Three-sources capture-recapture analysis to evaluate the comprehensiveness of reporting invasive meningococcal infections in France, 2005

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Background

In France Invasive meningococcal disease (IMD) surveillance is based on mandatory notification (MN) and microbiological characterization of invasive strains at the National Reference Centre for the Meningococci (NRC). Between 1985 and 2004, the observed incidence varied between 0.5 and 1.3 cases per 100,000 inhabitants.

To monitor trends in incidence, comprehensiveness of IMD notification is regularly evaluated by the two or three sources capture-recapture method and observed incidence is corrected for under-reporting.

Two capture-recapture studies using three data sources were performed in 1996 and 2000 and the comprehensiveness of MN was estimated at 67% and 73% respectively.

The objectives of this study were to:
• estimate the comprehensiveness of 3 IMD surveillance sources in 2005 ;
• identify the main factors influencing IMD reporting ;
• estimate the overall incidence of IMD in 2005.

Material and Methods

IMD CASE DEFINITION

The analysis was restricted to laboratory culture confirmed IMD cases (isolation of *Neisseria meningitidis* strains from blood and/or CSF).

DATA SOURCES

Mandatory notification (MN), National Reference Centre for the Meningococci (NRC) and Epibac network were the three studied sources. Unlike the two other sources, Epibac is a sentinel hospital laboratory network and does not cover all French hospitals.

SURVEILLANCE NETWORK
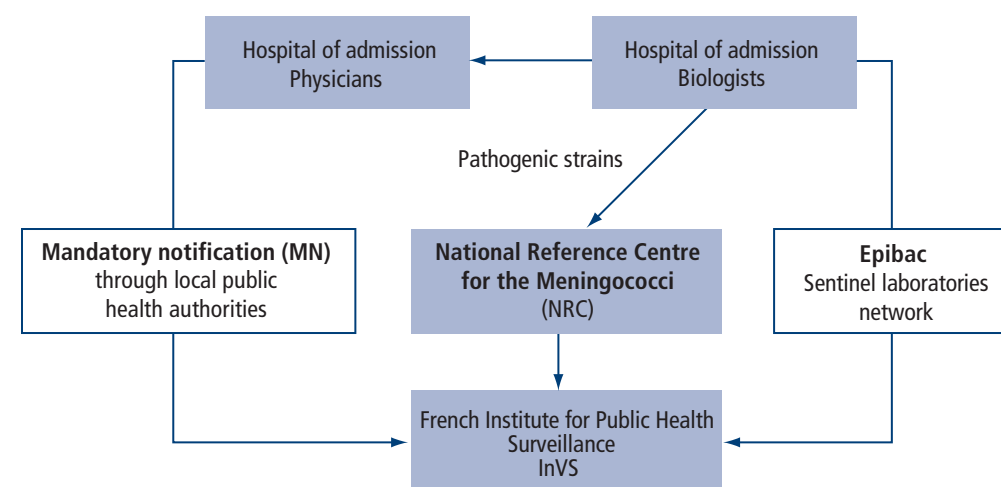
CAPTURE-RECAPTURE ANALYSIS

The capture-recapture method consists of matching cases from two or more sources in order to estimate the number of cases not registered in any of the sources and therefore, the total number of cases.

Dependance between paired sources were studied using Wittes method (sources are considered independent when the probability of notification in one source does not depend on its probability of notification in the other source).

Log-linear models allowed estimation taking into acount dependances and unequal catchability (equal catchability meaning that the probability of notification of one case in each source is not influenced by its characteristics).

Criteria used for model selection were model fit (using deviance), the Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

Analysis were performed using Stata™ and Excel™.

DUPLICATES AND MATCHING ANALYSIS

Date of birth, sex, date of hospitalization, zip code of hospital and serogroup were patient criteriae used to identify duplicates within each source and to match cases between sources.

Results

In 2005, 631 cases were identified at least by one of the three sources: 83% of cases were identified at least by 2 sources (figure 1).

FIGURE 1 — DISTRIBUTION OF IMD CASES BY SOURCES OF CAPTURE - FRANCE 2005
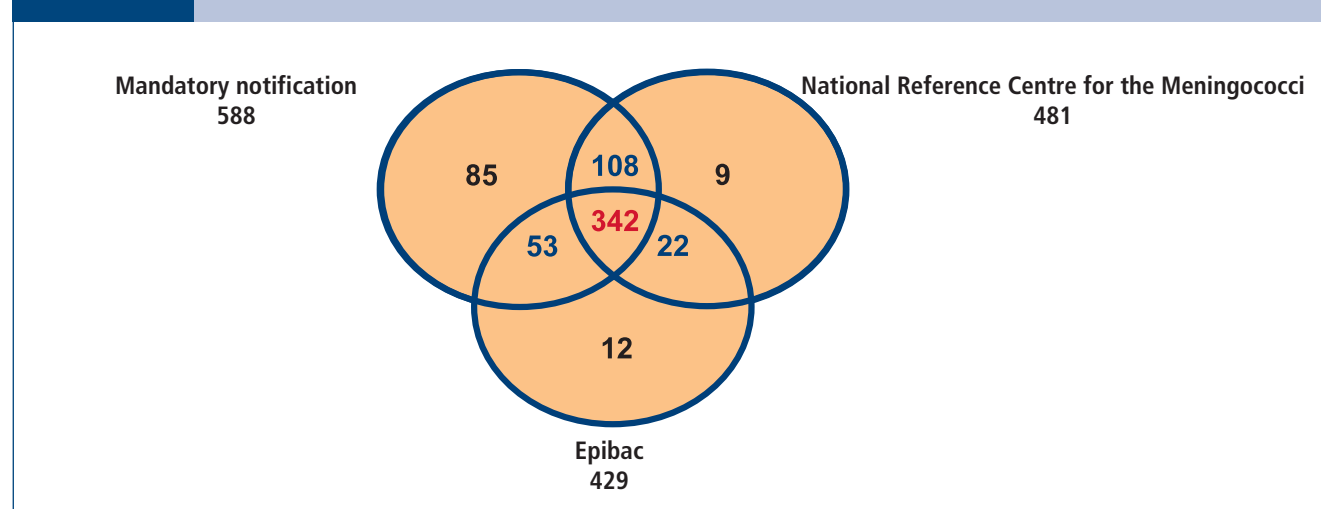
The log-linear model selected included the positive dependences found between MN and NRC and between NRC and Epibac network by the Wittes method (table 1).

TABLE 1 — LOG-LINEAR MODELS FITTED TO THREE SOURCES AND ESTIMATED NUMBER OF IMD CASES, FRANCE, 2005 (a)

	ddl	G²	p	N	lower 95% CI	upper 95% CI	AIC	BIC
Saturated model	0	0.0	1.0	656	628	684	0.0	0.0
MN-E & NRC-E	1	9.3	$0.2 \cdot 10^{-2}$	638	631	645	7.3	4,7
MN-NRC & NRC-E	**1**	**0.4**	**0,5**	**650**	**635**	**666**	**-1.6**	**-4.2**
MN-NRC & MN-E	1	64.5	$9.6 \cdot 10^{-16}$	636	630	642	62.5	59.9
NRC-E	2	9.3	$0.9 \cdot 10^{-2}$	638	632	644	5.3	0.1
MN-E	2	66.8	$3.1 \cdot 10^{-15}$	634	630	638	62.8	53.9
MN-NRC	2	64.7	$8.9 \cdot 10^{-15}$	637	631	643	60.7	55.5
No interaction	3	74.1	$5.7 \cdot 10^{-16}$	635	631	639	68.1	60.3

MN = Mandatory notification, NRC = National reference centre, E = Epibac
$AIC = G^2 - 2.(ddl)$, $BIC = G^2 - (\log Nobs/2_{obs}).(ddl)$

COMPREHENSIVENESS OF REPORTED IMD CASES

Considering the bold model in table 1, the estimated total number of laboratory culture confirmed IMD in 2005 in France is estimated at 650 [95% CI: 635-666]. MN comprehensiveness reached 90.5% (table 2).

Because Epibac has an incomplete geographical coverage, an analysis restricted to cases hospitalized in hospitals participating to Epibac network was also performed, providing an "internal" completeness estimate for Epibac of 81%; estimates obtained for MN and NRC comprehensiveness were similar than in the first global analysis.

TABLE 2 — COMPREHENSIVENESS OF THE THREE SOURCES - FRANCE, 2005

sources	N obs	N est	completeness	lower 95% IC	upper 95% IC
MN	588	650	90.5	88.2	92.6
NRC	481	650	74.0	72.2	75.7
Epibac *	429	650	66.0	64.4	67.6
*Epibac****	*429*	*531*	*80.8*	*79.0*	*82.5*

*Overall comprehensiveness ***Internal" comprehensiveness restricted to Epibac area coverage

VARIABLE CATCHABILITY

Age, serogroup and area of hospitalization were considered as possible sources of capture heterogeneity. Results of stratified analysis suggested that sources comprehensiveness descreased with age (figure 2) in particular for MN source and that capture probability varied with serogroup (figure 3).

FIGURE 2 — SOURCES COMPREHENSIVENESS BY AGE GROUPS

FIGURE 3 — SOURCES COMPREHENSIVENESS BY SEROGROUPS
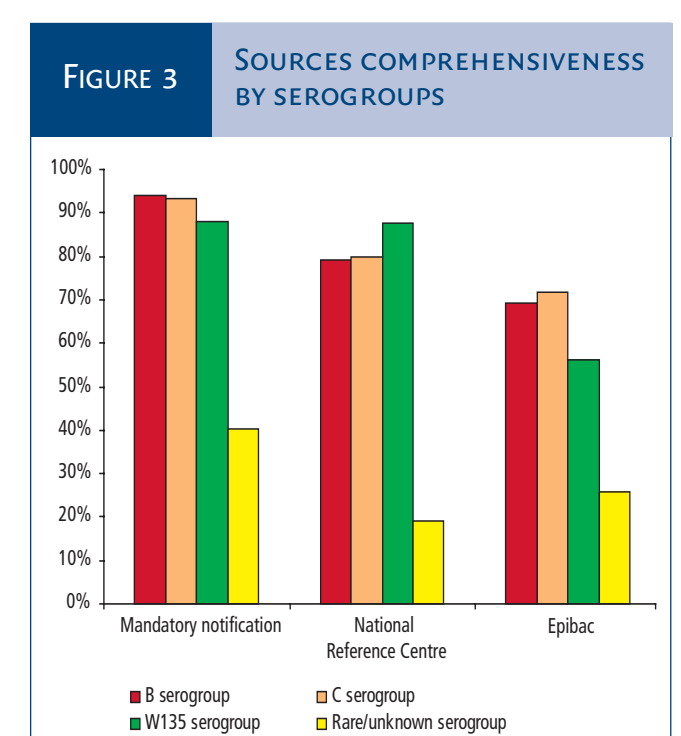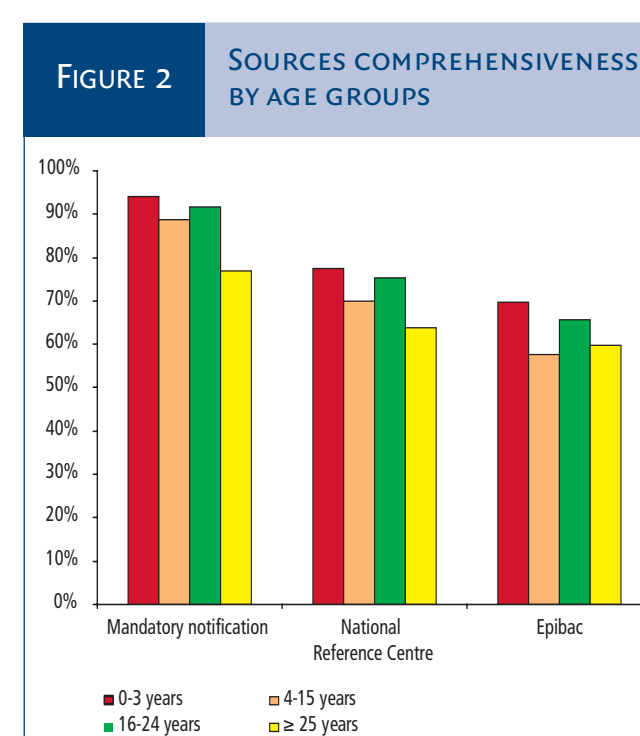
Discussion and conclusion

Using the study results, IMD incidence is estimated at 1.3/100,000.

Capture-recapture method represents an attractive and reproductible approach to assess the completeness of surveillance sources and to estimate more reliable incidence rates. However it relies on good quality data on each case in each source.

MN comprehensiveness increased from 73% in 2000 to 90.5% in 2005 suggesting that media coverage of sporadic cases, specific interventions (e.g. vaccination campaigns) and specific guidelines on IMD prevention disseminated to physicians, biologists and public health professionnals contributed to improve mandatory notification.

Completeness of NRC is stable (74% in 2000 and 2005) and needs to be improved.

Results of variable catchability analysis have underlined that under-reported IMD cases were more numerous for ≥ 25 years old and for rare/unknown serogroups. Notification has to be improved for those cases.

(a) Bishop YMM, Fienberg SE, Holland PW. Discrete Multivariate Analysis: Theory and Practice, The MIT Press, Cambridge, Massachussets, 1975.

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