

THE CONTRIBUTION OF STOOL CULTURE TO THE EPIDEMIOLOGICAL SURVEILLANCE OF PATHOGENIC ENTEROBACTERIA ISOLATED FROM 2011 TO 2016 AT THE MEDICAL BIOLOGY LABORATORY OF THE NATIONAL HOSPITAL AMIROU BOUBACAR DIALLO IN NIAMEY, NIGER

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Abstract

Stool culture is a test generally requested during gastroenteritis, which is a very common pathology in developing countries. The aim of this study was to determine the prevalence of bacterial infectious gastroenteritis, particularly for *Salmonella*, *Shigella*, and *E. coli* infections, as well as the most effective antibiotics against these enteropathogenic germs. This was a retrospective descriptive study that took place from January 1st, 2011, to December 31st, 2016, at the Biology Laboratory of the National Hospital Amirou Boubacar Diallo (HNABD) in Niamey (Niger). Stool culture was performed according to the conventional bacteriology technique.

The results showed that out of 8,102 samples analyzed, 2,940 revealed the presence of one of the 3 targeted germs. The isolation frequency for each was: 40.12% for *E. coli*, 10.89% for *Shigella*, and 9.78% for *Salmonella*. In infants, *E. coli* was the most isolated germ at 40.12%. As for *Salmonella* infections, they were more significant in adults with a rate of 19.24%.

The most active antibiotics against *Salmonella* infections were ciprofloxacin with 85.7%, ceftriaxone and amikacin with 83.3%, and azithromycin with 80%. For *Shigella*, the most active antibiotics were amikacin with 100%, azithromycin with 93.8%, and nalidixic acid with 94.1%. For *E. coli*, the most effective antibiotics were amikacin with 90.7%, nalidixic acid with 75.3%, and ceftriaxone with 73.3%.

These results highlight the need for vigilance because resistant strains are circulating, even though this resistance does not currently concern the most commonly used standard antibiotics in our context.

Keywords: stool culture, resistance, enterobacterium, pathogenic in Niger

Introduction

Acute gastroenteritis (AGE) is an inflammation of the digestive system manifesting as acute diarrhea with or without vomiting, and with or without fever (Guarino et al. 2014).

In developing countries (DCs), it is responsible for 5 to 10 million deaths per year and represents the leading cause of infant mortality and the 4th leading cause of death across all age groups, with the prognosis aggravated by the context of malnutrition (Barat A, Floret D. 2005).

Three bacterial agents are commonly sought during a stool culture in Niger, unless otherwise specifically indicated. These are *Salmonella* spp., *Shigella* spp., and enteropathogenic *Escherichia coli* serotypes in children under 18 months. *Escherichia coli* is recognized as the most common cause of diarrheal diseases in children under 2 years old. This bacterium causes 280 to 400 million diarrheal episodes in children annually (Chimalizeni et al. 2010).

Regarding *Salmonella*, its infection is endemic in DCs. Typhoid fever remains a major public health problem linked to poor hygiene in tropical and subtropical environments. Over 16 million cases are recorded each year, including 600,000 deaths (Troeger et al. 2018).

As for *Shigella*, the annual number of episodes is estimated at 160 million, with 1.1 million deaths, mainly in children under 5 years old in DCs (Kotloff et al. 1999).

In Niger, the impact of gastroenteritis due to *Salmonella*, *Shigella*, and *E. coli* remains significant. It is necessary to conduct an assessment of isolates and determine the susceptibility of the strains to common antibiotics in a context where access to diagnosis is difficult, with the aim of contributing to patient management.

Materials methods

The Amirou Roubacar Diallo National Hospital served as the setting for this study.

This was a retrospective descriptive study, carried out over a period of six (06) years, from January 1st, 2011, to December 31st, 2016. All patients who benefited from a stool culture at the medical biology laboratory of the HNA BD during the study period and whose results were recorded in the registers, constituted the study population. The sampling was exhaustive.

Inclusion Criteria

Included in our study were all patients whose stool culture results appeared in the laboratory registers.

Non-Inclusion Criteria

Patients whose culture and identification results were not mentioned in the register were not included in this study.

Data processing and analysis

Data collection and analysis were performed using the Epi Info 3.5.3 software. Quantitative variables were described using means, standard deviation, and extremes.

Results

A total of 8,735 stool cultures were performed during the study period, of which:

-633 had no results specified in the registers,

-8,102 had complete results.

Bacterial Profile of Gastroenteritis

The overall isolation rate for *Salmonella* is 9.78%, with a variation from 6.82% in 2011 to 13.16% in 2013.

Regarding the isolation frequency for *Shigella*, it varies from 16.34% in 2011 to 6.35% in 2012.

In Table II, it is observed that *Shigella* infections are slightly higher than *Salmonella* infections, with 10.89% compared to 9.78%.

Table II: Distribution of germs isolated during stool culture

Années	Salmonella		Shigella		Effective
	N	%	N	%	
2011	84	6,82	201	16,34	1230
2012	122	7,98	97	6,35	1527
2013	181	13,16	123	8,94	1375
2014	139	13,05	88	8,26	1065
2015	164	10,10	246	15,15	1623
2016	103	8,03	128	9,98	1282
Total	793	9,78	883	10,89	8 102

Bacterial Etiology According to Patient Age

We note a predominance of *Shigella* infections in children with 466 cases, or 17.67% (Table III). Conversely, in adults, *Salmonella* infections predominate with 415 cases, or 19.24%.

Table III : Distribution of *Salmonella* and *Shigella* according to patient age

Age	Effective	Salmonella +		Shigella +	
		N	%	N	%
0-2years	3150	91	2,88	221	7,01
3-15years	2637	279	10,58	466	17,67
≥15years	2156	415	19,24	194	8,99
Not specified	159	8	5,03	2	1,25

Annual Evolution of *E. coli* Isolations in Children Aged 0-2 Years

In Table IV, the overall rate of AGE due to *E. coli* was 40.12%, with a variation from 21.5% in 2011 to 55.83% in 2013.

Table IV : Annual prevalence of *E. coli* + in children aged 0-2 years

Years	Effective	<i>E coli</i> +	
		N	%
2011	400	86	21,5
2012	507	193	38,06
2013	711	397	55,83
2014	508	194	38,18
2015	519	205	39,49
2016	505	189	37,42
Total	3150	1264	40,12

Susceptibility of Strains to Antibiotics

In Table V, we observe that for *Salmonella* infections, the most effective antibiotics were ciprofloxacin and nalidixic acid, with 85.7% and 85% of the tested strains being susceptible to them, respectively.

For gastroenteritis related to *Shigella*, the most effective antibiotics were amikacin and nalidixic acid, with 100% and 94.1% of the tested strains being susceptible to them, respectively.

Concerning infections related to *E. coli*, the most effective antibiotics were **amikacin** and **nalidixic acid**, with 90.7% and 75.3% of the tested strains being susceptible to them, respectively.

Table V : Susceptibility of the 3 germs to antibiotics.

ATB	Salmonella			Shigella			E coli			ST :
	ST	S	%	ST	S	%	ST	S	%	
Amoxicillin	24	6	25	23	4	17,4	1278	64	5	
Amoxi.clavulanic ac	21	13	61,9	19	11	57,9	1254	476	38	
Ceftriaxone	24	20	83,3	23	18	78,3	1293	953	73,7	
Céfoxitin	3	1	33,3	9	6	66,7	164	113	68,9	
Ciprofloxacin	21	18	85,7	20	15	75	1264	913	72,2	
Nalidixic acid	20	17	85	17	16	94,1	912	687	75,3	
Azithromycin	15	12	80	16	15	93,8	940	674	71,7	
Gentamicin	20	16	80	19	13	68,4	1121	798	71,2	
Amikacin	6	5	83,3	2	2	100	668	606	90,7	
Sulfadiazine	2	1	50	0	0	0	148	11	7,4	

Strains Tested S : Susceptible Strains

Discussion

Our study determined *E. coli* as the most frequently encountered germ with 40.12%, followed by *Shigella* with 10.89%, and finally *Salmonella* with 9.78%. Our results are in agreement with those of Sawadogo Salfo (Sawadogo et al. 2017) in Ouagadougou, who noted a predominance of *E. coli* at 10.81%, followed by *Shigella* at 2.50%, and then *Salmonella* at 1.50%.

We observe that in infants, *E. coli* constitutes the most frequent cause of gastroenteritis at 40.12%. Sawadogo (Sawadogo et al. 2017) in Ouagadougou made the same observation with a rate of 10.81%. Germani (Germani et al. 1984) and Sissoko (Sissoko 2009) affirm that *E. coli* remains a frequent cause of diarrhea in developing countries (DCs).

In children, a predominance of Shigellosis is noted at 17.67%. This is contrary to Sawadogo S, who found a predominance of *Shigella* infections in adults, with a rate of 2.60%. In our study, *Salmonella* remains the most frequent cause of gastroenteritis in adults with a percentage of 19.24%. Although *Salmonella* is not the most isolated germ in children, its

rate remains non-negligible at 10.58%, or 279 cases. This reinforces the idea that *Salmonella* infections remain a pathology of adolescents and adults, as recalled by numerous studies (Amadou M 2010), (Traore et al. 1991).

We subjected the 3 targeted types of germs to 10 antibiotics belonging to 5 different families. For each of them, we determined the number of strains tested and the percentage of susceptible strains. In the beta lactam family, for *Salmonella* infections, we noted a high susceptibility to ceftriaxone at 83.3%. In 2005, Kounta (Kounta 2000) and Bougoudogo (Bougoudogo et Maiga 2010) in Mali had a rate of 100%. Due to their effectiveness against Gram-negative bacilli (GNB), third-generation cephalosporins constitute the reference molecule for the treatment of typhoid fever in a hospital setting (Gaborieau et al. 2010). Amoxicillin was the least effective, with a rate lower than 50% (25%). For *Shigella*, we found a strong susceptibility to ceftriaxone at 78.3%, whereas susceptibility to amoxicillin was only 17.4%. Studies on the susceptibility of *Salmonella* and *Shigella* to antibiotics reveal that these strains show fairly high resistance to aminopenicillins and advise against their use for empirical treatment of *Salmonella* or *Shigella* infection (Troeger et al. 2018). For *E. coli*, we noted a high susceptibility rate with ceftriaxone at 73.7%. Amoxicillin was the least effective, with a susceptibility rate of 5%. In 2009, Sissoko (Sissoko 2009) in Mali noted this same trend with a rate of 13.2% for amoxicillin.

In the quinolone family, we tested ciprofloxacin and nalidixic acid. In *Salmonella*, ciprofloxacin and nalidixic acid were active with respective susceptibility rates of 85.7% and 85%. In 2000, Kounta in Bamako had similar results with a rate of 82% for nalidixic acid.

In *Shigella*, nalidixic acid was very active with a susceptibility percentage of 94.1% ; ciprofloxacin was also effective with a susceptibility rate of 75%. For *E. coli*, nalidixic acid was active against 75.3%, and ciprofloxacin against 72.2% of the tested strains. From our study, we retain that quinolones were active against more than 50% of the 3 enteropathogenic germs.

In macrolides, we only tested azithromycin. We noted a susceptibility rate of 80% to azithromycin in *Salmonella*. Studies demonstrate that azithromycin, an antibiotic from the macrolide family, constitutes a very interesting alternative in the treatment, particularly of multi-drug-resistant typhoid fever and in the treatment of uncomplicated typhoid fever in children. It has good intracellular penetration and a long half-life (72 hours) (Effa et Bukirwa, n.d.) (Giri et al. 2021). For *Shigella*, the susceptibility rate was 93.8%. As for *E. coli*, its susceptibility rate to azithromycin was 71.7%. This makes this antibiotic a good option in the treatment of *Salmonella*, EPEC, and *Shigella* infections.

In the aminoglycoside family, we tested gentamicin and amikacin. For *Salmonella*, the respective susceptibility percentages were 80% for gentamicin and 83.3% for amikacin. In 2000, Kounta (Kounta 2000) in Bamako had a susceptibility percentage of 97% for gentamicin and 94% for amikacin. For *Shigella*, the susceptibility rate was 68.4% for gentamicin and 100% for amikacin. As for *E. coli*, we noted respective percentages of 71.2% for gentamicin and 90.7% for amikacin.

In sulfonamides, we only tested sulfadiazine. The susceptibility rate of sulfadiazine to *E. coli* was relatively low at 7.4%. A study conducted at the Cocody University Hospital (CHU de Cocody) on Gram-negative bacilli strains revealed that sulfonamides and tetracyclines have limited effectiveness against these types of bacteria (Coulibaly A. et al. 1988).

Conclusion

Acute infectious gastroenteritis of bacterial origin remains a public health problem in developing countries. The emerging resistance of enterobacteria to common antibiotics requires special surveillance and strategic and targeted decision-making to have a positive impact on population health.

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