Pregnancy-Related ICU Admissions in France: Trends in Rate and Severity, 2006–2009*

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Objective: To determine the national rate per delivery of pregnancy-related ICU admissions of women in France, the characteristics and severity of these cases, and their trends over the 4-year study period.

Design: Descriptive study from the national hospital discharge database.

Setting: All ICUs in France.

Patients: All women admitted to an ICU during the pregnancy, the delivery, or the postpartum period from January 1, 2006, to December 31, 2009.

Interventions: None.

Measurements and Main Results: Of 3,262,526 deliveries, 11,824 women had pregnancy-related ICU admissions, for an overall rate of 3.6 per 1,000 deliveries. The conditions reported most frequently were obstetric hemorrhages (34.2%) and hypertensive disorders of pregnancy (22.3%). Case severity was assessed with four markers: case-fatality rate (1.3%), length of ICU stay (mean, 3.0±0.1 d), Simplified Acute Physiology Score II score (mean: 19.7±0.1), and a SUP REA code, which indicates the combination of a Simplified Acute Physiology Score II score more than or equal to 15 and at least one specific procedure related to life support or organ failure (23.0%). The most frequent causes of ICU admission were those associated with the least severity in the ICU. During the study period, the rate of pregnancy-related ICU admissions decreased from 3.9 to 3.4 per 1,000 deliveries ($p < 0.001$), whereas the overall severity of cases increased with longer stays, higher Simplified Acute Physiology Score II scores, and a greater proportion of SUP REA codes (all $p < 0.001$). Analysis by principal diagnosis showed that the severity of the condition of women admitted to ICU significantly increased over time for hemorrhages and hypertensive complications.

Conclusions: The rate of women with pregnancy-related ICU admissions decreased and the severity of their cases increased. Most ICU admissions remained related to the least severe conditions. This raises the issue of the most appropriate organization of care for women with pregnancy-related conditions who require continuous surveillance but not necessarily intensive care. (*Crit Care Med* 2015; 43:78–86)

Key Words: hospital discharge database; intensive care units; obstetric ICU admissions; severe maternal morbidity; Simplified Acute Physiology Score II scores

Both obstetric practices and the profiles of women giving birth have changed substantially in the high income countries in recent decades. Although these changes vary in extent and time between and within countries, age at first delivery has grown older (1), and the rates of pregnant women who are obese or have chronic diseases have increased (2–4), together with the rates of labor induction and cesarean delivery (1, 5).

Some of these changes have increased the risk factors for maternal complications, but their precise effects on women's health remain uncertain. It is therefore essential to be able to monitor the frequency and profile of maternal morbid events, especially the severe ones, to be able to anticipate needs and optimize the supply and organization of care (6).

Given the rarity of maternal deaths, the study of severe acute maternal morbidity (SAMM) appears essential, but no consensus

definition yet exists (7–13). The definition proposed by the World Health Organization is complex, and its relevance for high-resource countries is controversial (14). Maternal admission to ICUs during pregnancy or in the postpartum period may be a marker of SAMM: except for the rare cases of sudden maternal deaths, all women with severe acute events are expected to be admitted to the ICU. Many authors thus consider ICU admission to be a good proxy for SAMM that provides an overview of the extreme part of the maternal morbidity spectrum (15–17).

Although several studies have focused on obstetric ICU admissions, they have usually been small series from single tertiary ICU centers and their results therefore cannot be generalized (18–21). Some have been population-based (22–29) but only one was national (15). Furthermore, none assessed severity in detail, and only one studied the temporal trends of these admission rates (23). Hospital discharge databases serve as a useful tool for monitoring ICU admissions because they contain routinely collected administrative and medical information about them. In a previous work, we assessed the quality of French hospital discharge data related to maternal morbid events and showed that the accuracy of the reporting of ICU admissions was high (30).

Here, we used the national hospital discharge database to assess the rate of pregnancy-related ICU admissions in France, the characteristics and severity of these cases, and their trends over a 4-year period (2006–2009).

MATERIAL AND METHODS

Data Source

We used data from the French hospital discharge database (Programme de Médicalisation des Systèmes d'Information). This database provides anonymous discharge data for each admission in every public and private hospital in France. The government agency for hospital-based information has established national rules for coding the medical information (31).

All diagnoses associated with the hospital stay are coded according to the *International Classification of Diseases*, 10th Edition (ICD-10). The principal diagnosis is defined as the condition involving the greatest use of resources during the hospitalization. Other conditions are recorded as associated diagnoses. All medical procedures performed during the hospital stay are reported in the database, coded according to a specific French classification. This database, which records more than 99% of all national hospitalizations, is considered very close to exhaustive (31).

Selection of the Study Population

From this national database, we extracted hospitalizations with discharge dates from January 1, 2006, to December 31, 2009, for women of reproductive age (14–50 yr), with at least one ICD-10 code related to pregnancy (Z35), delivery (Z37), or the postpartum period (Z39) or from the O (obstetrics) chapter as a principal or associated diagnosis (**Fig. 1**). This selection identified 5,572,069 obstetric hospitalizations.
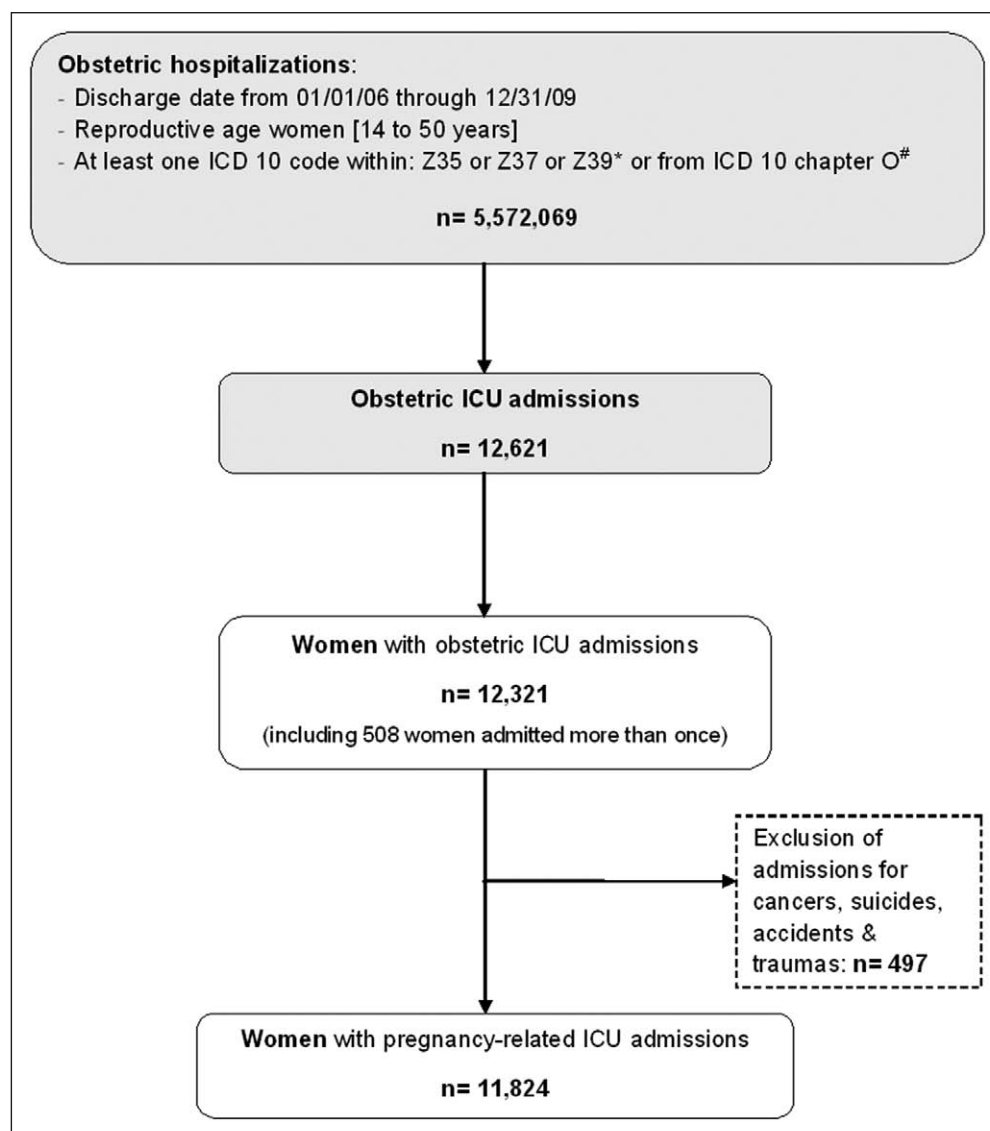

Figure 1. Algorithm for selection of women with pregnancy-related admissions to ICUs in the French hospital discharge database from 2006 to 2009. *Codes from the *International Classification of Diseases, 10th Edition* (ICD-10) indicating respectively the pregnancy, delivery, and postpartum period. #Obstetric chapter in ICD-10.

Within this selection, we identified obstetric ICU admissions ($n = 12,621$ abstracts). To enable woman-based analyses, we linked multiple abstracts from the same patient by their unique personal identification code. Exclusion of admissions for cancers, suicides, accidents, or traumas ($n = 497$) limited our analysis to ICU admissions related to pregnancy. Finally, the study population comprised 11,824 women with pregnancy-related ICU admissions.

Variables and Classification of Diagnoses

The women's characteristics that we studied included age, type of pregnancy (singleton or multiple), and mode of delivery (vaginal or cesarean delivery, for women admitted to ICUs in the delivery or postpartum periods). The characteristics of ICU stays included the timing of ICU admission relative to delivery: antepartum, delivery, or postpartum admissions; the length of stay in ICU (in days); the total length of stay in the facility (in days); the total number of therapeutic or diagnostic medical procedures performed during the ICU stay; the Simplified Acute Physiology Score (SAPS) II severity score, calculated in the first 24 hours after ICU admission based on the worst clinical, and physiologic indicators (32); a SUP REA code indicating a patient with a SAPS II score of 15 or more associated with at least one intensive care procedure needed for life support or organ failure (listed in **Appendix 1**); the principal diagnosis of the stay classified in nine categories: hemorrhage, hypertensive disorder of pregnancy, disease of the circulatory system, infectious disease, thromboembolic disorder, complication of anesthesia, amniotic fluid embolism, organ dysfunction, and other; and maternal death during the ICU stay. For women admitted to the ICU more than once ($n = 508$), the analysis considered the stay with the highest SAPS II score or, if they were equal, with the longest stay.

Statistical Analyses

The rate of pregnancy-related ICU admissions was calculated as the number of women admitted to ICUs, divided by the total number of deliveries reported in the database. This rate was calculated globally and by principal diagnosis, for each year from 2006 to 2009.

Maternal and ICU stay characteristics were described among women with pregnancy-related ICU admissions for each year from 2006 to 2009. The rate of cesarean deliveries was calculated among women admitted to the ICU during the delivery or postpartum period. The severity was assessed by four outcomes: length of ICU stay, SAPS II score, the presence of a SUP REA code, and death. Changes over the 4 years in the rate of ICU admissions, in the characteristics of women and ICU stays, and in the severity of cases were analyzed, globally, and by principal diagnosis, with chi-square and Student trend tests. Severity was also compared according to maternal age (age over 35 yr). Significance was defined as p value of less than 0.05. Analyses were performed with Stata 10.0SE software (College Station, TX).

The National Data Protection Authority (Commission Nationale de l'Informatique et des Libertés) approved the study (no. 1004749). Because we used anonymized and unidentifiable data, this study was exempt from review by an ethics committee.

RESULTS

During the 4-year period, there were 3,262,526 deliveries, and 11,824 women were admitted to ICUs during the pregnancy or afterward. The rate of pregnancy-related ICU admissions was 3.62 per 1,000 deliveries and decreased between 2006 through 2009, from 3.94 to 3.39 per 1,000 deliveries ($p < 0.0001$) (**Fig. 2**).

Overall, the mean age of women admitted to ICUs was 30.5 years and 21.5% were older than 35 years (**Table 1**). Most were admitted during the delivery hospitalization or the postpartum period (62.8%) and 57.7% had had a cesarean delivery. On average, 13.6 ($\pm$ 0.1) medical procedures were performed during the mean 3.0-day ($\pm$ 0.1 d) stay in the unit. This length of stay accounted for one third of the entire hospitalization. The mean SAPS II score was 19.7 ($\pm$ 0.1) and 23% of women had a SUP REA code that indicated that they underwent specific procedures for organ failure. There were a total of 154 maternal deaths, for a case fatality rate of 1.3% (Table 1).

Women admitted to the ICU more than once did not differ significantly from those admitted only once for the mean of age, the proportions of multiple pregnancies,
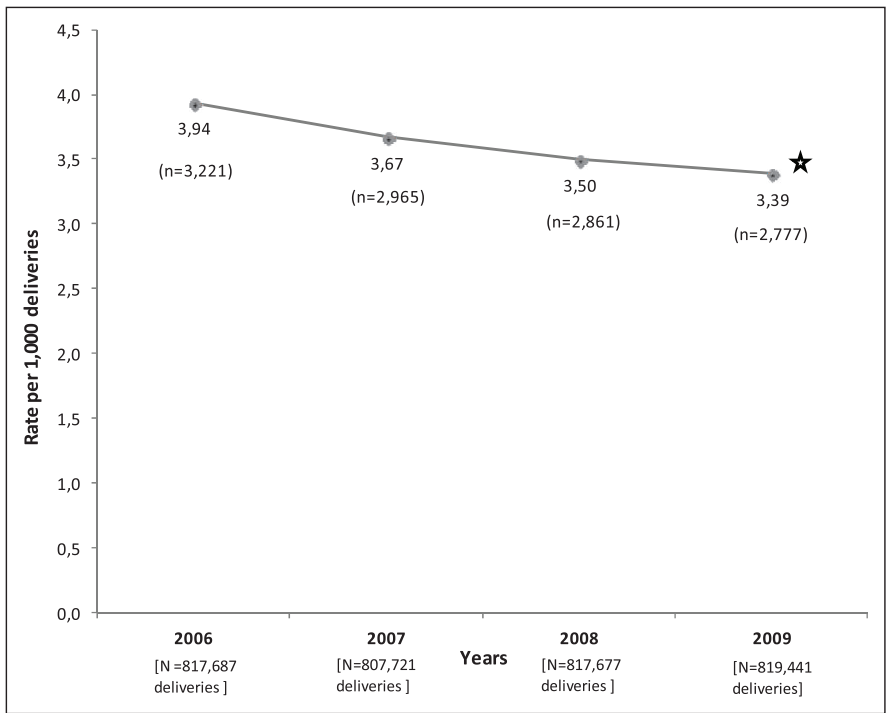

Figure 2. Rate of pregnancy-related ICU admissions, France 2006–2009. ☆Overall trend test: $p < 0.001$.

TABLE 1. Characteristics of Women With Pregnancy-Related ICU Admissions, Characteristics of ICU Stays and Trends in France, 2006–2009

Women and ICU Stays Characteristics	Total Mean ± SD n (%)	2006 Mean ± SD n (%)	2007 Mean ± SD n (%)	2008 Mean ± SD n (%)	2009 Mean ± SD n (%)	2006–2009 p Trend
Total of women	11,824 (100.0)	3,221 (100.0)	2,965 (100.0)	2,861 (100.0)	2,777 (100.0)	
Age	30.5 ± 0.1	30.4 ± 0.1	30.3 ± 0.1	30.6 ± 0.1	30.6 ± 0.1	0.08
Age > 35 yr	2,545 (21.5)	650 (20.2)	601 (20.3)	653 (22.8)	641 (23.1)	< 0.001
Multiple pregnancies	611 (5.2)	169 (5.2)	155 (5.2)	144 (5.0)	143 (5.1)	0.78
Cesarean deliveries[a]	4,290 (57.7)	1,153 (56.3)	1,138 (60.1)	1,047 (57.9)	952 (56.4)	0.82
Delivery and postpartum admissions	7,431 (62.8)	2,047 (63.6)	1,891 (63.8)	1,806 (63.1)	1,687 (60.7)	0.03
Length of ICU stays (d)	3.0 ± 0.1	2.7 ± 0.1	2.9 ± 0.1	3.2 ± 0.1	3.2 ± 0.1	< 0.001
Length of in-hospital stays	9.9 ± 0.1	9.7 ± 0.2	9.9 ± 0.2	10.1 ± 0.2	10.0 ± 0.2	0.85
Total number of medical procedures	13.6 ± 0.1	11.8 ± 0.2	13.3 ± 0.3	14.3 ± 0.3	15.4 ± 0.4	< 0.001
Simplified Acute Physiology Score (SAPS) II	19.7 ± 0.1	18.4 ± 0.2	19.2 ± 0.3	20.5 ± 0.3	20.8 ± 0.4	0.01
SUP REA	2,723 (23.0)	631 (19.6)	669 (22.6)	702 (24.5)	720 (25.9)	0.01
Maternal deaths	154 (1.3)	36 (1.1)	51 (1.7)	31 (1.1)	36 (1.3)	0.93

[a]Among women admitted to ICU during the delivery and the postpartum period.

and cesarean deliveries. However, they had significantly longer ICU stays (5.5 ± 0.4 days vs 2.9 ± 0.0 days, $p < 0.0001$), higher SAPS II scores (18.7 ± 0.7 vs 16.8 ± 0.1, $p = 0.005$) and a greater proportion of SUP REA codes than women admitted to ICU only once (30.8 vs 22.8%, $p < 0.0001$).

Over the 4-year period, the proportion of women older than 35 years increased significantly and the severity of cases increased, with significantly longer ICU stays, higher SAPS II scores, more medical procedures performed, and a greater proportion of SUP REA code. The case fatality rate did not change significantly (Table 1).

In women older than 35 years, severity of pregnancy-related ICU admissions was higher, ICU stays were significantly longer (3.2 vs 2.9 d, $p = 0.02$), SAPS II score significantly higher (23.2 vs 18.7, $p < 0.001$), the proportion of SUP REA codes significantly larger (28.4% vs 21.6%, $p < 0.001$), and the risk of death significantly higher (odds ratio = 1.6 [1.2–2.4]), than for women younger than 35.

The leading principal diagnoses in women with pregnancy-related ICU admissions to ICUs were obstetric hemorrhages (34.2%) and hypertensive disorders of pregnancy (22.3%); they were followed by organ dysfunctions and diseases of the circulatory system (Table 2). Over the 4 years, the cause-specific rate of pregnancy-related ICU admissions significantly decreased for hypertensive disorders, for thromboembolic disorders, and for the category of other diagnoses.

There were 154 maternal deaths that occurred in the ICUs, giving a case fatality rate of 1.3%. The three principal causes of maternal deaths in the ICUs were hemorrhages (25%), diseases

of the circulatory system (21%), and hypertensive disorders of pregnancy (13%) (**Table 3**). The severity of cases varied according to the principal diagnosis involved. Amniotic fluid embolism had the longest ICU stay, the greatest proportion of SUP REA codes (64%), and the highest case fatality rate (36%). It was followed by complications of anesthesia, infectious disease, and circulatory disease, all of which had high proportions of SUP REA codes (respectively, 24.2%, 48.0%, and 20.7%), and high case fatality rates (respectively, 6.1%, 3.8%, and 3.4%). Conversely, hemorrhages, hypertensive, and thromboembolic disorders had the lowest case-fatality rates, the lowest SAPS II scores, short ICU stays, and low proportions of SUP REA codes.

Between 2006 and 2009, the severity of cases significantly increased in women admitted to an ICU for hypertensive disorders (higher mean SAPS II score and higher proportion of SUP REA code) as for those admitted for hemorrhages and other diagnoses (greater proportions of SUP REA codes), whereas it remained stable for the other conditions (**Table 4**).

DISCUSSION
Using national hospital data, we estimated at 3.6 per 1,000 deliveries the mean rate at which women in France were admitted to ICUs during pregnancy, delivery, or the postpartum period from 2006 to 2009. During this period, this admission rate decreased, whereas the severity of the cases increased. Nonetheless, the case fatality rate remained stable at around 1.3%. Hemorrhages and hypertensive disorders of pregnancy were the two conditions accounting for the largest number of admissions, but they were not the most severe.

TABLE 2. Principal Diagnoses of Women With Pregnancy-Related ICU Admissions, Rates per 1,000 Deliveries and Trends in France, 2006–2009

Principal Diagnoses	Total		2006	
	n (%)	Rate/1,000 Deliveries	n (%)	Rate/1,000 Deliveries
Total of women	**11,824** (100)	3.62	**3,221** (100)	3.94
Hemorrhage	4,043 (34.2)	1.24	1,046 (32.5)	1.28
Hypertensive disorder of pregnancy	2,636 (22.3)	0.81	708 (22.0)	0.87
Disease of the circulatory system	941 (8.0)	0.29	225 (7.0)	0.27
Heart disease	545 (4.6)	0.17	134 (4.2)	0.16
Cerebrovascular disease	199 (1.7)	0.06	38 (1.2)	0.05
Other circulatory disease	197 (1.7)	0.06	53 (1.6)	0.06
Infectious disease	425 (3.6)	0.13	93 (2.9)	0.11
Thromboembolic disorder	333 (2.8)	0.10	103 (3.2)	0.13
Pulmonary embolism	262 (2.2)	0.08	86 (2.7)	0.11
Other thromboembolism disorder	71 (0.6)	0.02	17 (0.5)	0.02
Complication of anesthesia	66 (0.6)	0.02	13 (0.4)	0.02
Amniotic fluid embolism	52 (0.4)	0.02	13 (0.4)	0.02
Organ dysfunction	1,963 (16.6)	0.60	484 (15.0)	0.59
Other	1,365 (11.5)	0.42	536 (16.6)	0.66

Boldface values indicate the total number of women in each column.

The pregnancy-related ICU admission rate described in our study is close to that reported in other population-based studies (between 0.05% and 1.54%). Nonetheless, when we exclude the study by Madan et al (26) in New Jersey, which reported a 10 time higher rate than the others, the rate in France is near the upper end of the range (0.05–0.42%) (23, 28). Inversely, the French case fatality rate of 1.3% falls into the lower end of the range reported in the literature, with a mean rate around 3.0%. These combined results suggest that the criteria for pregnancy-related ICU admission are less restrictive in France than elsewhere (23).

Between 2006 and 2009, the pregnancy-related ICU admission rate decreased, whereas the severity of the cases admitted increased. The time spent in the ICU increased, with more medical procedures performed, more life support procedures (SUP REA code), and higher SAPS II scores. Nonetheless, the overall case mortality rate remained low and stable over this period, thereby suggesting an effective management of the women in these units.

The increase in severity was not uniform for all conditions; it affected particularly women with hemorrhages, hypertensive disorders of pregnancy, and "other" diagnoses. The decline in the frequency of ICU admissions for these diagnoses, recognized as the least lethal, together with the increase in their severity over the same period attests to the progressive improvement in the selection of cases for transfer to the ICU. Such changes indicate a lower underuse of ICU pointed out by Hazelgrove et al (25) in 2011 in England and others (33, 34).

Reserving ICUs for the most severe cases, which require the most high-technology care, enables more effective use of the resources available in these units.

However, our results underline that further improvements in this selection are still possible. For example, too many women with pulmonary embolisms seem to have been admitted according to the distribution marker in this subgroup. These cases, which are both rare and rarely fatal, use almost none of the technical life support equipment available in ICUs (6.9% of SUP REA codes compared with 64.2% for amniotic embolisms). On the other hand, although pulmonary embolisms do not appear to be the most severe pregnancy-related disorder in the ICU, they represent nonetheless the second most common direct cause of maternal deaths in France during our study period (35). Accordingly, as for other causes, it appears difficult to estimate the risk-benefit balance between too many ICU admissions and inadequate treatment and monitoring of pulmonary embolisms. Restricting ICU admissions further does not mean that women with diseases of intermediate severity who require close monitoring nonetheless can be treated in the maternity ward, where neither specialized staff nor the appropriate technical equipments are available (17, 25). It is for this reason that many specialists currently raise the question of opening high-dependency care units (HDUs) that can provide the continuous monitoring required for treating these intermediate-severity cases (15, 17, 25). Nonetheless, opening these kind of units throughout the country cannot be

2007		2008		2009		
n (%)	Rate/1,000 Deliveries	*n* (%)	Rate/1,000 Deliveries	*n* (%)	Rate/1,000 Deliveries	*p* Trend
2,965 (100)	3.67	**2,861** (100)	3.50	**2,777** (100)	3.39	< 0.001
999 (33.7)	1.24	1,001 (35.0)	1.22	997 (35.9)	1.22	0.25
684 (23.1)	0.85	640 (22.4)	0.79	604 (21.8)	0.74	0.01
213 (7.2)	0.26	264 (9.2)	0.32	239 (8.6)	0.29	0.20
127 (4.3)	0.16	152 (5.3)	0.18	132 (4.8)	0.16	0.75
50 (1.7)	0.06	60 (2.1)	0.07	51 (1.8)	0.06	0.13
36 (1.2)	0.04	52 (1.8)	0.06	56 (2.0)	0.07	0.44
120 (4.0)	0.15	100 (3.5)	0.12	112 (4.0)	0.14	0.45
81 (2.7)	0.10	77 (2.7)	0.09	72 (2.6)	0.09	0.02
63 (2.1)	0.08	58 (2.0)	0.07	55 (2.0)	0.07	0,01
18 (0.6)	0.02	19 (0.7)	0.02	17 (0.6)	0.02	0,92
17 (0.6)	0.02	20 (0.7)	0.02	16 (0.6)	0.02	0.52
18 (0.6)	0.02	12 (0.4)	0.02	9 (0.3)	0.02	0.29
485 (16.3)	0.60	499 (17.4)	0.61	495 (17.8)	0.60	0.70
348 (11.7)	0.43	248 (8.6)	0.30	233 (8.4)	0.28	< 0.001

the only approach; the local context of healthcare supply and demand must be taken into account. In France, the disappearance of small maternity units, in favor of very large ones, could justify the opening of some HDUs, but the minimal threshold of activity for their creation remains to be defined. Some of these units have recently opened in France, and it would be useful to assess their impact on the rate of ICU admissions.

Nonetheless, to better direct women toward the correct unit (ICU or intermediate-care unit), physicians need appropriate tools to document the severity of each patient's condition (25, 36). The use of the SAPS II mortality prediction score in obstetrics is controversial. This score, which is not adapted to the physiological norms of pregnancy, tends to overestimate mortality among pregnant or recently delivered women (24, 25, 36, 37). Since adequate predictive tools for deciding about the need to transfer these women to an ICU need to be developed, adaptation of the SAPS II score to obstetric situations seems conceivable, especially in reducing the age threshold, which is set at 50 years. In our study, all the severity markers were significantly associated with an age older than 35 years. We found that obstetric hemorrhages were the leading cause of both ICU admissions and maternal mortality there. They are also the leading cause of maternal mortality in France according to the national confidential survey (35, 38).Although these two distributions of causes are not entirely identical, this observation tends to strengthen the hypothesis of a continuum of severity of

obstetrical complications. In these circumstances, the pregnancy-related ICU admission can be considered a proxy for severe maternal morbidity, as other authors have mentioned (15, 23).

Our approach, based on a national temporal series of pregnancy-related ICU admissions in which we study the rate of ICU admissions in relation to case severity, is a first in the international literature. One previous study compared trends over time in the distribution of the diagnoses of the women admitted, but did not study the trends in either maternal characteristics or severity; moreover, this study covered data for a single U.S. state and the size of their study population was smaller (23).

The use of the national hospital discharge database was a substantial strength of our study. These data are exhaustive, national, and continuous. The high number of cases they include provides us one of the largest series in the literature. This series, based on more than 3 million deliveries, enables us to study subgroups of patients and conditions, even the limited subgroup of maternal deaths.

Contrary to the studies that have used such hospital data without having validated them, we assessed them first and have demonstrated the quality of coding for ICU admissions. Furthermore, to ensure homogeneity in the series, we chose a period when the regulations governing this coding was stable; this stability allowed us to study trends in frequency and in the women's profiles in an original aspect of this work.

TABLE 3. Severity of Pregnancy-Related ICU Admissions by Principal Diagnosis in France, 2006–2009

Principal Diagnoses	Total	Deaths[a]	Case Fatality-Rate[b]	Simplified Acute Physiological Score II	SUP REA[c]	ICU Length of Stay (d)
	n	n (%)	%	Mean ± SD	n (%)	Mean ± SD
Total of women admitted to ICU	**11,824**	**154 (100)**	**1.3**	**19.7**	**2,723** (23.0)	**3.0**
Hemorrhage	4,043	39 (25.3)	0.9	18.9 ± 0.2	1,131 (27.9)	2.0 ± 0.1
Hypertensive disorder of pregnancy	2,636	20 (13.0)	0.7	18.2 ± 0.3	400 (15.2)	3.0 ± 0.1
Disease of the circulatory system	941	32 (20.8)	3.4	25.8 ± 0.9	195 (20.7)	5.3 ± 0.3
Heart disease	545	11 (7.1)	2.0	28.1 ± 1.4	131 (24.0)	5.2 ± 0.5
Cerebrovascular disease	199	17 (11.0)	8.5	26.2 ± 1.8	51 (25.6)	7.5 ± 0.9
Other circulatory disease	197	4 (2.6)	2.0	18.6 ± 1.9	13 (6.6)	3.1 ± 0.3
Infectious disease	425	16 (10.5)	3.8	24.8 ± 0.8	204 (48.0)	6.6 ± 0.5
Thromboembolic disorder	333	3 (2.0)	0.9	15.6 ± 1.1	23 (6.9)	3.7 ± 0.3
Pulmonary embolism	262	3 (2.0)	1.1	16.7 ± 1.3	20 (7.6)	3.7 ± 0.3
Other thromboembolism disorder	71	0 (0.0)	0	12.0 ± 1.3	3 (4.2)	3.6 ± 0.4
Complication of anesthesia	66	4 (2.6)	6.1	23.1 ± 3.1	16 (24.2)	1.9 ± 0.2
Amniotic fluid embolism	52	19 (12.3)	35.8	41.7 ± 3.8	34 (64.2)	3.3 ± 0.5
Organ dysfunction	1,963	19 (12.3)	0.9	22.5 ± 0.4	581 (29.6)	3.9 ± 0.2
Other	1,365	2 (1.3)	0.1	15.7 ± 0.3	140 (10.3)	1.9 ± 0.1

[a]Proportions based on the total of maternal deaths, $n = 154$.
[b]Number of deaths by principal diagnosis divided by the total number of women admitted to ICU for the same diagnosis.
[c]Number of SUP REA codes by principal diagnosis divided by the total of women admitted to ICU for the same diagnosis.
Boldface values indicate the total number of women in each column.

Finally, another strength is our use of four indicators for studying severity. Particularly, the major advantage of the use of the SUP REA codes is to distinguish between women admitted to ICUs for management of life support and organ failure and those admitted to ICU only for monitoring. Indeed, its definition (SAPS II score over 15 and the use of specific organ failure procedures) characterizes the most severe cases (organ failure) and allows to consider this code as a useful marker of severity. This SUP REA code is available in the hospital discharge database and their use in the future for monitoring the most severe maternal complications in the ICU appears both possible and pertinent.

Our work also includes some limitations.

First, these databases are a medicoeconomic tool for managing healthcare facilities. Consequently, they do not provide some information that is nonetheless necessary for research, including women's parity, body mass index, geographic origin, socioeconomic status, or medical or obstetric history. This lack of information limits these analyses to some extent.

Another limitation concerns the accuracy of coding for diagnoses often considered as over reported in the literature. In a previous work we found that the validity of their coding depends principally on the organization of the information production circuits at the hospital level (30, 39). Nonetheless,

improvement in thequality of the coding has become a concern in France, with the multiplication of regular internal and external checks and progress in the training of coders. Consequently, the substantial decrease in the proportion of the category of diagnoses classified as "other" in our study is not due to changes in the classification rules but probably reflects the progressive improvement in the precision of diagnostic coding.

CONCLUSION

Available in numerous permanent databases, the criterion of pregnancy-related ICU admissions combined with severity indicators makes it possible to monitor in the general population trends in the frequency and profile of severe maternal morbidity, together with developments in the organization of care. The concomitant decrease in frequency admission and increase in severity of cases raises question about the need to transfer some women toward high-dependency care units, more adapted for the management of cases of intermediate severity, instead of ICUs.

ACKNOWLEDGMENTS

TABLE 4. Evolution of the Severity of Women With Pregnancy-Related ICU Admission by Condition in France, 2006–2009

Principal Diagnoses	Total	Evolution of the Simplified Acute Physiological Score II Score			Evolution of SUP REA			Evolution of the ICU Length of Stay (d)		
		2006	2009		2006	2009		2006	2009	
	n	Mean	Mean	*p* Trend	*n* (%)	*n* (%)	*p* Trend	Mean	Mean	*p* Trend
Hemorrhage	4,043	18.1	19.8	0.61	255 (24.4)	302 (30.3)	0.01	1.9	2.1	0.46
Hypertensive disorder of pregnancy	2,636	16.8	18.9	0.02	86 (12.1)	112 (18.5)	0.01	2.6	3.0	0.93
Disease of the circulatory system	941	23.4	28.9	0.10	43 (19.1)	45 (18.8)	0.89	4.6	5.7	0.66
Heart disease	545	25.4	31.9	0.07	29 (21.6)	33 (25)	0.35	5.0	6.2	0.60
Cerebrovascular disease	199	24.8	24.0	0.73	11 (28.9)	8 (15.7)	0.18	4.8	6.8	0.95
Other circulatory disease	197	15.6	25.4	0.33	3 (5.6)	4 (7.1)	0.87	2.9	2.6	0.53
Infectious disease	425	23.6	23.9	0.27	47 (50.5)	50 (44.6)	0.34	5.7	5.4	0.23
Thromboembolic disorder	333	14.8	15.2	0.74	6 (5.8)	3 (4.2)	0.84	3.5	3.8	0.90
Pulmonary embolism	262	15.5	17.3	0.50	6 (7.0)	2 (3.6)	0.64	3.6	4.1	0.63
Other thromboembolism disorder	71	11.0	11.3	0.78	0 (0.0)	1 (5.9)	0.43	2.9	2.6	0.53
Complication of anesthesia	66	15.6	30.2	0.50	4 (30.8)	4 (25.0)	0.90	1.7	1.9	0.51
Amniotic fluid embolism	53	53.1	45.5	0.09	8 (61.5)	5 (55.6)	0.88	2.6	3.4	0.43
Organ dysfunction	1,963	21.3	24.2	0.38	144 (29.8)	163 (32.9)	0.21	3.8	4.4	0.01
Other	1,365	15.0	17.2	0.14	39 (7.3)	36 (15.5)	<0.001	1.6	2.5	<0.001

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APPENDIX 1. Acts Indicating Life Support

Continuous intracranial pressure monitoring	ABQP001
Cardiopulmonary resuscitation	DKMD001; DKMD002
Spontaneous mask or cannula ventilation with positive expiratory pression	GLLD003
Mechanical ventilation	GLLD004; GLLD007; GLLD008; GLLD012
External cardiac shock <defibrillator>	DERP004
Temporary transcutaneous cardiac pacing	DERP005
Extracorporeal circulation and/or its monitoring	EQCF001
System monitoring	EQQP004; EQQP013; GLQP015
Others types of ventilation	GLLD019; GLLD011; GLLD009; GLLD010
Dialysis, of any type	JVJB002; JVJF002; JVJF003; JVJF005; GLJF001; GLJF002
Exchange-transfusion	FEJF001; FELF012
Pericardial drainage	DCJB001; DCJB002
Infusion of vasoactive products or high-throughput fluid replacement therapy	EQLF002; EQLF003
Local fibrinolytic treatment of pulmonary artery	DFNF001
Rapid transfusion	FELF004
Support (hemodynamic, ventilatory, coagulation)	EQMP001; EQMF003; FELF003
Hyperbaric oxygen therapy	GLLD001
Therapeutic plasma exchange	FEJF002