Full Length Research Paper

Investigating the prevalence and antimicrobial resistance patterns of *Pseudomonas aeruginosa* in Cameroon: A systematic review and meta-analysis

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Background: *Pseudomonas aeruginosa* is a non-fermentative bacteria which present a rapid increase in the rates of infections across the world. *Pseudomonas aeruginosa* ranks third among the resistant bacteria responsible for nosocomial infections. **Aim:** To assess the distribution and evolution of resistance *of Pseudomonas aeruginosa* in Cameroon. **Methods:** We carried out a systematic review of the research publications that determined the resistance phenotypes of *Pseudomonas aeruginosa* in Cameroon. A meta-analysis of the data was carried out to synthesize the data on resistance phenotypes, their distribution and their evolution in Cameroon. **Results:** A considerable increase in resistance to ceftazidime, aztreonam, gentamycin and tobramycin between 2005 and 2011 was observed. In addition, an increase in resistance to imipenem was noted between 2011 and 2013. The city of Douala has a high frequency of *Pseudomonas aeruginosa* followed by Buea and Yaounde. **Conclusion:** *Pseudomonas aeruginosa* has a high frequency and resistance to several antibiotics in Cameroon. There is a need to continue surveillance in several hospitals and in several regions of Cameroon in order to implement policies and measures to fight infections and antibiotic resistance.

Keywords: *Pseudomonas aeruginosa*, resistance, antibiotics, epidemiology, clinical isolates.

INTRODUCTION

Antibiotic resistance is one of the priority problems around the world. It is a problem which affects the evolution of infectious diseases by increasing virulence. This limits effective care and leads to an increase in hospital stay and the time taken to care for patients. This situation is still very worrying in Africa, where several factors contribute to the emergence and transmission of resistant strains. The threat posed by these resistant bacteria is however

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exacerbated in developing countries due to sub- optimal hygiene conditions, poor infection, prevention and control measures, lack of surveillance and the dearth antimicrobial stewardship programs (Årdal et al., 2016; Founou et al., 2016). These resistance are at the origin of a problem which is worrying because of the few number of active antibiotics classes during different treatments. Among these resistant bacteria, *Pseudomonas aeruginosa* ranks third among the bacteria responsible for nosocomial infections. It is a Gram negative non- fermentative bacteria. Studies by Cholley et*al.*, (2010) have shown an increase in the multidrug resistance of*P. aeruginosa* to almost all antibiotics except colistin. Rapid increases in the rates of infections due to metallo-beta- lactamase-producing *P.aeruginosa* have been reported across the world (Perovic et al., 2016; Rajagunalan et al., 2013).

Although *Pseudomonas aeruginosa* is regularly isolated from patients with urinary tract infections, septicemia, injuries, and several factors associated with increased resistance observed in Cameroon, most hospitals do not monitor for epidemiology of resistance.

The aim of this work was to give the prevalence of *Pseudomonas aeruginosa* and to assess the evolution of its resistance in Cameroon. To achieve this aim, a meta-analysis of some articles was conducted.

METHODS

This systematic review was designed in accordance with the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guideline (Moher et al., 2009). We conducted an exhaustive search of available literature via PubMed and Web of Sciences starting from the date of inception of each database until January 2020 and identified the evidence from descriptive prospective study investigating the evolution to antibiotic of clinical isolate of *Pseudomonas aeruginosa* in Cameroon. We used a controlled vocabulary during the research. These terms included words such as *Pseudomonas aeruginosa*, antibiotics, resistance and Cameroon and the following published and validated filter was applied. The research was carried out in English and French.

Data extraction

We synthesized the results of six articles and compared these data to assess the evolution of resistance of *Pseudomonas aeruginosa* in Cameroon from the articles. When the results presented only the sensitivity profile, the frequency of resistance to each antibiotic evaluated was determined by subtracting the percentage of sensitive isolates.

In the work of Gangoue-Pieboji et *al.*, (2006) the collection of isolates was carried out from 1995 to 1998. The isolates were collected between 2006 and 2011 in the

study of Ebongue et *al.*,(2014). The collection took place in 2011, 2012 in the studies ofClotilde et*al.*,(2013) and Gonsu et*al.*,(2015). For the studies conducted by Ndip et *al.*,(2005) and Ateba et *al.*,(2013) the collection took place in 2005 and 2013 respectively.

An evaluation of the frequency of *Pseudomonas aeruginosa* per city was also carried out by comparing the data of the different articles selected.

Inclusion criteria

The inclusion criteria used to select the articles were: original research, Studies conducted in Cameroon, antimicrobial susceptibility testing, clinical isolates of *Pseudomonas aeruginosa,* papers published in French or English. Overall, we retained six articles.

Exclusion criteria

The papers which do not allow us determine the frequency of resistance of *Pseudomonas aeruginosa* to antibiotics.

Data analysis methods

The graphs showing the increase in resistance of *Pseudomonas aeruginosa* were generated using excel software using the resistance frequencies from the selected articles.

Ethical consideration

Ethical clearance was not necessary for this study

RESULTS

Synthesis of data on the resistance of *Pseudomonas aeruginosa* to antibiotics

The data on the resistance of *Pseudomonas aeruginosa* to the various antibiotics studied in the selected articles are shown in Table 1.

Table 1 summarizes the data of authors on the resistance of *Pseudomonas aeruginosa* to cefotaxime, ceftazidime, aztreonam, imipenem, gentamycin, tobramycin and piperacillin.It appears from this table that the resistance of *Pseudomonas aeruginosa* to cefotaxime and to tobramicin was constant between 1998 and 2005. The work of Gangoue-Pieboji et *al.*, (2006)revealed frequencies of 98% and 44% respectively for cefotaxime and tobramycin. Seven years later, the frequency of resistance was 97% and 43.24% for cefotaxime and tobramicine respectively. During this same period, resistance decreased from 28% to 18.9% for ceftazidime and then from 67% to 32.43% for aztreonam. However, a significant increase in resistance to ceftazidime,

Table I: Summary of data on the frequency of resisstance of *Pseudomonas aeruginosa* isolates to antibiotics.

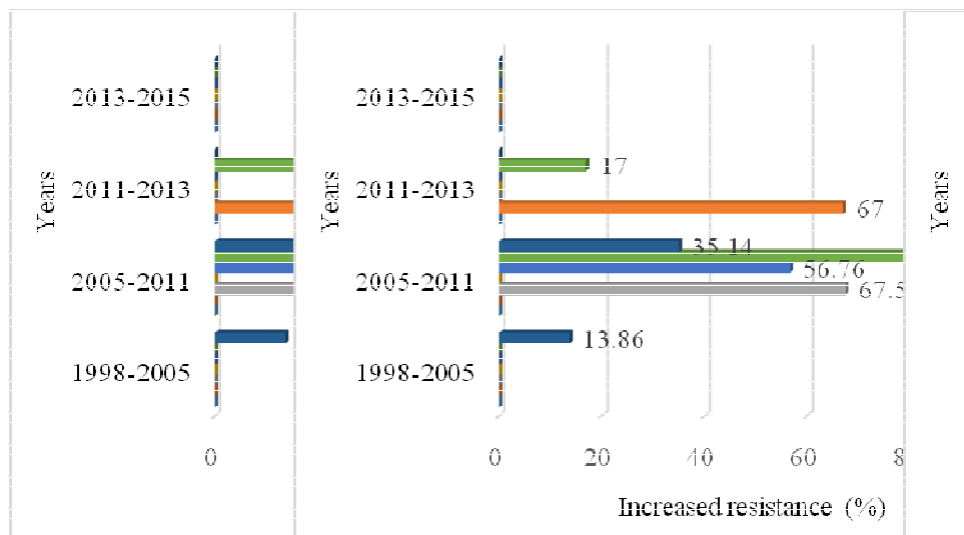| Authors	Number of isolate	cefotaxime	ceftazidime	Aztreo Nam	imipenem	Gentamycin	Tobramicin	piperacillin
Gangoue-Pieboji et *al.*, (2006)	67	98%	28%	67%	6%	51%	44%	54%
Ndip et *al.*,(2005)	37	97%	18,99%	32,43%	/	64,86%	43,24%%	/
Clotilde et *al.*,(2013)	2	/	100 %	100%	0%	100%	100%	100%
Ebongue et *al.*, (2014)	/	/	30,44%	/	9,5%	/	/	28,5%
Ateba et *al.*,(2013)	49	/	47,44%	/	67%	59,1%	49%	/
Gonsu et *al.*,(2015)	34	/	5,9%%	0%	5,9%	5,9%	5,9%	23,5%

NB : Not evaluated (/)

Figure 1: Increased resistance of *Pseudomonas aeruginosa* to antibiotics

aztreonam, gentamycin and tobramycin between 2005 and 2011 has been reported. In addition, ann increase in resistance to imipenem was noted between 2011 and 2013. On the other hand, a considerable decrease in resistance to all antibiotics was noted in 2015.

Figure 1 shows the increased r esistance of *Pseudomonas aeruginosa* to antibiotics. It appears in this figure that *P. aeruginosa* have increased resistance by 13.86% to gentamicin between 1998 and 2005. Furthermore an increase in resistance of 35.14%, 56.76%, 67.57 % and 81.1% was found with respect to gentamycin, tobramicin, aztreonam and ceftazidime respectively between 2005 and 2011.

Regarding, the distribution of *Pseudomonas aeruginosa* in Cameroon, the studies carried out in Douala, Yaounde and Buea to determine the resis tance phenotypes showed that the frequency of *Pseudomoonas aeruginosa* is highest in the city of Douala followed by Buea and Yaounde with respective frequencies of 32.66%%, 25.5% and 13.26%.

DISCUSSION

Pseudomonas aeruginosa is a bacteria that adapts to different environments and is involved in several nosocomial infections. The compplexity and variability of its genome partly explains the freequency of resistance to

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antibiotics. The work carried out in Cameroon revealed a considerable increase in the resistance of *Pseudomonas aeruginosa* to gentamycin, tobramicin, aztreonam and ceftazidime between 2005 and 2011 with an optimum of 81.1%. This increase in resistance is also noticeable between 2013 and 2015 with an optimum of 67%. Studies carried out in the city of Douala have revealed the highest frequencies of resistance (Ebongue et al., 2011; Clotilde et al., 2013; Ndip et al., 2005). The city of Douala represents the economic capital of Cameroon where the majority of commercial and industrial activities are carried out. This has led to overcrowding of the city, unsanitary environment and non-observance of hygiene measure. Many of the inhabitants also use street antibiotics. Other studies have revealed the impact of these factors on the increase in resistanceand the spread of resistant bacteria in the population(Amvene et al., 2013).

The study carried out in Yaounde by Gonsu et *al.*,(2015) showed low frequencies of antibiotic resistance compared to those carried out by Gangoue-Piebojiet *al.*, (2006)showing a reduction of transmission of resistance of *Pseudomonas aeruginosa* in Yaounde compared to Douala.However the difference in the two works reviewed in Yaounde could be due to the smaller number of isolates studied by Gonsu et *al.*

The characteristic of Buea may be different from Douala but they have a similarity in overcrowding in certain section of the town due to a concentration of housing. Buea is an inteselyacademic township with a high number of institutions of higher learning. Thus, the same factors in Douala are found in Buea. One factor for Bueais the milder climate.

On the whole, it would be necessary to conduct studies yearly for surveillance of resistance in the different regions of Cameroon.

The frequency of distribution of *Pseudomonas aeruginosa* is highest in the city of Douala. This could be due to the overcrowding of this city. Furthermore, the proximity of households and the non-observance of hygiene measures by a large part of its population would contribute to the spread of this bacteria in the population.

CONCLUSION

Although very few studies have been conducted in Cameroon to assess the resistance of *Pseudomonas aeruginosa* to antibiotics. This study allowed us to assess the dynamics of *P.aeruginosa*and the evolution of its resistance to some antibiotics in Cameroon. This bacteria thus presents a predominant resistance in the city of Douala followed by the city of Buea and Yaounde.

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