Real-time surveillance of bacteria and antibiotic resistance over 15 months using BALYSES and MARSS surveillance systems, Marseille, France

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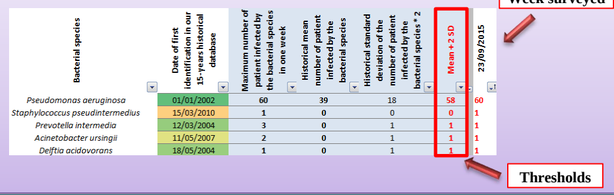
INTRODUCTION

Infectious diseases represent major and unpredictable causes of morbidity and mortality worldwide (1,2). Hence, efficient surveillance systems are warranted. Since 2002, we created at university hospitals of Marseille several automated real-time epidemiological surveillance systems to detect abnormal epidemiological events linked to infections using data from our routine clinical microbiology laboratory. These systems include EPIMIC (3), and BALYSES and MARSS, implemented in 2013, more specifically to survey bacteria and antibiotic resistance (4). **We present here results from the weekly surveillance by BALYSES and MARSS from July 2014 to September 2015 .**

MATERIALS AND METHODS

BALYSES (the BActerial real-time LaboratorY-based SurveillancE System): 676 bacterial species monitored

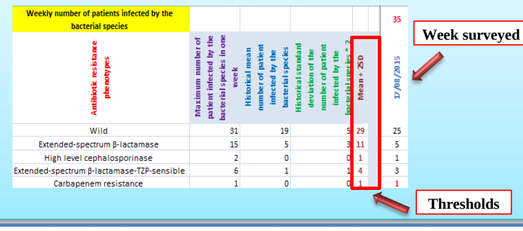
Fig 1.



Bacterial species	Date of first identification in our 15-years historical database	Maximum number of patient infected by the bacterial species in one week	Historical mean number of patient infected by the bacterial species	Historical standard deviation of the number of patient infected by the bacterial species * 2	Mean+2SD	23/09/2015
Pseudomonas aeruginosa	01/01/2002	60	39	18	58	60
Staphylococcus pseudintermedius	15/03/2010	1	0	0	0	1
Prevotella intermedia	12/03/2004	3	0	1	1	1
Acinetobacter ursingii	11/05/2007	2	0	1	1	1
Delftia acidovorans	18/05/2004	1	0	1	1	1

MARSS (the Marseille Antibiotic Real-time Surveillance System): β-lactam antibiotic resistance phenotypes for 15 bacterial species of interest monitored

Fig 2.



Antibiotic resistance phenotypes	Maximum number of patient infected by the bacterial species in one week	Historical mean number of patient infected by the bacterial species	Historical standard deviation of the number of patient infected by the bacterial species * 2	Mean+2SD	17/08/2015
Wild	31	19	5	29	25
Extended-spectrum β-lactamase	15	5	3	11	5
High level cephalosporinase	2	0	0	1	1
Extended-spectrum β-lactamase-TZP-sensible	6	1	1	4	3
Carbapenem resistance	1	0	0	1	1

Fig 1 and 2: Print screen of BALYSES and MARSS. Red numbers on the right side are alarms triggered for a week of interest. Alarms are automatically triggered when the weekly number of patient infected by a bacterium exceeds the historical mean number of isolation of the bacterium plus 2 standard deviations (thresholds).

CONCLUSIONS

Fig 7.

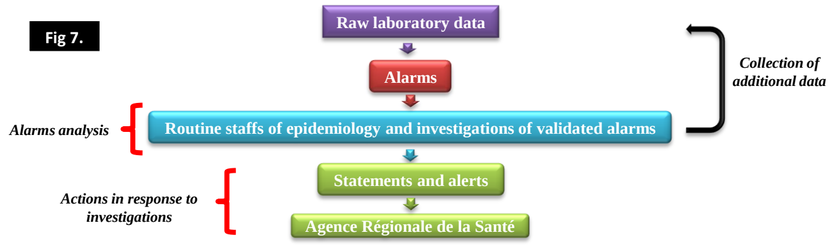


Fig 7. Diagram presenting the surveillance system of the AP-HM institution

Our automated surveillance tools allowed improving the control, prevention, and treatment of infections. A next step is to implement a web-based platform to merge all our surveillance systems for more accurate monitoring and alert management. We are also extending our surveillance to a representative panel of private and public clinical microbiology laboratories of the Provence-Alpes-Côte d'Azur French region.

REFERENCES

(1) Raoult D (2008). Les causes de l'émergence des agents infectieux. *Responsabilité & Environnement* 51: 21-25.
(2) Morens DM, Folkers GK and Fauci AS (2004). The challenge of emerging and re-emerging infectious diseases. *Nature*, 430(6996):242-9.
(3) Colson P, Rolain JM, Abat C, Charrel R, Fournier PE, Raoult D (2015). EPIMIC: a simple homemade computer program for real-time EPIdemiological surveillance and alert based on MICrobiological data. *PLoS One*, 10(12):e0144178.
(4) Abat C, Chaudet H, Colson P, Rolain JM, Raoult D (2015). A real-time microbiology laboratory surveillance system implemented for the detection of abnormal events and emerging infections, Marseille, France. *Emerg Infect Dis*, 21(8):1302-10.

RESULTS

Activity of the Timone hospital clincal laboratory

➢ **255,513** clinical samples collected from **13,470** non-redundant patients and cultivated to identify bacterial pathogens

Fig 3.

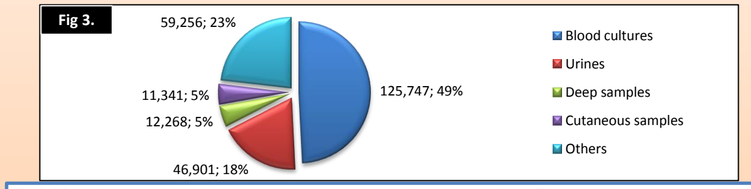


Fig 3. Main kind of samples collected and cultured for bacterial pathogens in the Timone clinical laboratory (Nb; %)

➢ **60,221** bacterial strains isolated over the study period

Fig 4.

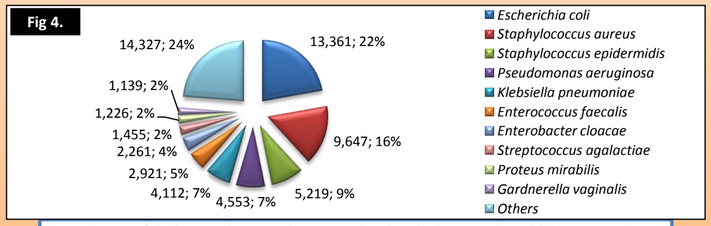


Fig 4. Top 10 of the bacterial species the most isolated in the Timone clinical laboratory (Nb; %)

➢ **44,362** antibiotic susceptibility testing perfomed on

Sum up of the surveillance activity of BALYSES and MARSS

➢ **1,172** alarms triggered by BALYSES (**898** alarms triggered for **297** bacterial species surveyed) and MARSS (**247** alarms triggered), i.e around **18** alarms per week over the study period

Fig 5.

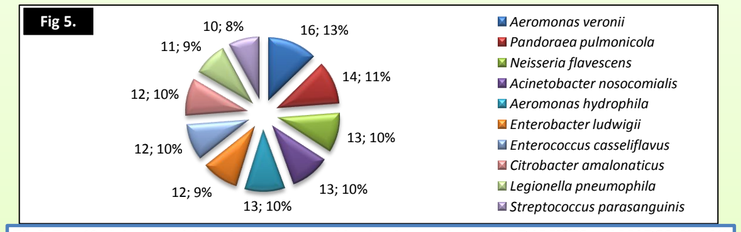


Fig 5. Top 10 of the bacterial species the most cited by the alarms triggered by BALYSES and MARSS (Nb; %)

➢ **61** alarms led to epidemiological and clinical investigations (**47** triggered by BALYSES / **14** by MARSS), **40** were true epidemiological events and **18** led to official report to the French Health Regional Agency

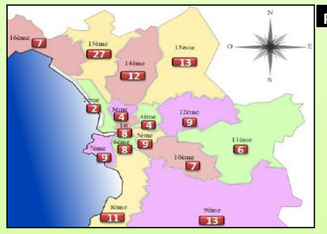
Bacterial species	Number of official reports
Klebsiella pneumoniae	10
Acinetobacter baumannii	7
Enterococcus faecalis	1

Bacterial species involved in the 18 official reports

Panel A.

Bacterial species	Date of first identification in our 15-years historical database	Mean+2SD	11/02/2015
Enterococcus faecalis	01/01/2002	46	56

Panel B.



Panel C.

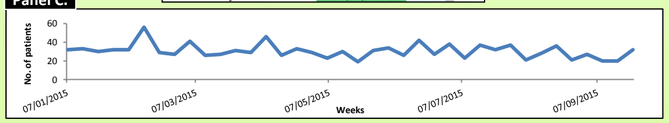


Fig 6. Detail of true outbreak of *Enterococcus faecalis* (BALYSES). Panel A is a print screen of BALYSES at the time of the alarm. Panel B is the distribution of patients infected by *E. faecalis* from January to March 2015 according the different districts of Marseille. Panel C is the kinetic of the number of patients infected by *E. faecalis* from January to September 2015.