M. Carrapato.) UK, Trent Region (E. Draper, D. Field, J. Konje); UK, Northern Region (A. Fenton, D. Milligan, S. Sturgiss); INSERM U149, Paris (G. Bréart, B. Blondel, H. Pilkington, J. Zeitlin); External contributors (M. Cuttini, S. Petrou).

Footnotes:

DISCLOSURE OF INTEREST The authors have no interest to declare

CONTRIBUTION TO AUTHORSHIP B.B. initiated the design of the study with E.P. and J. Z., wrote the drafts and reviewed the paper. D.D was responsible for the data management and carried out the statistical analysis. J.Z. and E.P. initiated the design of the cohort study; JZ coordinated the study. All authors participated in the interpretation of results, and reviewed the paper.

ETHICS APPROVAL All regions obtained ethical approval in accordance with national guidelines for research. Authorization for the constitution of the MOSAIC database in conformity with data confidentiality laws in France was provided by the CNIL (Commission Nationale Informatique et Libertés) on March 2003 (n° 03-1052).

References:

1. Paneth N, Kiely JL, Wallenstein S, Marcus M, Pakter J, Susser M. Newborn intensive care and neonatal mortality in low-birth-weight infants: a population study. *N Eng J Med*. 1982; 307: 149 - 55
2. Ozminkowski RJ, Wortman PM, Roloff DW. Inborn/outborn status and neonatal survival: a meta-analysis of non randomised studies. *Stat Med*. 1988; 7: 1207 - 21
3. Kollée LA, Verloove-Vanhorick PP, Verwey RA, Brand R, Ruys RH. Maternal and neonatal transport: results of a national collaborative survey of preterm and very low birth weight infants in The Netherlands. *Obstet Gynecol*. 1988; 72: 729 - 732
4. Truffert P, Goujard J, Dehan M, Vodovar M, Bréart G. Outborn status with a medical neonatal transport service and survival without disability at two years: A population-based cohort survey of newborns of less than 33 weeks of gestation. *Eur J Obstet Gynecol Biol Reprod*. 1998; 79: 13 - 18
5. Warner B, Musial MJ, Chenier T, Donovan E. The effect of birth hospital type on the outcome of very low birth weight infants. *Pediatrics*. 2004; 113: 35 - 41
6. Zeitlin J, Papiernik E, Bréart G. EUROPE Group. Regionalisation of perinatal care in Europe. *Semin Neonatol*. 2004; 9: 99 - 110
7. Hein HA. Regionalized perinatal care in North America. *Semin Neonatol*. 2004; 9: 111 - 116
8. Richardson DK, Reed K, Cutler C, Boardman RC, Goodman K, Moynihan T. Perinatal regionalization versus hospital competition: the Hartford example. *Pediatrics*. 1995; 96: 417 - 423
9. Howell EM, Richardson D, Ginsburg P, Foot B. Deregionalization of neonatal intensive care in urban areas. *Am J Public Health*. 2002; 92: 119 - 124
10. Dobrez D, Gerber S, Budetti P. Trends in perinatal regionalization and the role of managed care. *Obstet Gynecol*. 2006; 108: 839 - 845
11. Debauche C, Van Reempts P, Chabernaud J-L, Kollée LAA, Zeitlin J. Maternal and neonatal transfer policies in Europe. *Prenat Neonat Med*. 1999; 4S1: 5 - 14
12. Truffert P, Gadzinowski J, Peitersen B. Changing policies of perinatal transfer: Denmark, France and Poland. *Prenat Neonat Med J*. 1999; 4S1: 15 - 19
13. Kollée LAA, Chabernaud JL, Van Reempts P, Debauche C, Zeitlin J. Perinatal transport practices: a survey of inborn versus outborn very preterm infants admitted to European neonatal intensive care units. *Prenat Neonat Med J*. 1999; 4S1: 15 - 19

- 14 . Papiernik E , Zeitlin J , Milligan DWA , Carrapato MRG , Van Reempts P , Gadzinowski J . Variations in the organization of obstetric and neonatal intensive care in Europe . *Prenat Neonat Med J* . 1999 ; 4S1 : 73 - 87
- 15 . Wildman K , Blondel B , Nijhuis J , Defoort P , Bakoula C . European indicators of health care during pregnancy, delivery and the postpartum period . *Eur J Obstet Gynecol Reprod Biol* . 2003 ; 111 : (Suppl 1) S53 - 65
- 16 . Swyer PR . Organisation of perinatal/neonatal care . *Acta Paediatr* . 1993 ; 385 : (suppl) 1 - 18
- 17 . Rozenblatt RA , Macfarlane A , Dawson AJ , Cartlidge PHT , Larson EH , Hart LG . The regionalization of perinatal care in Wales and Washington State . *Am J Public Health* . 1996 ; 86 : 1011 - 1015
- 18 . Van Reempts P , Gortner L , Milligan D , Cuttini M , Petrou S , Agostino R . Characteristics of neonatal units that care for very preterm infants in Europe: results from the MOSAIC study . *Pediatrics* . 2007 ; 120 : e815 - 25
- 19 . Zeitlin J , Draper ES , Kollée L , Milligan D , Boerch K , Agostino R . Differences in rates and short term outcome of live births before 32 weeks of gestation in Europe in 2003: results from the MOSAIC cohort . *Pediatrics* . 2008 ; 121 : e936 - 944
- 20 . Phibbs CS , Baker LC , Caughey AB , Danielsen B , Schmitt SK , Phibbs RH . Level and volume of neonatal intensive care and mortality in very-low-birth weight infants . *N Engl J Med* . 2007 ; 356 : 2165 - 2175
- 21 . Bartels DB , Wypij D , Wenzlaff P , Dammann O , Poets CF . Hospital volume and neonatal mortality among very low birth weight infants . *Pediatrics* . 2006 ; 117 : 2206 - 2214
- 22 . Neto MT . Perinatal care in Portugal: effects of the 15 years of a regionalized system . *Acta Ped* . 2006 ; 95 : 1349 - 1352
- 23 . Arrêté royal . Arrêté royal fixant les normes auxquelles une fonction de soins périnatals régionaux doit satisfaire pour être agréée . *Moniteur belge* . 1996 ; 25275 -
- 24 . Cornette L , Miall L . Development of regional guidelines: the way forward for neonatal networks? . *Arch Dis Child Fetal Neonatal Ed* . 2006 ; 91 : F318 - 9
- 25 . Marlow N , Bryan Gill A . Establishing neonatal networks: the reality . *Arch Dis Child Fetal Neonatal Ed* . 2007 ; 92 : F137 - 42
- 26 . Pignotti MS . Extremely preterm births: recommendations for treatment in European countries . *Arch Dis Child Fetal Neonatal Ed* . 2008 ; 93 : F403 - 406
- 27 . Rautava L , Lehtonen-Veromaa M , Kautiainen H , Kajander S , Heinonen OJ , Viikari J , Mötönen T . The effect of birth in a secondary- or tertiary-level hospital in Finland on mortality in very preterm infants: a birth-register study . *Pediatrics* . 2007 ; 119 : e257 - e263
- 28 . Dobrez D , Gerber S , Budetti P . Trends in perinatal regionalization and the role of managed care . *Obstet Gynecol* . 2006 ; 108 : 839 - 845
- 29 . US Department of Health and Human Services . Healthy People 2010 . Washington, DC http://www.healthypeople.gov/Document/HTML/Volume2/16MICH.htm#_Toc494699664 accessed April 16, 2009
- 30 . Zeitlin J , Gwanfogbe C , Delmas D , Pilkington H , Jarreau P , Chabernaud JL . Risk factors for delivery out of a level III unit before 32 weeks of gestation: results from a population based study in Paris and surroundings districts in 2003 . *Paed Perinat Epidemiol* . 2008 ; 22 : 126 - 135
- 31 . Goodman DC , Fisher ES , Little GA , Stukel TA , Chang C-H , Schonendorf KS . The relation between the availability of neonatal intensive care and neonatal mortality . *N Engl J Med* . 2002 ; 346 : 1538 - 1544
- 32 . Thompson LA , Goodman DC , Little GA . Is more neonatal intensive care always better? Insights from a cross-national comparison of reproductive care . *Pediatrics* . 2002 ; 109 : 1036 - 1043
- 33 . Samuelson JL , Buehler JW , Norris D , Sadek R . Maternal characteristics associated with place of delivery and neonatal mortality rates among very-low-birthweight infants, Georgia . *Paediatr Perinat Epidemiol* . 2002 ; 16 : 305 - 313
- 34 . Attar MA , Hanrahan K , Lang SW , Gates MR , Bratton SL . Pregnant mothers out of the perinatal regionalization's reach . *J Perinatol* . 2006 ; 26 : 210 - 214
- 35 . Draper ES , Manktelow BN , McCabe C , Field DJ . The potential impact on costs and staffing of introducing clinical networks and British Association of Perinatal Medicine standards to the delivery of neonatal care . *Arch Dis Child Fetal Neonatal Ed* . 2004 ; 89 : F236 - F240

Table 1

Description of all maternity units and specialised maternity units in each participating region

Country	BE	DK	FR	GE	IT	NL	PL	PO	UK	UK	Total
Region ⁽¹⁾	Fl	Ea	IF	He	La	C-E	W-L	No	Tr	No	
All units (N)	(72)	(14)	(80)	(75)	(57)	(24)	(53)	(18)	(18)	(15)	(426)
2000 + deliveries per year %	4	57	38	1	7	8	4	50	71	27	18
Trained obstetrician 24/24h-7/7d%	26	90	76	45	100	19	96	94	24	67	63
Adult intensive care on site %	99	100	50	76	67	100	84	53	94	100	77
Level 3 units (N)⁽²⁾	(8)	(2)	(11)	(10)	(11)	(2)	(1)	(8)	-	(4)	(57)
% of the units in the region	11	14	14	13	19	8	2	44	-	27	14
2000 + deliveries/year-%	25	100	82	10	36	0	100	88	-	75	51
Trained obstetrician 24/24h-7/7d%	25	100	91	90	100	0	100	100	-	67	80
Adult intensive care on site %	100	100	82	90	100	100	100	88	-	100	93
Units associated with a large neonatal unit⁽³⁾ (N)	(6)	(2)	(10)	(6)	(2)	(2)	(1)	(2)	(5)	(4)	(40)
% of the units in region	8	14	13	8	4	8	2	11	28	27	9
2000 + deliveries/year %	17	100	90	17	100	0	100	50	100	75	63
Trained obstetrician 24/24h-7/7d%	33	100	90	100	100	0	100	100	20	67	69
Adult intensive care on site %	100	100	80	100	100	100	100	100	100	100	100

⁽¹⁾ Belgium (Flanders), Denmark (Eastern), France (Ile-de-France), Germany (Hesse), Italy (Lazio),the Netherlands (Central & Eastern), Poland (Wielkopolska & Lubuskie), Portugal (Northern),UK (Trent) and UK (Northern).

⁽²⁾ in the Trent region, no regional policy based on the level of care at the time of the survey in 2003

⁽³⁾ neonatal unit on the same site with at least 50 annual admissions of newborns under 32 weeks

Table 2

Rate of maternity units per 10 000 total births in each region for all maternity units and specialised maternity units in each participating region

Country	BE	DK	FR	GE	IT	NL	PL	PO	UK	UK	Total
Region ⁽¹⁾	Fl	Ea	IF	He	La	C-E	W-L	No	Tr	No	
All units (N)	(72)	(14)	(80)	(75)	(57)	(24)	(53)	(18)	(18)	(15)	(426)
	12.3	4.0	5.5	14.3	11.6	6.0	12.4	5.2	3.2	5.1	7.8
Level 3 units⁽²⁾ (N)	(8)	(2)	(11)	(10)	(11)	(2)	(1)	(8)	-	(4)	(57)
	1.3	0.6	0.8	1.9	2.2	0.5	0.2	2.3	-	1.4	1.0
Units associated with a large neonatal unit⁽³⁾ (N)	(6)	(2)	(10)	(6)	(2)	(2)	(1)	(2)	(5)	(4)	(40)
	1.0	0.6	0.7	1.1	0.4	0.5	0.2	0.6	0.9	1.4	0.7

⁽¹⁾ Belgium (Flanders), Denmark (Eastern), France (Ile-de-France), Germany (Hesse), Italy (Lazio),the Netherlands (Central & Eastern), Poland (Wielkopolska & Lubuskie), Portugal (Northern),UK (Trent) and UK (Northern).

⁽²⁾ in the Trent region, no regional policy based on the level of care at the time of the survey in 2003

⁽³⁾ neonatal unit on the same site with at least 50 annual admissions of newborns under 32 weeks

Table 3

Proportion of very preterm births which took place in specialised maternity units, by gestational age, in each participating region

Country	BE	DK	FR	GE	IT	NL	PL	PO	UK	UK	Total
Region ⁽¹⁾	Fl	Ea	IF	He	La	C-E	W-L	No	Tr	No	
Number of births ⁽²⁾											
total (24–31 weeks)	574	326	901	601	451	379	398	289	766	406	5091
24–27 weeks	181	89	262	185	137	79	140	90	221	131	1515
28–29 weeks	153	91	258	164	102	102	90	83	210	114	1367
30–31 weeks	240	146	381	252	212	198	168	116	335	161	2209
% in level 3 unit ⁽³⁾											
Total (24–31 weeks)	82	64	76	85	87	74	63	93	-	73	78
24–27 weeks	81	83	74	87	88	71	63	94	-	82	80
28–29 weeks	83	69	83	87	87	88	69	96	-	79	83
30–31 weeks	82	50	72	81	87	68	61	89	-	61	73
% in unit associated with a large neonatal unit ⁽⁴⁾											
Total (24–31 weeks)	72	64	76	60	37	75	63	46	58	73	64
24–27 weeks	69	83	75	63	37	73	63	54	60	82	66
28–29 weeks	76	69	84	62	41	88	69	43	60	79	69
30–31 weeks	73	50	73	56	35	69	61	43	55	61	59

⁽¹⁾ Belgium (Flanders), Denmark (Eastern), France (Ile-de-France), Germany (Hesse), Italy (Lazio), the Netherlands (Central & Eastern), Poland (Wielkopolska & Lubuskie), Portugal (Northern), UK (Trent) and UK (Northern).

⁽²⁾ fetal deaths before labour excluded

⁽³⁾ in the Trent region, no regional policy based on the level of care at the time of the survey in 2003

⁽⁴⁾ neonatal unit on the same site with at least 50 annual admissions of newborns under 32 weeks

Table 4

Proportion of total births in specialised maternity units and proportion of very preterm births (with or without in utero transfer) in specialised maternity units

Country	BE	DK	FR	GE	IT	NL	PL	PO	UK	UK	Total
Region ⁽¹⁾	Fl	Ea	IF	He	La	C-E	W-L	No	Tr	No	
Number of births											
Total births in the region (thousands) ⁽²⁾	60	34	85	52	52	48	43	35	57	30	497
Births 24–31 wks ⁽³⁾	574	326	901	601	451	379	398	289	766	406	5091
% in level 3 units⁽⁴⁾											
Total births in the region%	20	21	20	25	42	8	13	61	-	44	26
Births 24–31 wks											
without in utero transfer%	44	54	31	62	76	22	53	57	-	36	47
after in utero transfer%	38	10	45	23	11	51	10	35	-	36	31
% in units associated with a large neonatal unit⁽⁵⁾											
Total births in the region%	14	21	19	16	13	8	13	14	48	44	20
Births 24–31 wks											
without in utero transfer%	38	54	31	45	35	23	53	20	43	36	38
after in utero transfer%	34	10	45	16	1	52	10	27	16	36	26

⁽¹⁾ Belgium (Flanders), Denmark (Eastern), France (Ile-de-France), Germany (Hesse), Italy (Lazio), the Netherlands (Central & Eastern), Poland (Wielkopolska & Lubuskie), Portugal (Northern), UK (Trent) and UK (Northern).

⁽²⁾ total annual births, or 7 months period in Ile-de-France (France)

⁽³⁾ fetal deaths before labour excluded

⁽⁴⁾ in the Trent region, no regional policy based on the level of care at the time of the survey in 2003

⁽⁵⁾ neonatal unit on the same site with at least 50 annual admissions of newborns under 32 weeks