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## **Hospital discharge data can be used for monitoring procedures and intensive care related to severe maternal morbidity.**

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1 **Abstract**

2

3 **Objective:** To estimate the accuracy and reliability of the reporting of diagnoses and  
4 procedures related to severe acute maternal morbidity in French hospital discharge data.

5

6 **Study design and setting:** The study, conducted in four French tertiary teaching hospitals,  
7 covered the years 2006 and 2007 and 30,607 deliveries. We identified severe maternal  
8 morbid events – eclampsia, pulmonary embolism, procedures related to postpartum  
9 hemorrhages, and intensive care – in administrative hospital discharge data and medical  
10 records and compared their recording. Information from medical records was the gold  
11 standard. Sensitivity, specificity, positive and negative predictive values of the hospital  
12 discharge data for these events were calculated. False positives and false negatives were  
13 examined to identify the reasons for misrecorded information.

14

15 **Results:** The positive predictive value of the hospital discharge data was 20% for eclampsia.  
16 For procedures related to postpartum hemorrhages, their positive predictive values were  
17 high, but sensitivities were lower; however, 95% of recording errors could be corrected. All  
18 indicators for intensive care exceeded 98%.

19

20 **Conclusion:** Intensive care and procedures seem reliably reported in the hospital  
21 administrative database, which therefore can be used to monitor them. Use these data for  
22 monitoring diagnoses will require a greater investment by clinicians in the accuracy of their  
23 reporting.

24

25 **Key words:** Severe maternal morbidity - Hospital discharge data – Validity – Sensitivity -  
26 Positive predictive value - Medical records.

27

**Running title:** Validity of obstetric hospital discharge data.

28

**Word count:** 200 words.

29 **What is new ?**

30

31 **- Key finding**

32 Intensive care and procedures for postpartum hemorrhages seem reliably and accurately  
33 reported in the hospital discharge database.

34

35 **- What this adds to what we know?**

36 Hospital discharge data could be used for monitoring several events related to severe  
37 maternal morbidity.

38

39 **- What should change now?**

40 Monitoring diagnoses in hospital discharge databases will require a greater investment by  
41 clinicians in the accuracy of their reporting and regular internal quality controls.

42

## 43 **Introduction**

44

45 Hospital administrative databases are a useful tool for measuring hospital activity [1]. They  
46 are employed to define health priorities, assess the costs of providing health care, and  
47 optimize the organization of healthcare facilities [2,3]. For some 20 years, these routinely  
48 collected data have also been used for research purposes to measure disease incidence  
49 [4,5] or procedure frequencies, assess the rate of complications of hospitalizations or surgery  
50 [6,7] and identify the determinants of medical conditions [8-10]. The validity of these data  
51 depends simultaneously on the reliability of the information recorded and the accuracy of  
52 their coding at different stages of processing. Studies to validate hospital administrative data  
53 in the United States [11,12], Canada [6], Australia [9,10,13] and Scandinavia [5,14,15] have  
54 generally concluded that they can be used, but underline their numerous limitations,  
55 including substantial inter-facility variability in coding quality [16-19], better coding for more  
56 serious complications and diseases [7,20], and better recording of procedures than  
57 diagnoses [16,21,22]. Most reports on the validation of these data come from English-  
58 speaking countries. They are relatively sparse in Europe. Such studies in France have  
59 covered the fields of oncology [4,10,23,24], intensive care [25] and vascular disease [26], but  
60 not obstetrics.

61 Routine childbirth in France takes place within the hospital system. Although no disease is  
62 present in most obstetric hospitalizations, a non-negligible but unknown number involve  
63 complications of pregnancy, delivery or the postpartum period. Today, changing trends in  
64 obstetric practices and in maternal profiles require the development of indicators that can  
65 measure and monitor severe maternal morbidity.

66 Hospital databases are a potential tool for estimating the frequency of severe maternal  
67 morbidity and following its trends over time because women with such morbidity are always  
68 hospitalized and administrative records are supposedly exhaustive, rapidly available and

69 inexpensive to use. However, before this information can be used, its validity must be  
70 assessed.

71 Several studies in Australia and in the USA sought to validate hospital discharge data for  
72 numerous obstetrical complications (as many as 50) [13], or on the contrary, have  
73 concentrated on only one or two [20,27,28]. Because there is no consensual definition for  
74 severe maternal morbidity, we focused on the severe maternal morbid events (SMME) that  
75 are the most frequent causes of maternal mortality [29-31].

76 Our objective was to study the validity of French hospital discharge data from the  
77 Programme of Medicalization of Information System (PMSI) for some SMME. More  
78 specifically, our aim was to evaluate whether the SMME were transcribed in the PMSI as  
79 they were described in the medical records.

80

## 81 **Material & methods**

82

### 83 *PMSI*

84 Inspired by the American DRG (diagnosis-related groups) model [2], the PMSI was  
85 established in France in 1991 [3] and extended in 1997 to all French healthcare facilities [32].  
86 Initially designed to analyze hospital activity and contribute to the strategic elaboration of  
87 facility plans, it has become an instrument of financial management. Since 2008, each  
88 hospital's budget has depended on the medical activity described in this PMSI [33], which  
89 compiles discharge abstracts for every admission. Information in these abstracts is  
90 anonymous and covers both administrative (age, sex, geographic code of residence, year,  
91 month and type of admission, year, month, and type of discharge, facility status) and medical  
92 data. Diagnoses identified during the admission are coded according to the 10th edition of  
93 the International Classification of Diseases (ICD10). The condition occasioning the greatest  
94 use of resources during the hospitalization is recorded as the main diagnosis, with other  
95 diseases listed as associated diagnoses [34]. All procedures performed during the  
96 hospitalization are coded according to the French Common Classification of Medical

97 Procedures (CCAM). PMSI rules are national and imposed by the government. Each facility  
98 produces its own anonymous standardized data, which are then compiled at the national  
99 level. Our validation study was conducted on this PMSI database.

100

#### 101 *Selection of the study population*

102 First, PMSI abstracts from the four study hospitals (Caen, Cochin [AP-HP, Paris], Grenoble  
103 and Lille, university hospitals) were extracted from the national database. Then, we selected  
104 hospitalizations of women of reproductive age (14 to 50), with at least one code related to  
105 pregnancy, delivery, or the postpartum period, and who were discharged from 1 January  
106 2006 through 31 December 2007 (Figure 1). Women who did not give birth in one of the  
107 study hospitals were excluded because the content of their medical records was incomplete.

108

#### 109 *Selection of hospitalizations*

110 Within the selected PMSI database (= 64,061 abstracts), we identified abstracts including at  
111 least one of the following SMME: diagnosis of eclampsia; diagnosis of pulmonary embolism;  
112 one of the following procedures for treating postpartum hemorrhages: uterine artery  
113 embolization, uterine artery ligation, uterine vascular pedicle ligation, or hysterectomy; or  
114 finally, intensive care. In the PMSI, the intensive care variable is defined by admission to  
115 intensive care unit and/or a simplified acute physiology score (SAPS II)  $\geq 15$  associated with  
116 at least one specific procedure. The hospitalizations were selected from the PMSI by  
117 searching for specific codes for each of these SMME (figure 1) which occurred during the  
118 whole maternal risk period as defined by the WHO (pregnancy, delivery and post-partum).  
119 When several abstracts described the same event for the same woman, the event was  
120 counted only once.

121

#### 122 *Validation of the PMSI recorded data*

123 The medical record was considered to be the gold standard. The term or name of each of the  
124 SMME under study was used to search for it in the medical records.

125 The SMME identification in the medical records was made possible by querying an additional  
126 database: the database of computerized medical records available in all four centers. For  
127 2006-2007, 30,614 deliveries were recorded in this database. In centers 1 and 3, the medical  
128 records and computerized medical records were combined. In centers 2 and 4, the  
129 computerized records consisted of a complementary database where information was  
130 entered daily by clinicians during hospitalization. SMME were identified in the computerized  
131 databases by searching for their terms.

132 This computerized medical records database has been linked with the database extracted  
133 from the PMSI using the following variables: patient's age, month and type of admission to  
134 hospital, month and type of discharge, length of stay and geographic code of residence.

135 The cases selected from the PMSI were compared with the data from the matching medical  
136 records. This comparison involved a simple reading of the source medical record with all its  
137 components: discharge letters (to referring and primary care physicians), nursing records,  
138 hospital and surgical reports. Specifically, we did not interpret any examinations or judge any  
139 diagnoses. The SMME we sought was either specifically mentioned in the record or it was  
140 not.

141 The true positives were the SMME identified simultaneously in the PMSI abstracts and in the  
142 corresponding medical records. Inversely, false positives were events recorded in the PMSI  
143 that did not exist as such in the patients' records.

144 False negatives were the SMME experienced by patients and listed in their medical records,  
145 but not reported in the PMSI. On the contrary, true negatives corresponded to all the  
146 situations in which no SMME was listed in either the patient's record or the PMSI abstract.

147 The causes of both false positives and false negatives were further analyzed by reading the  
148 complete medical chart and examining all the codes of the hospital discharge abstract.

149

150 The National Data Protection Authority (Commission Nationale de l'Informatique et des  
151 Libertés) approved the study (n° 1004749).

152

153 *Statistical analyses*

154 To estimate the accuracy and reliability of the PMSI database for the SMME studied, we  
155 analyzed sensitivity, specificity, positive predictive value (PPV), and negative predictive value  
156 (NPV) of the PMSI data relative to the source medical records.

157 Sensitivity was the probability that PMSI data correctly identified a woman with a SMME;  
158 specificity was the probability that PMSI data correctly identified a woman with no SMME.

159 The PPV corresponded to the probability that a woman had a SMME given that SMME was  
160 also coded in the PMSI. The NPV, on the other hand, was the probability that a woman had  
161 not a SMME given SMME was also not coded in the PMSI.

162 Cohen kappa scores were calculated to assess the degree of agreement between the two  
163 databases, taking random agreement into account. The Kappa score proposes a neutral  
164 description of the agreement between the two data sources for each event, without  
165 attributing more importance to the database serving as a reference for the other analyses.  
166 Excellent agreement was defined as a score greater than 0.80, substantial from 0.80 to 0.60,  
167 moderate from 0.59 to 0.40, and poor below 0.40 [35]. Confidence intervals (CI) were  
168 determined with a type I risk of 5%.

169

170 **Results**

171

172 For 2006-2007, among the 64,061 PMSI abstracts, 1,022 abstracts identified an SMME.

173 After the study of duplicates, 403 single SMME were identified in the PMSI.

174 In the PMSI, the three most frequent SMME were, in decreasing order: intensive care,  
175 eclampsia, and embolizations (Table 1). Comparison with the content of the corresponding  
176 medical files validated 314 SMME of the 403 identified in the PMSI. After validation, the order  
177 of frequency was modified, and eclampsia moved from the second most frequent event in the  
178 PMSI to the least frequent.

179

180 Considering the study population of 30,614 women who delivered during the study period,  
181 the analysis of the false positives and false negatives in the PMSI showed three distinct  
182 situations: a high proportion of false positives for diagnoses, false negatives for procedures,  
183 and few false positives or negatives for intensive care (Table 1).

184 The rate of false positives was 80% for eclampsia. Analysis of the medical records failed to  
185 validate 67 of the 84 cases of eclampsia identified in the PMSI. Similarly, 36% of the  
186 pulmonary embolisms, that is, 11 of 31 recorded in the PMSI, were not confirmed in the  
187 medical records.

188 There was only one case of false positive for postpartum hemorrhage procedures, for 1 of  
189 the 34 ligations mentioned in the PMSI. However, the proportion of false negatives for  
190 procedures was 44% for embolizations and 25% for hysterectomies and ligations. Overall, 56  
191 embolizations, 8 hysterectomies and 11 ligations were not identified in the PMSI.

192 The PMSI and the medical records listed the same number of cases receiving intensive care,  
193 although there were three false positives and three false negatives.

194 For seven SMME identified in the PMSI, the corresponding computerized file was empty, and  
195 the accuracy of the information could not be checked. Consequently, these cases could not  
196 be classified as either true or false positive, and their status is described as “uncertain”  
197 (Table 1). This concerned five eclampsia and two embolisations.

198  
199 The analysis of the content of medical records showed that the false positives for eclampsia  
200 in the PMSI corresponded to less severe situations, such as preeclampsia, isolated  
201 gestational hypertension or isolated proteinuria. The study of the PMSI false negatives for  
202 procedures found that 95% of them (71/75) were due to inappropriate coding of procedures  
203 for postpartum hemorrhage management that were mentioned in the PMSI but with codes  
204 not specific to the postpartum period. For example, medical records reported emergency  
205 hysterectomies for massive postpartum hemorrhage, whereas the corresponding PMSI  
206 abstract coded for a planned hysterectomy in a non-obstetric context (CCAM code JFKA015  
207 instead of JNFA001). Another frequent error was miscoding of embolization of uterine

208 arteries for postpartum hemorrhage as embolization conducted as a preoperative phase for  
209 oncologic surgery, outside of pregnancy.

210

211 Table 2 presents the values of the indicators calculated for the PMSI, with the medical  
212 records as the reference, by type of SMME.

213 Because the PMSI had numerous false positive errors for eclampsia, its PPV for this disease  
214 was low, only 20%. Its PPV for pulmonary embolism was 65%. On the contrary, the PMSI  
215 was highly sensitive for these diagnoses, respectively, 85% and 83%. Inversely, the PPVs of  
216 the PMSI for procedures were very high, ranging from 97% to 100%, although values for  
217 sensitivities ranged from 56% to 75%, reflecting the false negative errors found in the  
218 preceding analysis. We considered these false negatives for procedures rectifiable since the  
219 context of pregnancy/delivery could be identified through other codes contained in the PMSI  
220 abstracts. In consequence, we secondarily considered these records as true positive cases  
221 of SMME in PMSI, and recalculated revised estimates for the validity indices (Table 2).The  
222 revised sensitivities of the PMSI exceeded 95% for embolizations as for ligations, and  
223 reached 100% for hysterectomies.

224 For intensive care, the sensitivity, specificity, PPV and NPV of the PMSI all exceeded 98%  
225 and the kappa score was close to 1.

226 Sensitivity analyses were conducted to evaluate the impact on the calculated indicators of  
227 the seven PMSI SMME cases for which the accuracy of information could not be checked in  
228 the medical records, and showed similar results.

229

230 The results by center point out two particular situations (Table 3). In centers 1 and 2, the  
231 sensitivity, specificity, PPV and NPV of the PMSI data were greater than 80% for identifying  
232 SMME. On the other hand, SMME were recorded less accurately in centers 3 and 4. In  
233 center 3 where most of the mis-coding errors for embolizations were found, the sensitivity of  
234 the PMSI data greatly improved after correction of these codes. In center 4, the sensitivity of  
235 the PMSI data also improved after correction of procedures codes not specific to the

236 obstetrical context, but its 57% PPV reflected the large number of false positives found for  
237 cases of eclampsia in this facility.

238

## 239 **Discussion**

240

241 This validation study of French hospital discharge database for severe maternal morbidity  
242 shows a various quality of data according to the types of event and centers. The PMSI  
243 appears to overreport diagnoses, although procedures are reported correctly on the whole.  
244 PMSI reporting of intensive care is very reliable. Two hospitals correctly transcribed their  
245 SMME data in hospital discharge abstracts, whereas two others require improvements: one  
246 for false negatives, the other because of false positives.

247

248 Our study has several limitations. First, there is no consensual definition of severe maternal  
249 morbidity. Our selected SMME do not cover all types of maternal morbidity, but they do cover  
250 those that are the most frequent causes of maternal deaths [29-31]. In addition, our  
251 combination of events makes it possible to analyze the validity of various types of hospital  
252 data, namely diagnoses, procedures and management codes.

253 The type of hospitals selected might have resulted in selection bias. All are tertiary teaching  
254 hospitals, chosen because they treat the most severe cases of maternal morbidity in their  
255 regions. Even though SMME are, obviously, not exclusive to these tertiary hospitals, this type  
256 of facility, which concentrates SMME, remains best for an initial study of PMSI validity related  
257 to severe maternal morbidity, given the low expected frequency of these events. Hsia *et al.*  
258 showed in a different context and field that data from small non-university hospitals are not  
259 reliable [11]. Inversely, Iezzoni *et al.* argued that level III hospitals, because they handle  
260 more complex cases, face greater difficulties in coding and may thus make more frequent  
261 errors [17]. In the obstetric field, Lydon-Rochelle *et al.* [36] found that type II maternity units  
262 (average size and able to care for moderately serious situations) have the most reliable

263 hospital discharge databases. Di Giuseppe *et al.* found no difference in data validity  
264 according to hospital size in a study of 20 maternity units [37].

265 The number of centers included in our study is small, and each has its own organization  
266 regarding collection and coding of hospital discharge data. Despite the national rules for  
267 treatment of these medical data, the quality of their PMSI differed. In our study, it is not the  
268 PMSI data processing system that seems inappropriate for dealing with severe maternal  
269 morbidity, but rather the rigor and quality of its application within each facility. This limitation  
270 prevents us from generalizing our results to the national level. However, this issue is less  
271 relevant for intensive care because the great majority of intensive care units are located in  
272 teaching hospitals; moreover, the intensive care variable is less error-prone due to its  
273 particular coding rules.

274 Our objective was to study the validity of the PMSI database for some SMME. More  
275 specifically, our aim was to know how accurately the PMSI database reflected diagnoses  
276 made and procedures performed by the team in charge of the case. In that context, we did  
277 not reinterpret a posteriori the whole medical information like other authors did [6-  
278 14,16,17,22,27,38-40], but we evaluated whether the SMME were transcribed in the PMSI as  
279 they were described in the medical records. Therefore, our study is based on the comparison  
280 of existing records, and the gold standard is represented by the diagnoses which justified  
281 and generated a specific management. In a different perspective, a study assessing the  
282 accuracy of diagnoses recorded in a series of randomly selected source medical files, by  
283 using a blinded recoding by experts would provide complementary information.

284  
285 The use of computerized medical files was required to search easily and inexpensively for  
286 SMME that were described in records but not reported in the PMSI (false negatives). In half  
287 of the centers (n°1 and 3), these computerized medical files were the actual entire and only  
288 medical record. The search for false negatives in the PMSI was thus possible and even easy.  
289 In the other two centers (n°2 and 4), the computerized medical files were a supplementary  
290 document, completed bit by bit by the clinicians during the course of the hospitalization, and

291 verified daily by midwives specifically assigned to this function. They might therefore be  
292 considered a relevant source for false negatives searching. Our method therefore simplified  
293 the study of false negatives and allowed us to estimate the validity of PMSI coding for the  
294 SMME in a large sample of more than 30,000 deliveries. Nonetheless, it is possible that  
295 some SMME were not entered in the source medical record or in the computerized files.  
296 These false negatives may not have been identified, their number may have been  
297 underestimated, and consequently the sensitivities overestimated. It would have been  
298 possible to randomly sample hospitalizations to estimate the false negative rate in the  
299 medical records. Because SMME are rare events, however, to be valid, this method would  
300 have had to include a very large sample. The cost/benefit ratio of such a study appeared  
301 quite negative to us, and we did not chose this option.

302 However, in the two centers with complementary computerized medical files, midwives daily  
303 verify all the information reported in the computerized medical records, thereby minimizing  
304 the risk of errors and oversights. In addition, according to Altman, serious events are seldom  
305 forgotten during coding [41]. Thus, although this bias should be borne in mind, it is likely to  
306 remain marginal.

307  
308 The analyses of the diagnoses in the PMSI show that their coding validity is poor. The  
309 numerous false positives indicate that diagnoses are overreported in the discharge abstracts.  
310 The low PPV of the PMSI for eclampsia — 20.2% — means that in this database, most so-  
311 called eclampsia cases are not. Detailed examination showed that these cases were instead  
312 severe preeclampsia or HELLP syndrome. Such coding errors are not unusual. Other  
313 authors have found PPVs for eclampsia in hospital databases ranging from 23.5% in an  
314 Australian multicenter study [13,39] to 41.7% for single-center study in Chicago [28], and  
315 50% for a statewide validation in Washington [36].

316 Several factors may explain the overreporting or upcoding of diagnoses in hospital  
317 databases. First, the large variety of participants of diverse skill levels involved in coding  
318 leads to heterogeneity in the quality of the medical information [15,18,36,40,42,43]. Second,

319 the most serious cases, which involved the mobilization of the entire medical team, may be  
320 overcoded to indicate the seriousness of situation [39,40,44,45]. Finally, the payment system  
321 based on severity of diagnosis is a strong incentive to overcoding, that is, it increases  
322 remuneration for the hospital [11,43,46,47]. Our study confirmed these hypotheses for  
323 eclampsia and pulmonary embolisms. Coding at all four hospitals was routinely performed by  
324 employees with widely heterogeneous skill levels and with little or no training in this quite  
325 particular task: nurses, midwives, interns, residents, and sometimes even secretaries or  
326 students. Also in all centers, the cases of severe preeclampsia or deep venous thrombosis  
327 overcoded as eclampsia or pulmonary embolism corresponded to cases with prolonged  
328 hospitalizations or severe illness that required major and expensive treatment.

329

330 On the other hand, the high positive predictive value of the PMSI data for procedures  
331 indicates that these are not overreported. Analysis of the procedures does not show false  
332 positives but rather some false negatives, indicating moderate underreporting of their true  
333 number in the PMSI. The sensitivity of the PMSI for the procedures therefore varies. It is  
334 relatively elevated for hysterectomies and ligations (close to 75%), but lower (56%) for  
335 embolizations. An Australian multicenter study on the validity of administrative databases  
336 found a sensitivity of 28.3% for hysterectomy data in the context of postpartum hemorrhage  
337 and attributed this result to specific coding errors [13,20]. The quality of reporting is better in  
338 our study, but the same type of errors is still present. These errors, first mentioned in the  
339 1990s [12,42-44] and reported still today [20,22], are the consequence of using a  
340 classification that is ever more specific and increasingly complicated. Coding becomes  
341 extremely time-consuming, thus inciting physicians to record procedures in the hospital  
342 databases with the code they use most often, even though perfectly appropriate codes exist  
343 for the specific situation. A similar problem is seen with the use of the "thesaurus", a  
344 summary of codes of procedures performed regularly in the department, which facilitates  
345 coding, but does not describe rare and severe situations correctly [22,42]. Demlo [44,45]

346 predicted this type of problem at the implementation of the system of health-related  
347 administrative databases in the United States in the early 1980s.

348 In our study, most of these false negatives could be easily identified because the hospital  
349 discharge summaries with the non-specific procedure code also contained codes indicating  
350 the context of pregnancy/delivery. In consequence, such a correction could be introduced in  
351 routine. Overall, the high PPV and sensitivity of the PMSI for most of the procedures studied  
352 indicates that their coding is relatively valid and that errors are rectifiable. In these conditions,  
353 it appears acceptable to us to monitor their frequencies from the PMSI.

354  
355 Our findings are consistent with those from international studies that validated similar types  
356 of databases. In obstetrics as in other field, the coding in hospital databases is more reliable  
357 for procedures than for diagnoses [16,19-22,38]. This research appears to us to be an  
358 essential prerequisite to any use of administrative databases. Nonetheless, because they are  
359 easy to access, they are regularly used in hospital departments for research purposes,  
360 without validation. Erroneous data leading to biased results, incorrect conclusions and thus  
361 flawed proposals cannot improve either quality of care or patient health. Like Pollock and  
362 Hadfield [10,48], we hope that other teams across the world will make an effort to validate  
363 their hospital administrative data, especially in the field of severe maternal morbidity, to  
364 facilitate comparisons between countries.

365  
366 An original aspect of our study is to have sought to validate the coding for intensive care in  
367 hospital data. Their sensitivity, specificity, PPV and NPV in the PMSI are very high (>98%).  
368 Related PMSI data are both accurate and reliable. In obstetrics, such intensive care can  
369 therefore be used as a marker of the severity of maternal morbidity, and our results are the  
370 first to show its validity.

371  
372 Our study is one of the first to estimate the validity of hospital administrative databases in  
373 Europe [15,19,26]. Although the only moderate validity of the hospital data means that

374 research cannot be based exclusively on them, it appears likely that the system in France will  
375 improve. Because the reimbursement of medical services is directly correlated with PMSI  
376 data, the national health insurance fund is multiplying external audits to identify coding errors  
377 and overcoding. Facilities where abuses are identified will be required to reimburse  
378 payments for unjustified services. The increase in these external quality controls, in addition  
379 to the internal controls organized by the hospitals, should surely lead to improvements in  
380 data quality.

381

### 382 **Conclusion**

383 Hospital discharge data can be used for monitoring the frequencies of procedures for  
384 postpartum hemorrhages and intensive care related to severe maternal morbidity. The  
385 utilization of PMSI data about diagnoses will require a greater investment by clinicians in the  
386 accuracy of their reporting and regular internal quality controls.

387

388

389 **Count of words** : 4,013 words.

390

391

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397

398

399

### 400 **Titles of figure and tables:**

401

402 - **Figure 1** - Algorithm for selection of the PMSI abstracts

403 - **Table 1** - Severe maternal morbid events (SMME) identified in the PMSI database and in  
404 the medical records, 4 centers, 2006-2007: number, false positives and false negatives \*.  
405 - **Table 2** - Validity of the PMSI data for severe maternal morbid events (SMME): kappa  
406 score, sensitivity, specificity, positive predictive value (PPV) and negative predictive value  
407 (NPV) \*.  
408 - **Table 3** - Validity of the PMSI data for severe maternal morbid events (SMME), per center:  
409 sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) \*.  
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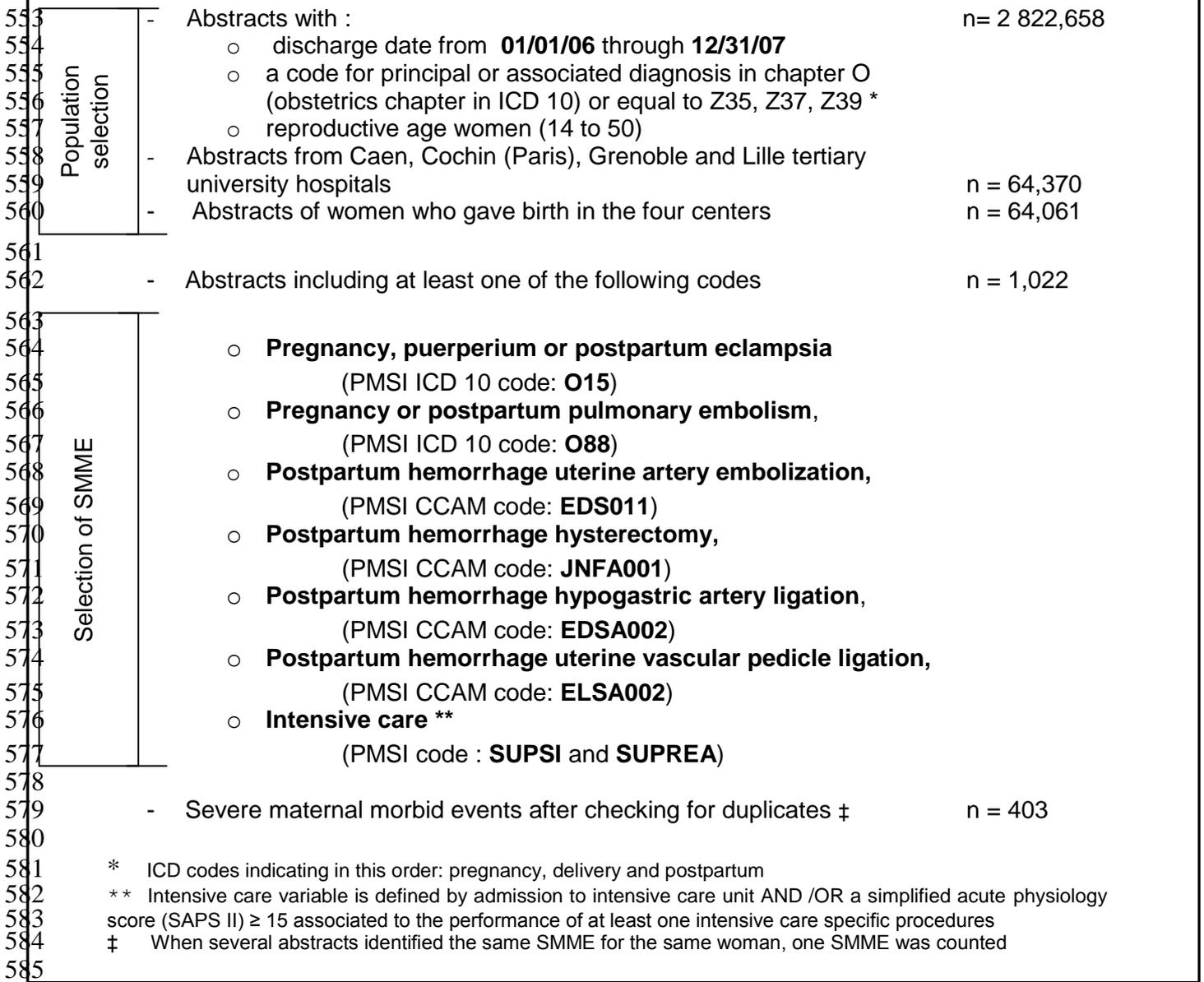
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**Figure 1-** Algorithm for the selection of the PMSI abstracts



**Table 1 - Severe maternal morbid events (SMME) identified in the PMSI database and in the medical records, 4 centers, 2006-2007 : number, false positives and false negatives \*.**

	Single SMME identified in PMSI	SMME in medical records	SMME identified in PMSI and validated in medical records	False- positives	False- negatives	Uncertain status
	n (%)	n (%)	n (%)	n	n	n
<b>Total</b>	403 (100%)	399 (100%)	314 (100%)	82	85	7
<b>Eclampsia</b>	89 (22)	20 (5)	17 (5)	67	3	5
<b>Pulmonary embolism</b>	33 (8)	24 (6)	20 (6)	11	4	2
<b>Uterine artery embolization</b>	72 (18)	128 (32)	72 (23)	0	56	-
<b>Hysterectomy</b>	23 (6)	31 (8)	23 (7)	0	8	-
<b>Uterine artery and pedicle ligation</b>	34 (8)	44 (11)	33 (11)	1	11	-
<b>Intensive care</b>	152 (38)	152 (38)	149 (48)	3	3	-

\* on the basis of 30,614 deliveries, medical record as reference.

**Table 2 - Validity of the PMSI data for severe maternal morbid events (SMME): kappa score, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) \*.**

	<b>Kappa</b>	<b>Sensitivity</b> % [95% CI]	<b>Specificity</b> % [95% CI]	<b>PPV</b> % [95% CI]	<b>NPV</b> % [95% CI]
<b>Eclampsia</b>	0,33	85,0 [69,3-100,0]	99,7 [99,6-99,8]	20,2 [11,6-28,8]	99,9 [99,9-100,0]
<b>Pulmonary embolism</b>	0,73	83,3 [68,4-98,2]	99,9 [99,9-100,0]	64,5 [47,6-81,3]	99,9 [99,9-100,0]
<b>Embolization</b>	0,72	56,2 [47,6-64,5]	100,0 -	100,0 -	99,8 [99,7-99,8]
<i>revised results **</i>	0,98	95,3 [91,6-98,9]	100,0 -	100,0 -	99,9 [99,8-100,0]
<b>Hysterectomy</b>	0,85	74,2 [58,8-89,6]	100,0 -	100,0 -	99,9 [99,9-100,0]
<i>revised results **</i>	1	100,0 -	100,0 -	100,0 -	100,0 -
<b>Ligation</b>	0,84	75,0 [62,2-87,8]	99,9 [99,9-100,0]	97,6 [92,4-100,0]	99,9 [99,9-100,0]
<i>revised results **</i>	96,5	95,5 [89,4-100,0]	99,9 [99,8-100,0]	97,7 [93,2-100,0]	99,9 [99,8-100,0]
<b>Intensive care</b>	0,99	98,0 [95,8-100,0]	99,9 [99,9-100,0]	98,0 [95,8-100,0]	99,9 [99,9-100,0]

\* 4 centers, 2006-2007, on the basis of 30,607 deliveries, medical record as reference.

\*\* : revised results after correction of procedure codes not specific to the obstetrical context

**Table 3 - Validity of the PMSI data for severe maternal morbid events (SMME) per center: sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) \*.**

	Deliveries n	Single SMME in PMSI n	Sensitivity	Specificity	PPV	NPV
			%	%	%	%
			[95% CI]	[95% CI]	[95% CI]	[95% CI]
<b>All centers</b>	30 607	396	78,7 [74,6-82,7]	99,7 [99,6-99,8]	79,3 [75,3-83,3]	99,7 [99,6-99,8]
<i>revised results *</i>		465	96,7 [94,9-98,4]	99,7 [99,6-99,8]	83,0 [79,6-86,4]	99,9 [99,9-100,0]
<b>Center 1</b>	6555	74	97,3 [93,6-100,0]	99,9 [99,8-99,9]	97,3 [93,6-100,0]	99,9 [99,8-99,9]
<i>revised results *</i>		74	97,3 [93,6-100,0]	99,9 [99,8-99,9]	97,3 [93,6-100,0]	99,9 [99,8-99,9]
<b>Center 2</b>	10 486	126	84,4 [78,4-90,4]	99,9 [99,8-100,0]	94,4 [90,4-98,4]	99,8 [99,7-99,9]
<i>revised results *</i>		141	95,0 [91,4-98,6]	99,9 [99,8-100,0]	95,0 [91,4-98,6]	99,9 [99,8-100,0]
<b>Center 3</b>	3970	38	51,5 [39,4-63,6]	99,9 [99,8-100,0]	89,4 [79,6-99,2]	99,2 [98,9-99,5]
<i>revised results *</i>		70	97,0 [92,9-100,0]	99,9 [99,8-100,0]	94,2 [88,7-99,7]	99,9 [99,8-100,0]
<b>Center 4</b>	9596	158	75,4 [67,6-83,2]	99,3 [99,1-99,5]	57,4 [49,6-65,2]	99,7 [99,6-99,8]
<i>revised results *</i>		181	98,3 [95,9-100,0]	99,3 [99,1-99,5]	63,5 [56,5-70,5]	100,0 -

\* 4 centers, 2006-2007, on the basis of 30,607 deliveries, medical record as reference.

\*\* : revised results after correction of procedure codes not specific to the obstetrical context