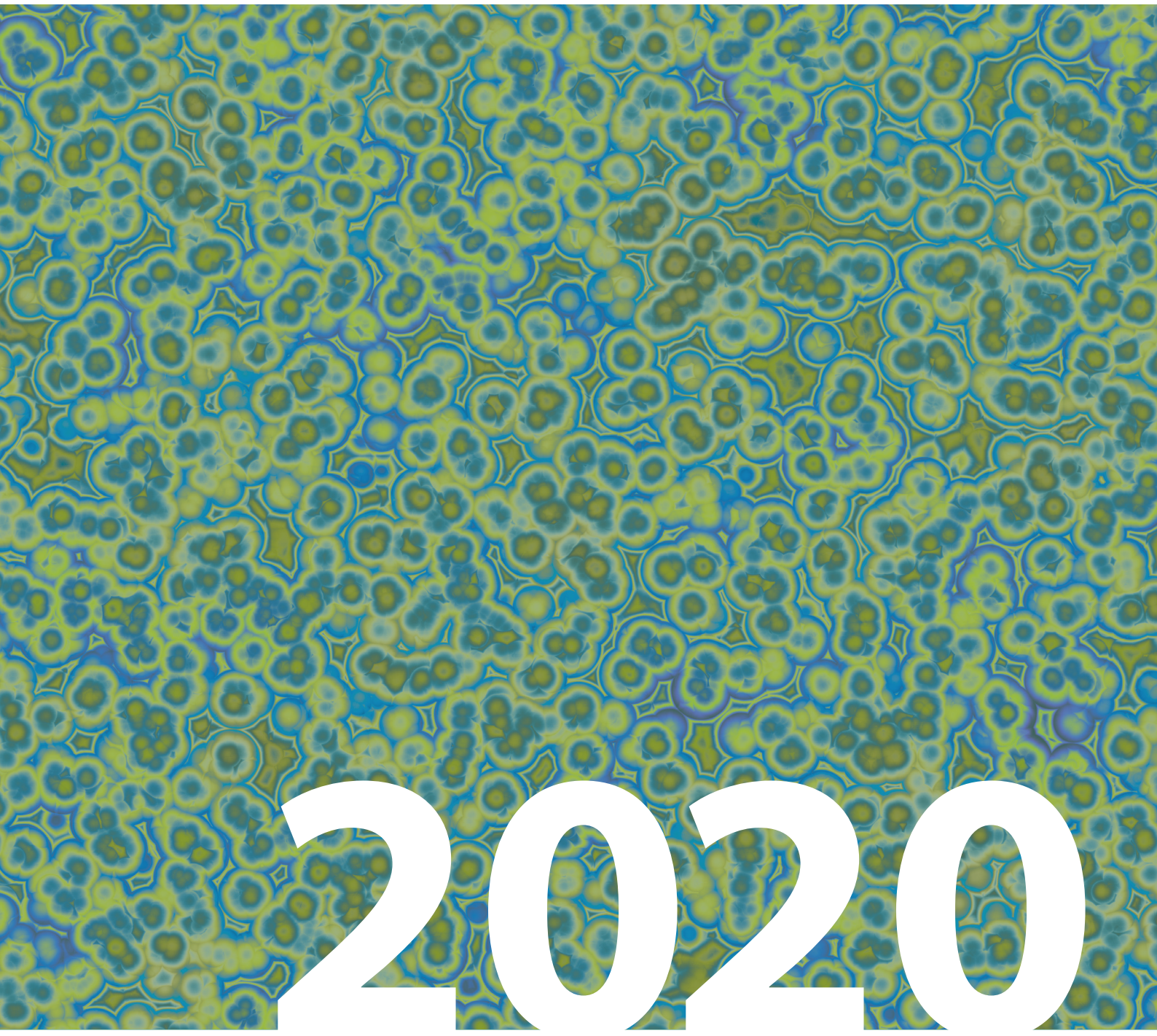
NATIONAL INSTITUTE FOR COMMUNICABLE DISEASES

Division of the National Health Laboratory Service



2020

GERMS-SA: ANNUAL SURVEILLANCE REVIEW

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THE GERMS-SA ANNUAL REPORT 2020 WAS COMPILED BY THE **NATIONAL INSTITUTE FOR COMMUNICABLE DISEASES**, A DIVISION OF THE NATIONAL HEALTH LABORATORY SERVICE, JOHANNESBURG, SOUTH AFRICA.

Editors	
Ms. Tiisetso Lebaka	Division of Public Health Surveillance and Response
Dr. Vanessa Quan	Division of Public Health Surveillance and Response
Contributing Authors	
Prof Nelesh Govender	Centre for Healthcare-associated Infections, Antimicrobial Resistance and Mycoses
Ms. Liliwe Shuping	Centre for Healthcare-associated Infections, Antimicrobial Resistance and Mycoses
Prof Olga Perovic	Centre for Healthcare-associated Infections, Antimicrobial Resistance and Mycoses
Dr. Susan Meiring	Centre for Respiratory Diseases and Meningitis
Prof Anne von Gottberg	Centre for Respiratory Diseases and Meningitis
Prof Cheryl Cohen	Centre for Respiratory Diseases and Meningitis
Dr. Juno Thomas	Centre for Enteric Diseases
Dr. Farzana Ismail	Centre for Tuberculosis
Dr. Nicola Page	Centre for Enteric Diseases
Dr Jenny Rossouw	Centre for Emerging Zoonotic and Parasitic Diseases

Please contact the NICD division which coordinates GERMS-SA, the Division of Public Health Surveillance and Response (DPHSR) for further information:

Physical address:
National Institute for Communicable Diseases, a Division of the National Health Laboratory Service
PRF Building , 1 Modderfontein Road, Sandringham, Johannesburg, 2192

Postal address:
National Institute for Communicable Diseases, a Division of the National Health Laboratory Service
Private Bag X4, Sandringham, 2131, South Africa

Telephone: +27 11 386 6234
Facsimile: +27 11 386 6221

The GERMS-SA website can be accessed via the NICD website: http://www.nicd.ac.za
Suggested citation: GERMS-SA Annual Report 2020. Available from: https://www.nicd.ac.za/wp-content/uploads/2022/02/GERMS-Annual-Review-2022.pdf

Inner cover photograph: Helen Jospeh/ Rahima Moosa GERMS-SA surveillance team.

CONTENTS

INTRODUCTION

The National Institute for Communicable Diseases (NICD) reference units report the GERMS-SA surveillance 2020 findings which continue to be useful in reporting trends in pathogen-specific data. The impact of the COVID-19 pandemic has affected the number of isolates reported through our routine GERMS-SA surveillance, partly due to decreased hospital admissions for illnesses other than COVID-19 and partly due to real decreases in disease transmission through reduced social interaction, mask-wearing and increased hand washing. The number of isolates received by NICD reference laboratories decreased as well as isolate viability. Many clinical laboratories were under pressure, impacting the rates of audit cases which are still out of target range. Therefore we were unable to do antimicrobial susceptibility testing and serotyping/serogrouping on these missing isolates. We urge all microbiology laboratories, in their challenged capacities, to continue to participate in laboratory surveillance so monitoring can continue and relevant, evidence-based policies can be made. The 2020 report also includes other NICD projects using the GERMS-SA platform: rotavirus/diarrhoeal aetiological surveillance and Mnisi Zoonosis acute febrile illness project (data from 2019). These projects differ from the laboratory-based surveillance in that it is syndromic surveillance and specimens are taken from patients with various clinical syndromes.

We encourage all laboratory staff to continue participating in the NICD surveillance programmes. We thank you for your ongoing service to the health of all South Africans.

METHODS

In 2020, diseases under surveillance included:

1. Opportunistic infections associated with HIV, e.g. cryptococcosis, invasive pneumococcal disease (IPD) and rifampicin-susceptible *Mycobacterium tuberculosis*
2. Epidemic-prone diseases, e.g. *Neisseria meningitidis, Salmonella enterica* serotype Typhi, *Salmonella enterica* serotype Paratyphi A, B and C, Nontyphoidal *Salmonella* species, *Shigella* species, *Vibrio cholerae,* Diarrhoeagenic *Escherichia coli, Campylobacter* species, *Listeria* species and *Streptococcus pyogenes.*
3. Vaccine-preventable diseases, e.g. *Haemophilus influenzae* type b (Hib), *Streptococcus pneumoniae* and *Streptococcus agalactiae.*
4. Healthcare-associated bloodstream infections caused by Carbapenem resistant Enterobacteriaceae.

The methods utilised by the GERMS-SA surveillance programme have been previously described in detail (1).
In brief, approximately 222 South African clinical microbiology laboratories participated in the surveillance programme in 2020. The population under surveillance in 2020 was estimated at 59,6 million (Table 1). Diagnostic laboratories reported case patients to the NICD using laboratory case report forms, according to standard case definitions. If available, isolates from case patients were submitted on Dorset transport media to the NICD for further phenotypic and genotypic characterisation. From 1 July 2008 to 31 December 2013, surveillance methodology for the cryptococcal project was changed, so that only enhanced surveillance sites (ESS) (29 hospitals in 9 provinces), NHLS laboratories in KZN, and laboratories in the private, mining, and military sectors were required to directly report case patients to NICD. In 2015 and 2016 to current, no laboratories were required to directly report case patients or send isolates to NICD. For these cases of cryptococcosis, data were obtained directly from the NHLS Surveillance Data Warehouse (SDW), which stores information from Disa*Lab and TrakCare laboratory information systems. Cryptococcal isolates, obtained from patients at enhanced surveillance sites, continued to be characterised by phenotypic and genotypic tests through 2013. Carbapenam Resistant Enterobacteriaceae (CRE) surveillance started in July 2015 in four provinces and these organisms were requested to be sent: *Klebsiella* spp., *Enterobacter* spp., *Citrobacter* spp., *Serratia* spp., *E. coli*, *Providentia* spp., *Proteus* spp., *Salmonella* spp., *Morganella* spp. and *Acinetobacter baumannii*. Submission of *Streptococcus agalactiae* and *Streptococcus pyogenes* isolates was also introduced in 2019.

Enhanced surveillance was not conducted on any of the enteric pathogens in 2015 but restarted for *Salmonella* Typhi only in 2016 and also *Salmonella enterica* serotype Paratyphi A, B and C and Nontyphoidal *Salmonella* spp. in 2019. At ESS, for 2020, surveillance officers completed clinical case report forms electronically using the Mobenzi application on mobile phones/ tablets for patients with nine laboratory-confirmed diseases: cryptococcosis, invasive pneumococcal disease, invasive meningococcal disease, invasive *Haemophilus influenzae* disease, invasive *Salmonella* Typhi disease, Paratyphi A,B,C,

Nontyphoidal diseases (country-wide), CRE (in four provinces), and rifampicin-susceptible TB (in five provinces), by case patient interview or hospital medical record review, to obtain additional clinical details, including antimicrobial use, vaccination history, HIV status, and patient outcome. Case patients were followed up only for the duration of the hospital admission. Data management was centralised at the NICD. Laboratory, clinical and demographic data from case patients were recorded on a Microsoft Access database. A surveillance audit was performed for NHLS laboratories in all provinces using the NHLS CDW. For all diseases under surveillance, except cryptococcosis and rifampicin-susceptible TB, the audit was designed to obtain basic demographic and laboratory data from additional case patients with laboratory-confirmed disease not already reported to GERMS-SA by participating laboratories. Data from case patients, detected by audit, were included on the surveillance database, and have been included in this report. Incidence was calculated using mid-year population estimates for 2019 and 2020 from Statistics South Africa (Table 1) (2). Incidence in the HIV-infected and AIDS populations was calculated for 2019 and 2020, using the Thembisa model (Table 1) (3). All reported incidence is expressed as cases per 100 000 population, unless otherwise stated. Reported p-values were calculated using the Mantel-Haenszel chi-squared test and p values <0.05 were considered significant throughout. Ethics approval for the on-going activities of the surveillance programme was obtained from the Human Research Ethics Committee (Medical), University of Witwatersrand and from relevant University and Provincial Ethics Committees for other enhanced surveillance sites. Surveillance activities were funded by the NICD/NHLS.

Table 1. Population denominators used to calculate incidence rates, South Africa, 2019 and 2020

Province	General population*		HIV-infected population**	
	2019	2020	2019	2020
Eastern Cape	6712276	6734001	804431	812694
Free State	2887465	2928903	374237	376154
Gauteng	15176116	15488137	1912525	1939019
KwaZulu-Natal	11289086	11531628	2011200	2027027
Limpopo	5982584	5852553	467585	473701
Mpumalanga	4592187	4679786	711983	724469
Northern Cape	1263875	1292786	82622	83448
North West	4027160	4108816	489380	493037
Western Cape	6844272	7005741	460181	469776
South Africa	**58775022**	**59622350**	**7314143**	**7399323**

Data source: *Statistics South Africa, **Thembisa Model

OPERATIONAL REPORT

Site visits

In 2020, NICD staff members continued with surveillance training at enhanced surveillance sites and laboratories. Other site visits were reduced due to COVID-19 travel restrictions.

Coordination of meetings

GERMS-SA Laboratory and Syndromic Surveillance Officers' meeting 18-20 March 2020 (just before COVID-19 lockdown) at Genesis: the aim was to train on current GERMS-SA surveillance projects and new COVID-19 projects within Pneumonia surveillance.

Surveillance audit

A total of 12 436 surveillance cases were detected by GERMS-SA in 2020 (about two-thirds of the previous year's total). Excluding the cases of cryptococcosis (n=5 545) which are all detected by audit, 1 845/6 891 (26.8%) of cases were detected by audit of the NHLS Corporate Data Warehouse (Table 2) and isolates not sent to the NICD by the clinical microbiology laboratories. GERMS-SA constantly strives to reduce the number of cases detected on audit by raising awareness of the surveillance programme; this is important because GERMS-SA is unable to perform additional microbiological characterisation of isolates detected only through audit.

Table 2. Cases detected by surveillance audit by province, 2020

Surveillance case		Percentage of cases detected by audit* n_1/n_2 (%)	Number of cases detected by audit									
			EC	FS	GA	KZ	LP	MP	NC	NW	WC	SA
Invasive	Cryptococcosis**	5 545/5 545 (100)	784	222	1 221	1474	422	407	63	424	528	5 545
	Salmonella Typhi	4/66 (6%)	2	0	2	0	0	0	0	0	0	4
	Non-typhoidal salmonellosis†	138/823 (17%)	13	6	58	20	6	9	8	5	13	138
	Shigellosis	4/36 (11%)	1	0	2	1	0	0	0	0	0	4
	Meningococcal disease	10/50 (20)	1	0	2	3	1	0	0	0	3	10
	Haemophilus influenzae disease	63/202 (31)	3	2	24	8	8	2	2	3	11	63
	Pneumococcal disease	272/1 262 (22)	28	21	74	49	5	12	8	23	52	272
	Streptococcus pyogenes	216/443 (49)	14	4	58	29	1	3	7	0	100	216
	Streptococcus agalactiae	393/753 (52)	22	13	201	74	4	8	5	2	64	393
	Carbapenem resistant Enterobacteriaceae (BC only)	440/1 094 (40)	N/A	13	288	101	N/A	N/A	N/A	N/A	38	440
Non-invasive	*Salmonella Typhi*	1/17 (6%)	0	0	0	0	0	0	0	0	1	1
	Non-typhoidal salmonellosis†	137/1 483 (9%)	13	5	34	27	6	3	3	14	32	137
	Shigellosis	167/662 (25%)	11	10	26	25	2	2	7	3	81	167
Total (excl crypto and RSTB)		**1 845/6 891 (26.8%)**	**108**	**74**	**769**	**337**	**33**	**39**	**40**	**50**	**395**	**1 845**

Note - Percentage of cases detected by audit = number of cases detected on audit (n1)/total number of cases detected by GERMS-SA (n2) x 100;**All cases of cryptococcal disease are detected by LIS audit and no isolates are received; therefore this disease is excluded from the total; †Excluding Salmonella enterica serotype Paratyphi; EC: Eastern Cape; FS: Free State; GA: Gauteng; KZ: KwaZulu-Natal; LP: Limpopo; MP: Mpumalanga; NC: Northern Cape; NW: North West; WC: Western Cape; SA: South Africa; BC: Blood culture.

Enhanced surveillance site performance indicators

The proportion of completed CRFs in 2020 decreased compared to 2019. Because of COVID-19, surveillance officers were asked to reduce their contact with patients so the majority of case report forms were done through medical records, a challenge because of poor record systems in many hospitals (Table 3); 3 160/ 4 482 (71%) of cases had a case report form (CRF) completed (target=90%). Since 2007, enhanced surveillance site operational reports (ESSOR) have been provided to the site coordinators, laboratory staff and surveillance officers to enable the site team to regularly review site performance, in comparison with set targets. The main objective of these reports is to provide information regarding the overall functioning of the surveillance site, by providing indicators of laboratory participation (submission of isolates), and indicators of surveillance officer performance (completion of CRFs). By reviewing these indicators, problems with data collection can be targeted, and recommendations are provided to improve the site performance. In 2020, because of COVID-19, there were challenges in providing these reports. Our roving technologist, employed for the Gauteng enhanced surveillance sites, did help to improve sending of isolates.

Enhanced surveillance site quality monitoring

In 2020, as per annual performance management and improving quality of data collection, surveillance officers (SOs) were audited in terms of quality of work. CRFs from a fixed time period were randomly selected for each surveillance officer so that CRFs for each organism could be audited per SO. The medical record files were drawn and the GERMS-coordinating staff filled in a modified clean CRF from the original source data and compared their CRF with the original SO CRF. A scoring system was set up and, although the scores varied widely amongst SOs, many of the errors were ones of omission and overlooking information rather than entry of incorrect data. Data training was done regularly to overcome these errors.

Table 3. Enhanced surveillance site performance indicators, 2020

Enhanced surveillance site	Case patients, n	Completed case report forms*, n (%)**		Case report forms completed by interview, n (%)***	
Addington	55	40	73	20	50
Charlotte Maxeke Johannesburg Academic [1]	424	264	62	56	21
Chris Hani Baragwanath/ Zola-Jabulani District [1,2]	812	452	56	145	32
Dr George Mukhari [1]	154	129	84	31	24
Edendale/ Greys'/ Northdale [1]	327	298	91	281	94
Groote Schuur/ Red Cross [1]	302	211	70	43	20
Helen Joseph/ Rahima Moosa Mother & Child [1]	316	267	84	109	41
Kimberley	93	0	0	0	0
King Edward VIII/ Inkosi Albert Luthuli Central Hospital [1,2]	240	174	73	52	30
Klerksdorp/ Tshepong [2]	236	182	77	125	69
Mankweng/ Polokwane/ Seshego	143	68	48	18	26
Pelonomi/ Universitas [1]	187	146	78	58	40
Port Elizabeth/ Dora Nginza/ Livingstone [2]	416	355	85	100	28
RK Khan [1,2]	165	103	62	44	43
Rob Ferreira/ Themba [2]	144	118	82	18	15
Steve Biko Pretoria Academic/ Tshwane District [1]	257	199	77	7	4
Tygerberg [1]	211	154	73	2	1
Total	**4482**	**3160**	**71**	**1109**	**35**

Note - The percentage in each cell was calculated using the numerator from that cell and the corresponding denominator from the cell to the left; *Low case report form completion rates and patient interviews at the majority of sentinel sites for 2020 were due to Covid-19 challenges of capacity, lock-down and data delays from CDW. Kimberley no longer has a SO on site therefore CRFs were completed quarterly, by medical record reviews (which are a challenge to access); **Target = 90%; ***Target = 70%; [1]Sites doing CRE surveillance; [2] Sites doing rifampicin-susceptible TB surveillance. Data includes Salmonella Typhi from all specimen sites, and nontyphoidal Salmonella from sterile sites.

SURVEILLANCE REPORTS

Enhanced surveillance site project

In 2020, 4 482 surveillance case patients were diagnosed at enhanced surveillance sites (Table 3). Of case patients with recorded HIV status, 73% (2 191/3 046) were HIV-infected (Table 4). The proportion of case patients with confirmed HIV infection varied by surveillance disease: unsurprisingly, a very high proportion of patients with AIDS-defining infections like cryptococcosis (98%) were HIV-infected. HIV infection amongst patients with invasive pneumococcal disease, for which HIV is a known risk factor, was 61%.

Table 4. Numbers and percentage* of patients diagnosed with laboratory-confirmed invasive disease at GERMS-SA enhanced sur-veillance sites, with confirmed HIV-1 infection **, South Africa, 2020

Pathogen	Case patients, n	Case patients with completed case report forms, n (%)*		Case patients with known HIV status, n (%)		Case patients with confirmed HIV infection, n (%)**	
Cryptococcus species	1408	1167	83	811	69	792	98
CRE	1094	739	68	504	68	126	25
Neisseria meningitidis	12	8	67	7	88	1	14
Haemophilus influenzae	95	71	75	53	75	30	57
Streptococcus pneumoniae	510	398	78	334	84	205	61
Streptococcus pyogenes	230	120	52	71	59	25	35
Streptococcus agalactiae	378	206	54	150	73	13	9
Salmonella Typhi	26	23	88	13	57	6	46
Non-typhoidal *Salmonella*	408	314	77	248	79	185	75
Total	**4161**	**3046**	**73**	**2191**	**72**	**1383**	**63**

*The percentage (in brackets) in each cell was calculated using the numerator from that cell and the corresponding denominator from the cell to the left. **HIV infection was confirmed by an age-appropriate, laboratory test and recorded by surveillance officers at enhanced surveillance sites.

Cryptococcus species

Results

During 2020, 5 545 patients with a first episode of laboratory-confirmed cryptococcal disease were reported, excluding 796 with isolated cryptococcal antigenaemia (Table 5). A majority (n=5 167, 93%) of the cases were diagnosed with cryptococcal meningitis (laboratory tests on cerebrospinal fluid positive for *Cryptococcus* species), 6% (n=317) with fungaemia (*Cryptococcus* species cultured from blood) and 1% (n=61) with culture-positive disease at other sites. Of the patients diagnosed with cryptococcosis at other sites, 26% (n=16) were diagnosed with a positive culture from a respiratory tract specimen. Between 2019 and 2020, the national incidence risk of laboratory-confirmed cryptococcosis decreased from 83 to 75 cases per 100 000 HIV-infected persons. The provincial incidence risks remained similar (overlapping 95% confidence intervals) over the 2 years, except in the Eastern Cape and North West provinces where the incidence decreased (Table 6). The highest incidence risk was recorded among males aged 40-44 years and the peak incidence among females, though lower than for males, was among those aged 35-39 years (Figure 1). Age was known for 5 360 (97%) case patients; the median age was 37 years (interquartile range [IQR], 31 – 44 years) and children younger than 15 years accounted for 2% of cases (n=105). There were 1 408 case patients reported at ESS during 2020 and case report forms were completed for 83% (n=1 167). Among 811 patients with known HIV status, 98% were HIV-seropositive (Table 4), a majority (70% [535/769]) of whom had previously received antiretroviral therapy or were on antiretroviral treatment at the time of cryptococcal disease diagnosis. Of the HIV-seropositive patients, 86% (677/792) had a CD4+ T-lymphocyte (CD4) cell count test result recorded close to the time of diagnosis; the median CD4 cell count was 30 cells/µl (IQR, 12 – 71 cells/µl) and 94% (633/677) had a CD4 cell count <200 cells/µl. Viral load test results were available for 487 patients; 24% (n=115) had a viral load of <400 copies/mL, 11% (n=52) had viral loads of 400 - 10 000 copies/mL, and 66% (n=320) had viral loads of >10 000 copies/mL. A majority of the case patients received antifungal therapy in-hospital (88%, 979/1 119); 35% (345/979) received a flucytosine-containing induction regimen. The in-hospital case-fatality ratio for patients at ESS with a first episode of cryptococcal disease was 39% (435/1129).

Table 5: Number and percentage of cases of cryptococcal meningitis or culture-positive cryptococcal disease detected by GERMS-SA by specimen type, South Africa, 2019-2020, n=11 591

Site of specimen	2019		2020	
	n*	%	n*	%
Cerebrospinal fluid	5594	93	5167	93
Blood	327	5	317	6
Other	125	2	61	1
Total	**6046**		**5545**	

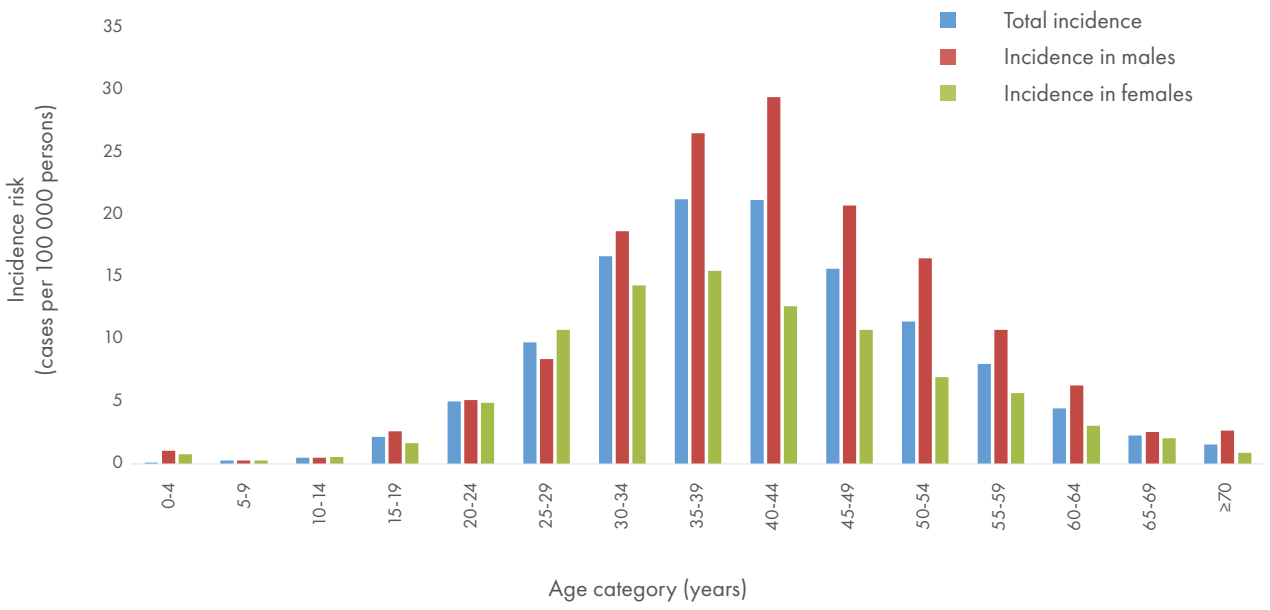
*These case numbers exclude 1151 patients (355 in 2019 & 796 in 2020) who tested positive for cryptococcal antigenaemia at NHLS microbiology labs.

Table 6: Number of cases and incidence of cryptococcal meningitis or culture-positive cryptococcal disease detected by GERMS-SA by province, South Africa, 2019-2020, n=11 591

Province	2019		2020	
	n*	Incidence risk (95% CI)†	n*	Incidence risk (95% CI)†
Eastern Cape	999	124 (116-132)	784	96 (90-103)
Free State	235	63 (55-71)	222	59 (5167)
Gauteng	1 319	69 (65-73)	1221	63 (59-67)
KwaZulu-Natal	1 581	79 (75-82)	1474	73 (69-76)
Limpopo	433	93 (84-101)	422	89 (81-98)
Mpumalanga	433	61 (55-67)	407	56 (51-62)
Northern Cape	71	86 (66-106)	63	75 (57-94)
North West	514	105 (96-114)	424	86 (78-94)
Western Cape	461	100 (91-109)	528	112 (103-122)
South Africa	6046	83 (81-85)	5545	75 (73-77)

*These case numbers exclude patients who tested positive for cryptococcal antigenaemia. †Incidence risk was calculated using mid-year population denominators determined by the Thembisa model and is expressed as cases per 100 000 HIV-infected persons (refer to Table 1).

Figure 1. Number of cases and incidence of cryptococcal meningitis or culture-positive cryptococcal disease detected by GERMS-SA , by sex and age group, South Africa, 2020, n= 5 360



Discussion

The national incidence risk of cryptococcal meningitis or culture-confirmed cryptococcosis decreased overall in 2020 compared to 2019, although it remained stable in most provinces. This decline may be related to barriers to accessing the healthcare system with COVID-19-related restrictions in 2020. Relatively fewer patients with advanced HIV disease may have been screened for cryptococcal antigenemia through the national reflex screening programme and fewer diagnoses of symptomatic cryptococcal disease may have been made. An interrupted time-series analysis is being conducted by the NICD to explore this in more depth. This decrease may also be related to the fact that audits of private laboratories for case reporting are incomplete for 2020. The overall in-hospital case-fatality ratio was very high in 2020, despite at least a third of the patients at GERMS-SA ESS receiving flucytosine-based induction regimens through an access programme. This may be related to delayed presentation to hospital among people with symptomatic cryptococcal disease during the pandemic. These data also indicate the need to generally strengthen the HIV programme in the country to reduce cryptococcal disease and mortality.

Enhanced sentinel surveillance for CRE bacteraemia in four provinces

Results

There were 3 670 cases of CRE bacteraemia (as detected by a diagnostic laboratory) reported to GERMS-SA from July 2015 through to December 2020 (Table 7). There was an increase in the number of cases from 1 052 in 2019 to 1 094 in 2020. In 2020, a high proportion of cases were detected from sentinel sites in Gauteng (66%; 725/1 094) followed by KwaZulu-Natal (19%; 211/1 094). In the Western Cape, there was a decrease in the percentage of cases from 15% in 2019 to 12% in 2020 (Table 7, Figure 2). In 2020, males accounted for 55% (601/1 094) and females 45% (489/1 094). Approximately 26% (279/1 094) of cases were aged less than one-year-old (Figure 3). Approximately 40% (440/1 094) of cases were identified by audit (Table 2). CRE isolates were available for 58% (638/1 094) of patients and submitted to NICD for antimicrobial susceptibility testing in 2020. *Klebsiella pneumoniae* was the predominant organism (80%, n=508) followed by *Enterobacter cloacae* (6%; n=39), *Escherichia coli* (5%; n=31) and *Serratia marcescens* (4%; n=27) (Figure 4). Among isolates in 2020, 74% (n=473) were resistant to ertapenem and 13% (n=86) were intermediate, 36% (n=226) were resistant to imipenem and 14% (n=88) were intermediate, and 50% (n=321) were resistant to meropenem, 4.6% (n=29) intermediate and 46% (n=294) resistant and 8% (n=48) intermediate to doripenem (Figure 5). Of the 638 isolates, colistin testing using the Sensititre reference method was performed on 623 isolates. Of the 623 isolates, 19% (n=123) were resistant to colistin (Figure 6). We confirmed carbapenemase genes in 87% (558/638) of isolates, including OXA-48 & variants (73%; 468/638) and NDM (12%; 79/638) as the highest amongst all genes in 2020 (Figure 7). Six percent (37/638) of isolates were susceptible to ertapenem with an MIC ≤ 0.5 mg/L but were OXA-48 positive. A shift was noted among CRE mediated by OXA-48 & variants (Figure 8). Data on tigecycline showed that 84% (534/638) of isolates were susceptible. HIV status was known for 68% (504/739) of cases that had completed case report forms. Of cases with known HIV status, 25% (126/504) were HIV-positive in 2020 (Table 4). Patient outcome was known for 98% (723/739) of cases, of which 38% (278/723) died in hospital.

Table 7: Number of cases of carbapenem-resistant Enterobacteriaceae (CRE) bacteraemia reported to GERMS-SA by province, July 2015 to December 2020, n=3 670 (including audit cases)

Province	2015		2016		2017		2018		2019		2020		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Free State	1	1	3	1	11	2	11	2	17	2	25	2	68	2
Gauteng	80	68	218	67	375	78	471	78	669	64	725	66	2 538	69
KwaZulu-Natal	32	27	73	23	76	16	74	12	209	20	211	19	675	18
Western Cape	4	4	29	9	21	4	45	8	157	15	133	12	389	11
Total	**117**	**100**	**323**	**100**	**483**	**100**	**601**	**100**	**1052**	**100**	**1 094**	**100**	**3 670**	**100**

Figure 2. Distribution of CRE bacteremia cases by province, 2019-2020, n= 2 146

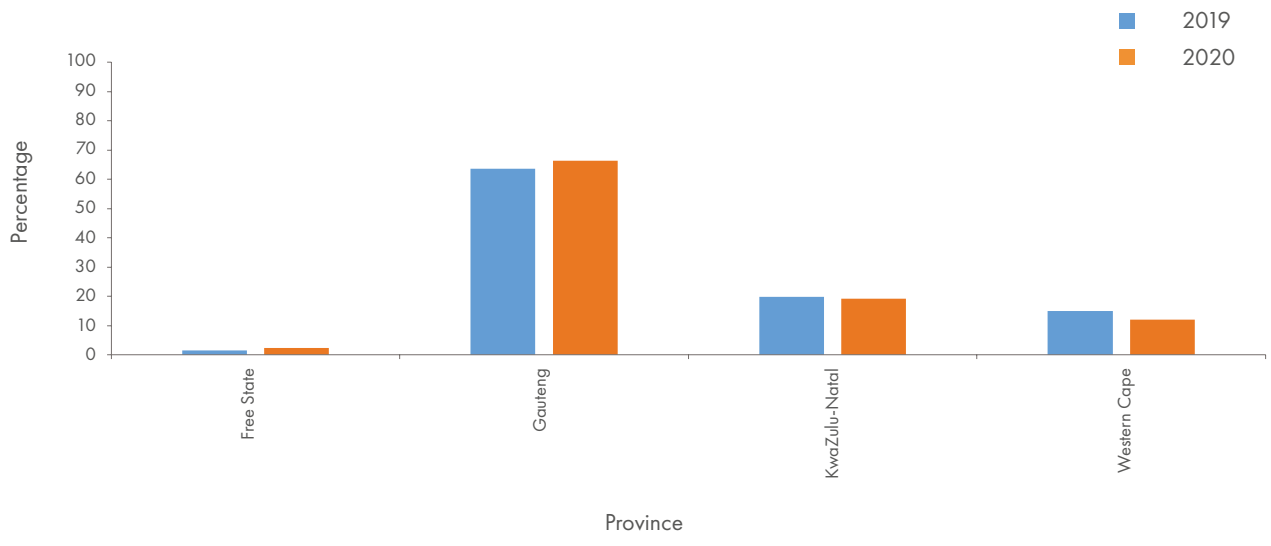


Figure 3. Distribution of CRE bacteremia by age category, 2019-2020, n= 2 146

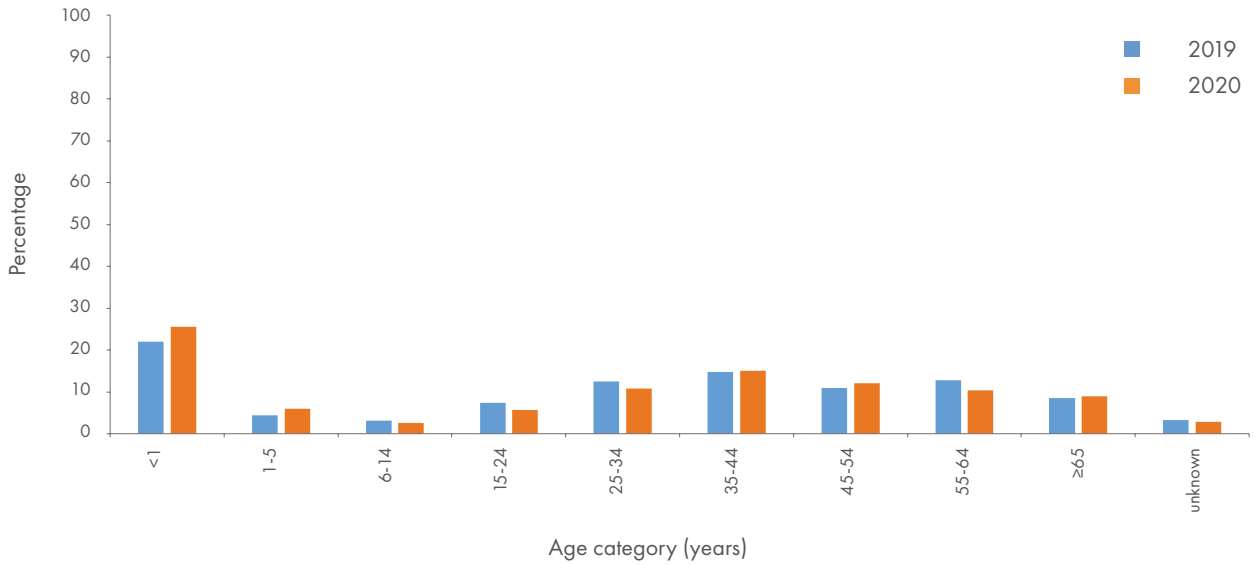


Figure 4. Enterobacteriaceae distribution by species for CRE bacteraemia surveillance, 2019-2020, n=1 068

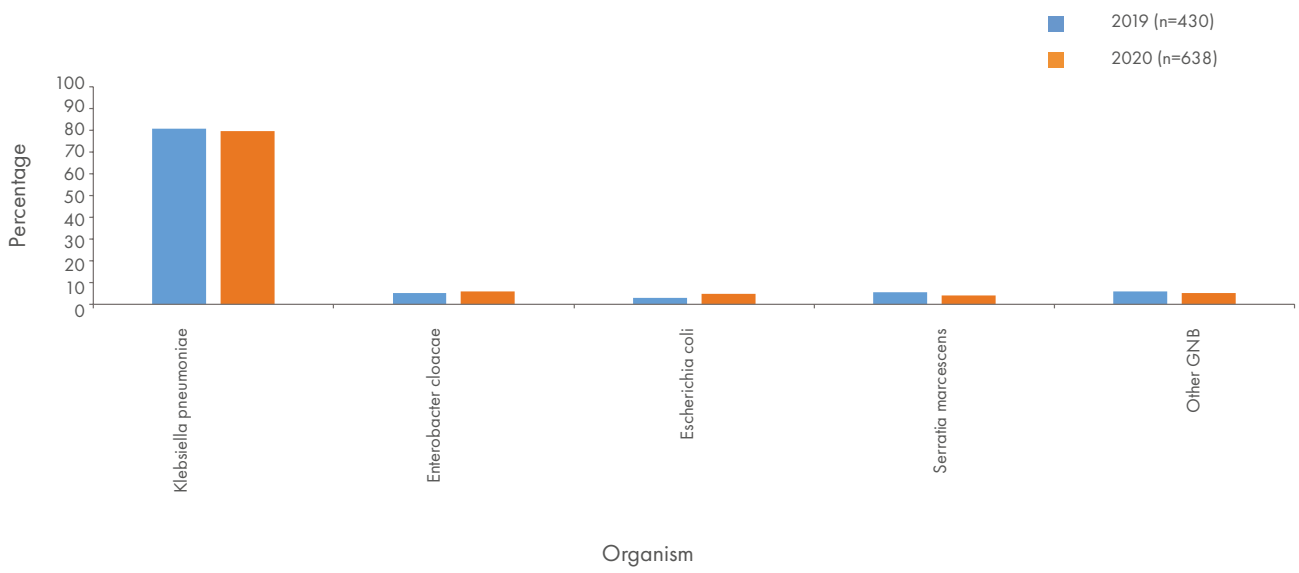


Figure 5. MIC breakpoints for carbapenem results in 2020, n=638

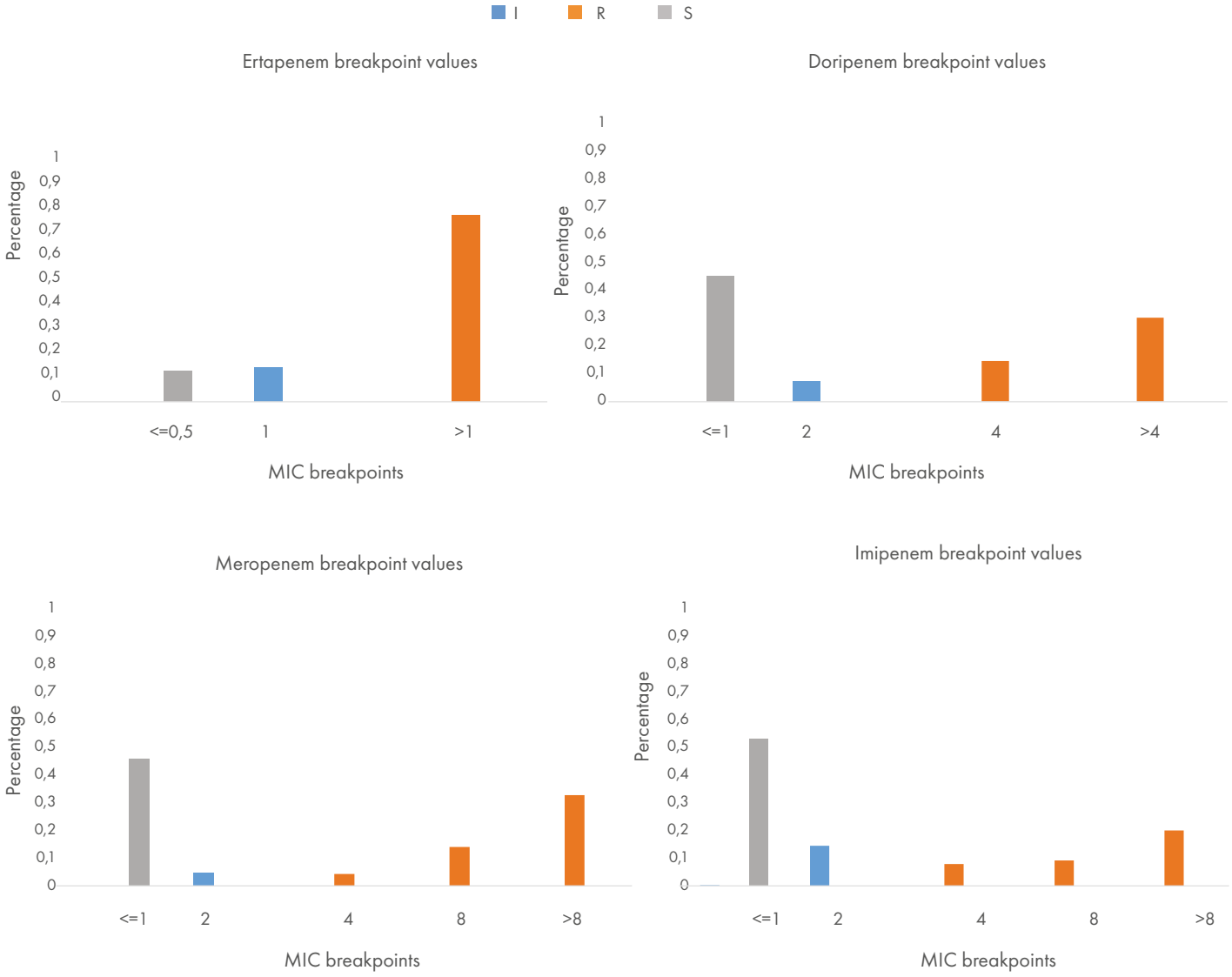
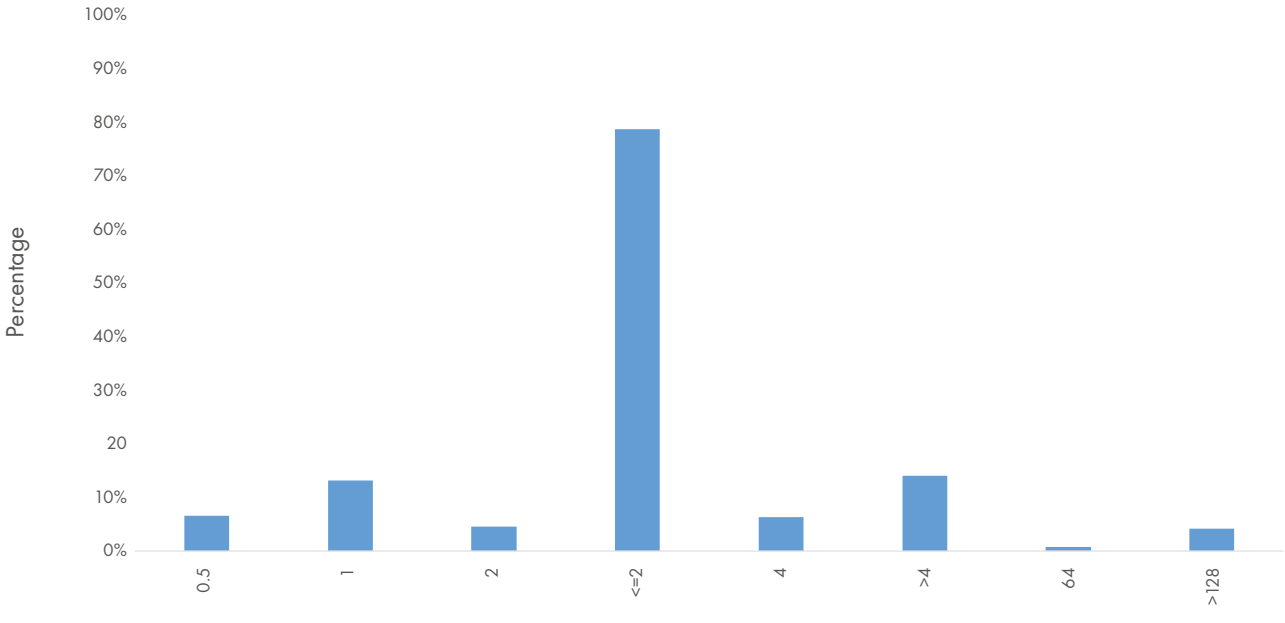


Figure 6. Colistin susceptibility by Sensititre in 2020, n=623



No mcr 1-5 were detected from 19% colistin resistant isolates

Figure 7. Distribution of carbapenemase genes in Enterobacteriaceae, 2020, n=638

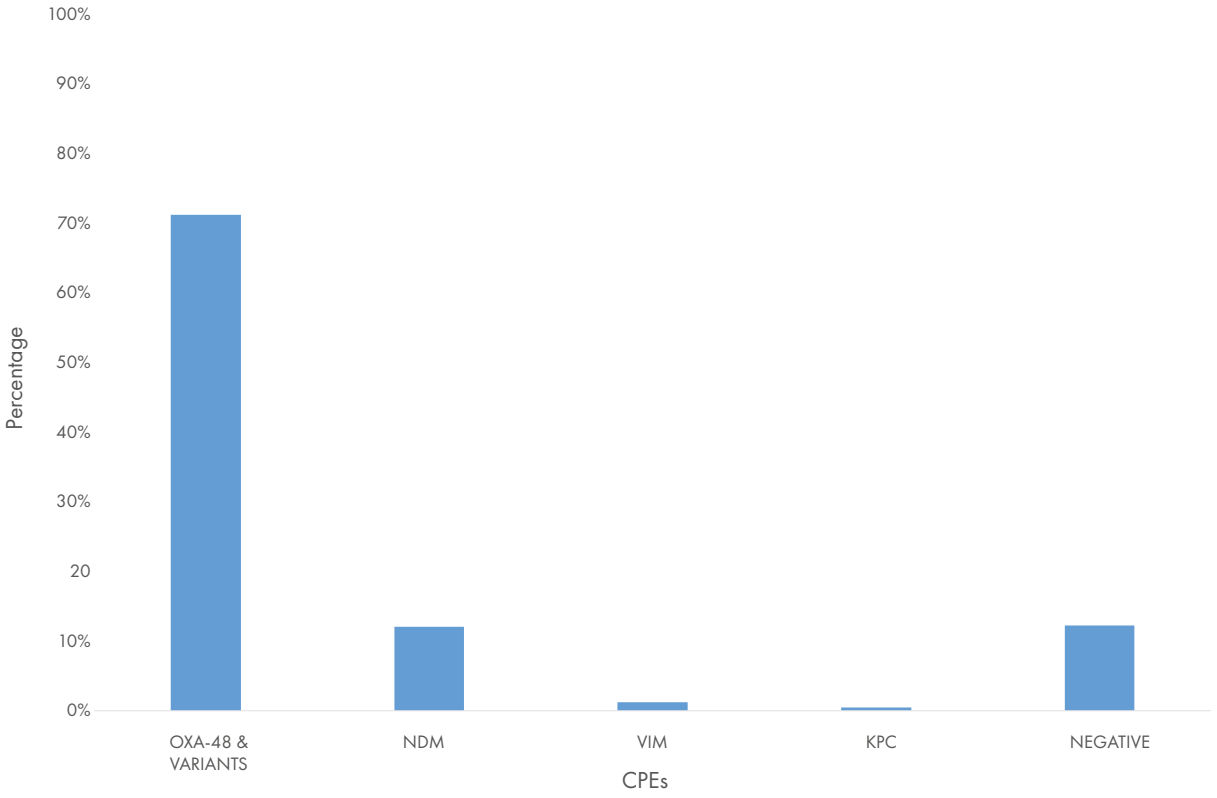
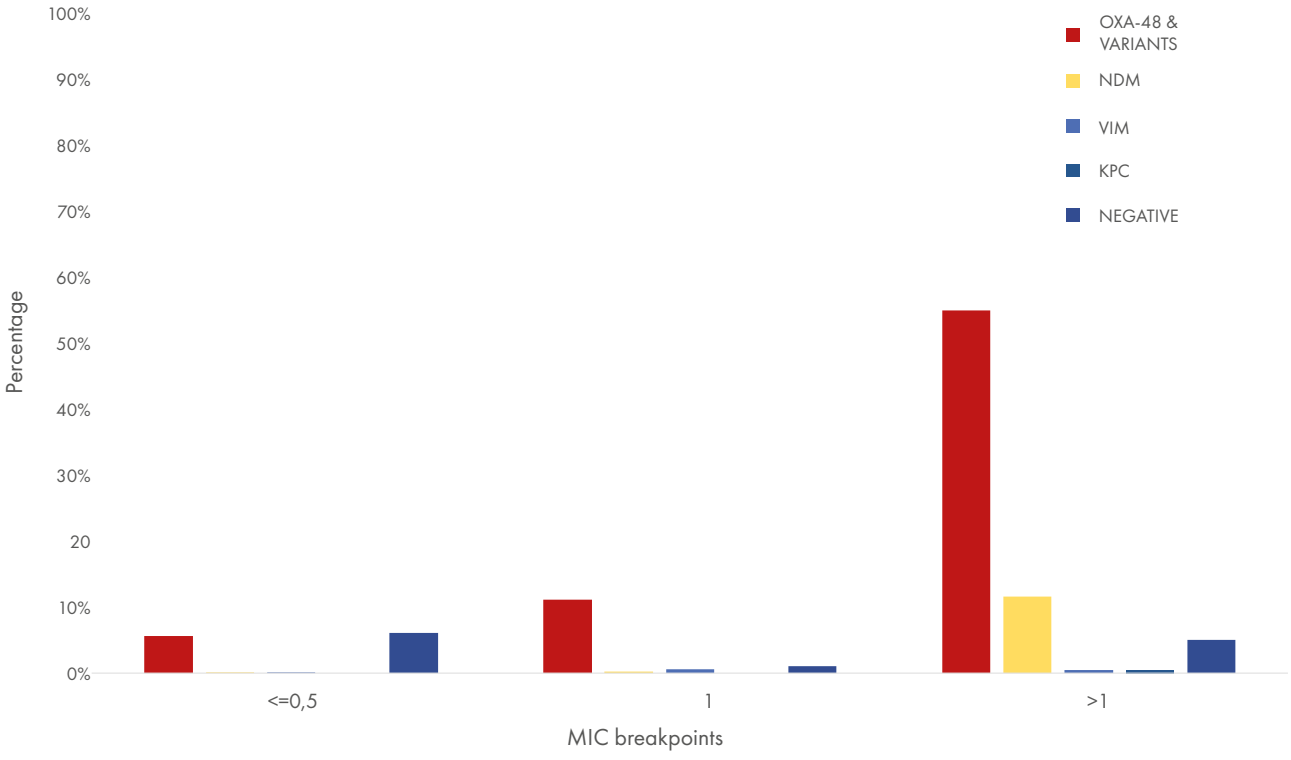


Figure 8. Correlation of CPE genes and ertapenem susceptibility, 2020, n=638



Discussion

The number of CRE bacteraemia cases detected over the surveillance period is relatively small. However, there has been an increase in 2019 and 2020 compared to 2017 and 2018 of these highly-resistant organisms, which has an impact on the public-sector health system in terms of patient outcomes and healthcare costs. Most cases were detected in Gauteng and KwaZulu-Natal. We noted a shift to CPE mediated by OXA-48 & variants; these enzymes are not easily detected in the laboratory. In addition, the OXA genes are located on a very efficient transposon with the potential for point mutations, which would render them even more difficult to detect. Plasmid mediated colistin resistance has not been detected amongst our isolates.

Neisseria meningitidis

Results

In 2020, 50 cases of invasive meningococcal disease (IMD) were identified through the GERMS-SA surveillance system (less than half the cases detected in 2019 (n=111)). Twenty-three viable isolates were received for further characterisation, ten were detected through audit (Table 2) and 17 were detected through PCR-detection only. IMD incidence in 2020 was 0.08 cases per 100 000 population. Provincial IMD incidence varied markedly with a decrease from 2019 noted in all provinces. Western Cape had the highest incidence (0.39 per 100 000 population) followed by Eastern Cape and Gauteng Provinces (0.09 and 0.06 per 100 000 respectively) (Table 8). Cases occurred sporadically, and following a peak in January, most cases occurred from the winter through spring months (Figure 9). IMD was diagnosed in equal proportions from cerebrospinal fluid (24/50, 48%) and blood (26/50, 52%); and equally amongst males and females (24/50, 48% and 26/50, 52%, respectively) (Table 9). Serogroup B was predominant (26/38, 68%), followed by serogroup W (7, 18%), Y (3, 8%) and C (2, 5%) (Table 10). Incidence was highest amongst children <1 year (0.9/100 000), with serogroup B dominating in most age groups, except 5-9 years where serogroup W was most prevalent and 10-14 years where serogroup Y predominated (Figure 10). Of the via-ble isolates tested for antimicrobial susceptibility, 39% (9/23) were non-susceptible to penicillin with minimum inhibitory concentrations (MICs) between 0.094µg/ml and 0.19µg/ml, and all were susceptible to third generation cephalosporins, rifampicin and ciprofloxacin.

Eight of the 12 (67%) IMD patients presenting to our enhanced surveillance sites had clinical information available (Table 4). Six were less than 5 years of age and two were in the 25-44 year age category. Median length of hospital admission was six days. Case fatality rate was 38% (3/8); with two adult deaths occurring on the day of admission. One of seven persons with known HIV status was HIV-infected (Table 4). Amongst those who survived to discharge, one (1/5, 20%) developed ongoing seizures.

Table 8: Number of cases and incidence rates of meningococcal disease reported to GERMS-SA by province, South Africa, 2019 and 2020, n=161 (including audit cases)

Province	2019		2020	
	n	Incidence rate*	n	Incidence rate*
Eastern Cape	12	0,18	6	0,09
Free State	3	0,1	0	0
Gauteng	37	0,24	10	0,06
KwaZulu-Natal	13	0,12	4	0,03
Limpopo	2	0,03	1	0,02
Mpumalanga	1	0,02	1	0,02
Northern Cape	1	0,08	0	0
North West	4	0,1	1	0,02
Western Cape	38	0,56	27	0,39
South Africa	**111**	**0,19**	**50**	**0,08**

*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Figure 9: Number of laboratory-confirmed, invasive, meningococcal cases, reported to GERMS-SA, by month and year, South Africa, 2019-2020, n=161

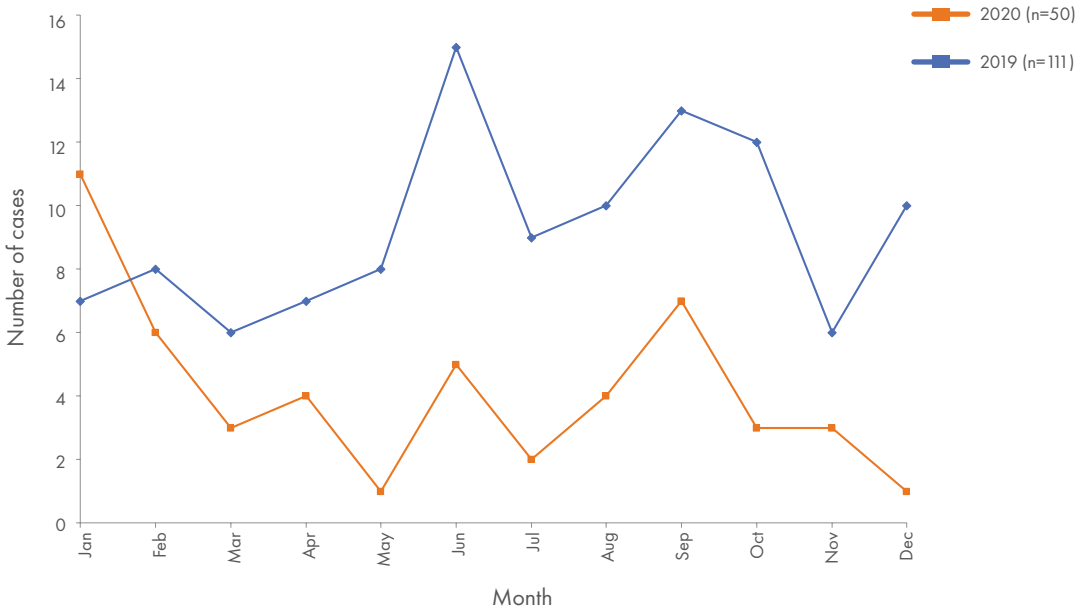


Table 9. Number and percentage of cases of meningococcal disease reported to GERMS-SA by specimen type, South Africa, 2019 and 2020, n=161

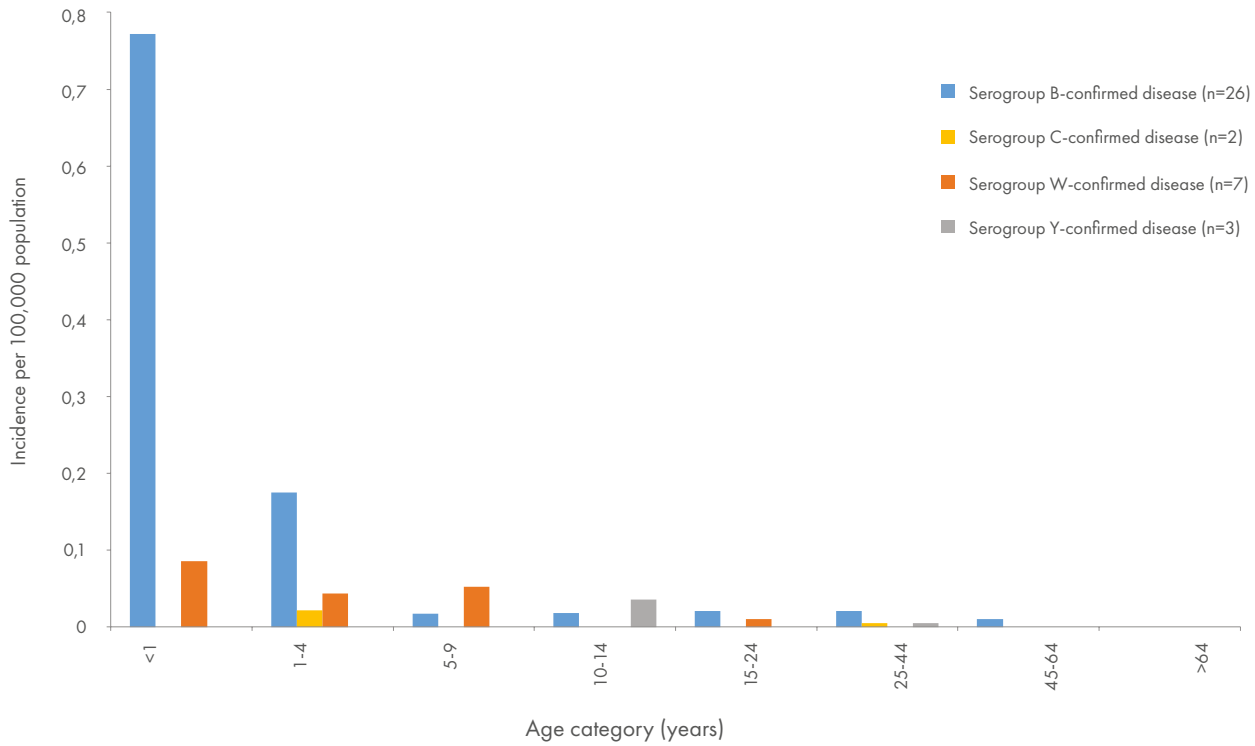
Site of specimen	2019		2020	
	n	%	n	%
Cerebrospinal fluid	70	63	24	48
Blood	41	37	26	52
Other	0	0	0	0
Total	**111**		**50**	

Table 10: Number of cases of invasive meningococcal disease reported to GERMS-SA by serogroup and province, South Africa, 2020, n=50*

Province	Serogroup								
	Serogroup not available	A	B	C	W	Y	Z	E**	Total
Eastern Cape	2	0	2	2	0	0	0	0	6
Free State	0	0	0	0	0	0	0	0	0
Gauteng	2	0	6	0	1	1	0	0	10
KwaZulu-Natal	3	0	1	0	0	0	0	0	4
Limpopo	1	0	0	0	0	0	0	0	1
Mpumalanga	0	0	1	0	0	0	0	0	1
Northern Cape	0	0	0	0	0	0	0	0	0
North West	0	0	1	0	0	0	0	0	1
Western Cape	4	0	15	0	6	2	0	0	27
South Africa	12	0	26	2	7	3	0	0	50

*38 (76%) with viable isolates or specimens available for serogrouping/genogrouping; There were no Non-groupable meningococcal isolates causing invasive disease in 2020.

Figure 10. Age-specific incidence rates* for laboratory-confirmed, invasive, meningococcal cases, by serogroup B, C, W and Y, South Africa, 2020, n=50 (**specimens or viable isolates unavailable for serogrouping n=12)**



*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Discussion

IMD incidence in 2020, was half of that in 2019, likely as a result of measures implemented nationally from March 2020 to reduce transmission of respiratory droplets through social distancing of persons, mask-wearing and various lockdown levels following the WHO announcement of the COVID-19 pandemic. This reduction has been seen in multiple countries (5) IMD is a severe illness requiring urgent hospitalization, therefore, it is unlikely that changes in health-seeking behaviour could fully account for these reductions. Although disease occurs infrequently and affects all ages, burden is highest in young children and mortality remains high. Penicillin non-susceptibility continued to increase, however all isolates remained susceptible to third generation cephalosporins and ciprofloxacin. Although a variety of serogroups are circulating nationally, serogroup B remains predominant, particularly in the Western Cape and Gauteng Provinces.

Haemophilus influenzae

Results

In 2020, there were 202 cases of invasive *Haeomophilus influenzae* (HI) disease identified through the surveillance programme. Sixty-three (31%) were audit cases, 34 (17%) were detected through PCR only, and 105 (52%) isolates were available for further characterisation (Table 2). Five cases were co-infected with *Streptococcus pneumoniae*. Incidence of invasive HI disease was 0.34 cases per 100 000 population, a 23% reduction from 2019 (0.44/100 000). The highest number of cases were from Gauteng (58/202, 29%) and Western Cape Provinces (57/202, 28%) (Table 11). Amongst cases that were available for serotyping, non-typeable (HNT) was most common (58/130, 45%), followed by serotype b (Hib, 47/130, 36%). The majority of HI disease (124/202, 61%) was detected on blood specimens (72% of HNT, 57% of Hib); however, Hib was more likely than HNT to be detected in cerebrospinal fluid (18/47, 38% vs 6/58, 10%) (Table 12). Although disease burden of serotypes is spread across all age categories, the highest incidence of both Hib and HNT invasive disease was in children <1 year (1.63/100 000 Hib and 0.69/100 000 HNT) (Figure 11 and 12). Despite year on year fluctuations, Hib incidence in children <5 years has remained stable since 2013, whilst a steady decline is noted in HNT (Figure 13). Eighteen percent (7/40) of Hib and two percent (1/45) of HNT isolates were non-susceptible to ampicillin (MIC>1mg/L). Twenty-eight Hib cases occurred in children <15 years of age and of these vaccine history was available for 29% (8/28). Two infants were too young to receive the first Hib vaccine dose. Two had received at least 3 doses of Hib vaccine, and are possible vaccine failures (one child who received 4 doses was HIV-infected). Two infants <3 months had received 2 doses and were up to date with their vaccination schedule, and a further two infants (a 3-month- and a 10-month-old) had received one dose each.

Clinical information was available for 75% (71/95) of HI cases presenting to the enhanced surveillance sites (ESS) (Table 4) Patients were hospitalised for a median of 8 days (interquartile range (IQR) 4-13). Case-fatality ratio was 31% (22/71), 14% (1/7) for HI meningitis and 35% (17/48) for HI on blood culture. Median time to death was within 4 days of admission (IQR 1-7). Fifty-seven percent (30/53) of those tested for HIV were HIV-infected. Conditions other than HIV predisposing to HI disease were reported in 34/71 (48%) patients – the most common conditions included history of smoking (9), prematurity (5), chronic lung disease (4), malignancy (3) and diabetes (3). Of the 6 surviving HI meningitis patients at ESS: 50% (3/6) suffered sequelae upon discharge – one developed ongoing seizures, one hearing loss and another neurological fallout.

Table 11. Number of cases of invasive *Haemophilus influenzae* disease reported to GERMS-SA by serotype and province, South Africa, 2020, n=202*

Province	Serotype								
	Serotype not available	A	B	C	D	E	F	Non-typeable	Total
Eastern Cape	3	0	7	0	2	0	0	8	20
Free State	2	2	0	0	0	0	1	7	12
Gauteng	28	3	13	0	0	0	2	12	58
KwaZulu-Natal	9	0	9	0	0	0	0	7	25
Limpopo	8	0	3	0	0	0	1	1	13
Mpumalanga	4	0	2	0	0	0	0	1	7
Northern Cape	2	2	0	0	0	0	0	1	5
North West	3	1	1	0	0	0	0	0	5
Western Cape	13	5	12	1	0	1	4	21	57
South Africa	72	13	47	1	2	1	8	58	202

*130 (64%) with specimens or viable isolates available for serotyping.

Table 12. Number and percentage of cases of invasive *Haemophilus influenzae* disease reported to GERMS-SA by specimen type, South Africa, 2020, n=202

Site of specimen	No serotype available		Serotype b		Serotypes a, c, d, e, f		Non-typeable	
	n	%	n	%	n	%	n	%
Cerebrospinal fluid	15	21	18	38	7	28	6	10
Blood	37	51	27	57	18	72	42	72
Other	20	28	2	4	0	0	10	17
Total	**72**		**47**		**25**		**58**	

Figure 11. Number of laboratory-confirmed, invasive, *Haemophilus influenzae* cases, reported to GERMS-SA, by serotype and age group, South Africa, 2020, n=202 (age unknown for n=8; specimens or viable isolates unavailable for serotyping for n=72)

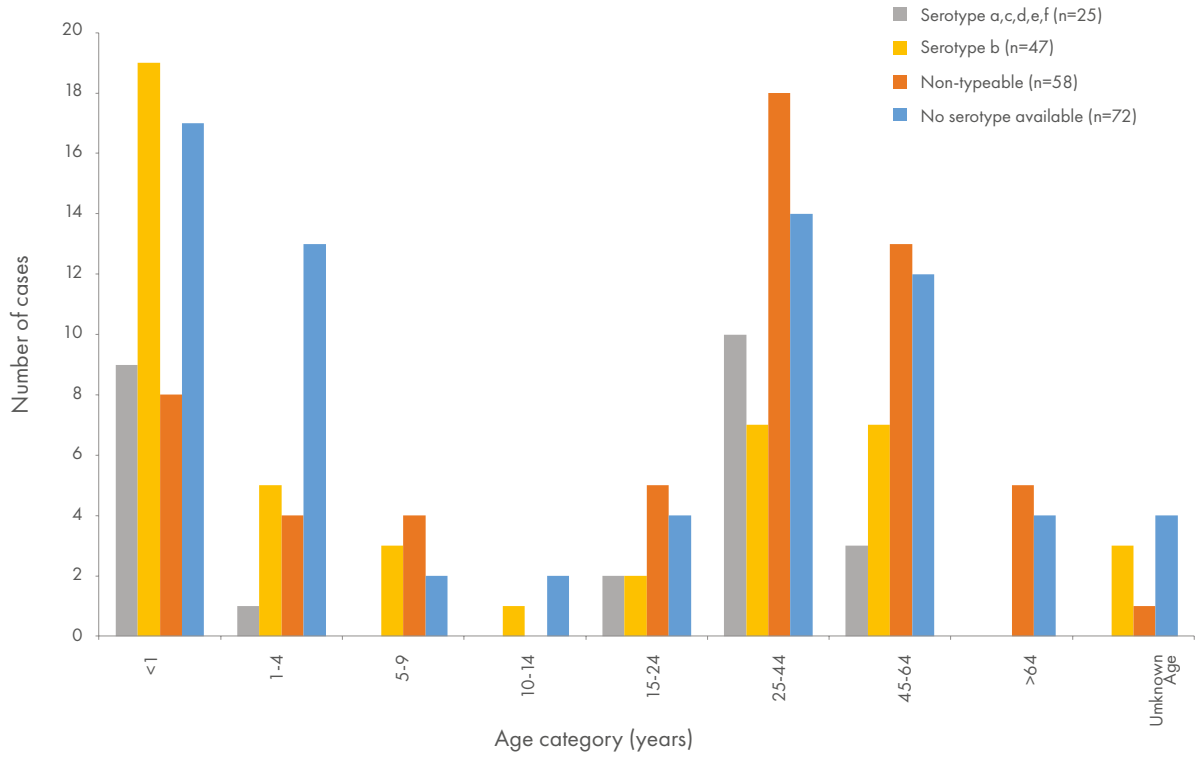


Figure 12. Age-specific incidence rates* for laboratory-confirmed, invasive *Haemophilus influenzae* disease, reported to GERMS-SA, by serotype b and non-typeable, South Africa, 2020, n=202 (age unknown, n=8; isolates unavailable for serotyping, n=72; other serotypes from cases with known age, n=25)

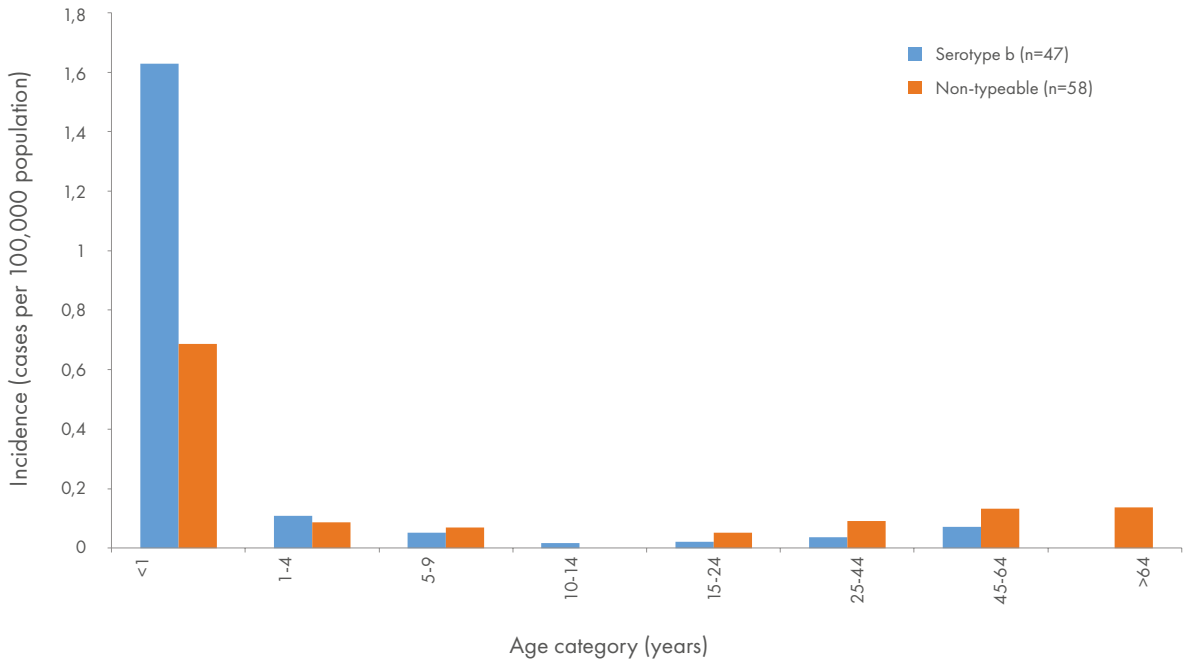
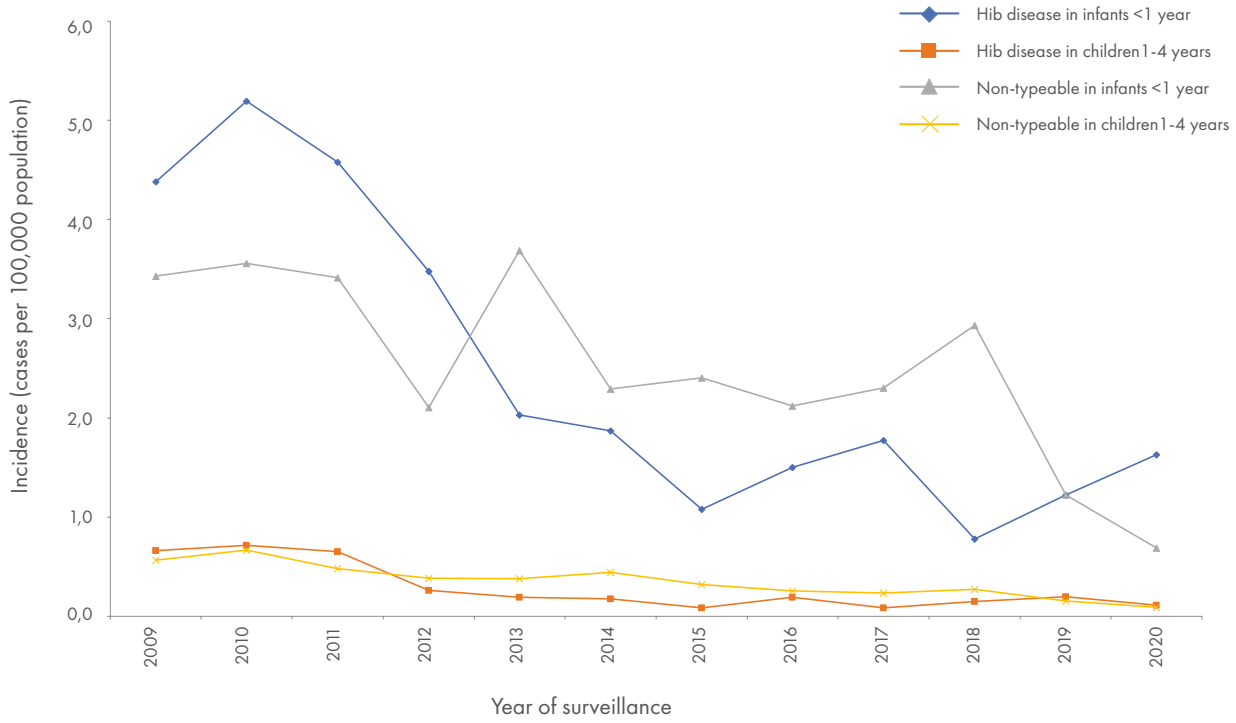


Figure 13: Incidence rates* of laboratory-confirmed, Haemophilus influenzae serotype b and non-typeable disease, reported to GERMS-SA, in children <5 years old, South Africa, 2009-2020



*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Discussion

Incidence of invasive HI remains low, with a slight reduction in cases from 2019. This may be due to reduced respiratory droplet transmission due to COVID-19 containment measures implemented from March 2020. Infants have the highest incidence of HI, with Hib predominating over HNT in <1 and 1-4 year olds. Many patients have underlying conditions predisposing them to infection. Of children with Hib infection, many were not fully vaccinated with 3 doses of Hib vaccine, either due to skipping doses or they were too young to receive at least 3 doses. Overall case fatality from HI is high with a large proportion of patients with HI meningitis developing long-term sequelae. Clinicians need to ensure that infants receive all doses of Hib vaccine timeously in order to prevent deaths and sequelae from this disease.

Streptococcus pneumoniae

Results

In 2020, incidence of invasive pneumococcal disease (IPD) in South Africa was 2.12 cases per 100 000 persons; a 47% reduction from 2019 (4.01/100 000) (Table 13). This reduction was seen across all age groups and all provinces, and coincided with the introduction of COVID-19 containment measures from March 2020 (Figure 14). Incidence was once again highest in the Western Cape Province (6/100 000), followed by Gauteng, Free State, Eastern Cape and Northern Cape Provinces (2/100 000 each) (Table 13). Of those with known sex, 53% of episodes (655/1 246) occurred in males. Most cases were cultured from blood specimens (818/1,262, 65%) (Table 14). Five IPD patients were co-infected with *H. influenzae*. IPD incidence was highest amongst infants (13/100 000), followed by adults >25 years (2.5-3/100 000) (Figure 15). Penicillin non-susceptibility (minimum inhibitory concentration (MIC) >0.06µg/ml) was detected in 31% (251/806) of IPD isolates, the highest proportion was in children 1-4 years of age (50%, 20/40) and in KwaZulu-Natal Province (52%, 24/46) (Table 15 and Figure 16). Ceftriaxone non-susceptibility (MIC >0.5µg/ml) was detected amongst 6% (52/806) of isolates from all specimen types, including 6% (11/200) of IPD isolated from CSF. The five most predominant serotypes in children <5 years included sero-types 8, 19F, 16F, 9N and 10A (Table 16). Whilst in persons >5 years, serotypes 8, 19A, 3, 19F and 9N were most common (Table 17, Figure 17A and 17B). Serotypes in the pneumococcal conjugate vaccine (PCV-13) accounted for 20% of IPD in children <5 years (27/132) and 34% (223/658) in persons >5 years.

Seventy-eight percent (398/510) of IPD patients presenting to our enhanced surveillance sites (ESS) had clinical information available (Table 4). Patients were admitted for a median hospital stay of 6 days (interquartile range (IQR) 2-11) and most deaths occurred within 1 day of admission (IQR 0-5). Overall case-fatality ratio was 32% (127/394). HIV-infection was present in 61% (205/334) of IPD patients; and 37% (15/41) of infants with maternal HIV-status available were HIV-exposed (3 HIV-infected, 11 HIV-uninfected and 1 HIV-status unknown). Forty-nine percent (182/368) of patients had a condition/risk factor (excluding HIV-infection) predisposing them to IPD. The top

five factors included: history of smoking (48 patients), chronic lung or renal disease (19 patients each) and underlying cardiac condition or malignancy (13 patients each).

Of 99 patients at ESS with pneumococcus on CSF: 41% (41/99) died during their hospitalisation, and 33% (19/58) who survived to discharge suffered at least one sequelae upon discharge – these included new onset seizures (9), limb weakness/paralysis (6), necrotic skin lesions (3) and hydrocephalus (1).

Nineteen episodes of IPD caused by serotypes present in the PCV13 vaccine occurred in children <10 years-of-age at ESS. Vaccine history was available for 68% (13/19) of these children. Fifteen percent (2/13) were too young to receive vaccine; 64% (7/11) of children eligible to receive vaccine had not received any PCV doses; 9% (1/11) had received all 3 doses of PCV; two children (18%) had received two doses; and 9% (1/11) had only received one dose of PCV at 6 weeks of age. The serotypes responsible for disease in those who had received any PCV13 included serotypes 19F (two episodes), 3 (one episode) and 23F (one episode).

Table 13. Number of cases and incidence rates of invasive pneumococcal disease reported to GERMS-SA by province, South Africa, 2019 and 2020, n=3 614 (including audit cases)

Province	2019		2020	
	n	Incidence rate*	n	Incidence rate*
Eastern Cape	274	4,08	138	2,05
Free State	83	2,91	62	2,12
Gauteng	774	5,11	379	2,45
KwaZulu-Natal	237	2,1	101	0,88
Limpopo	96	1,62	53	0,91
Mpumalanga	102	2,22	42	0,9
Northern Cape	89	7,12	26	2,01
North West	66	1,64	37	0,9
Western Cape	631	9,25	424	6,05
South Africa	**2 352**	**4,01**	**1 262**	**2,12**

*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Figure 14: Cumulative number of invasive pneumococcal disease cases reported to GERMS-SA by month, South Africa, 2019-2020 (n=3 614: 2019: n=2 352 and 2020: n= 1 262)

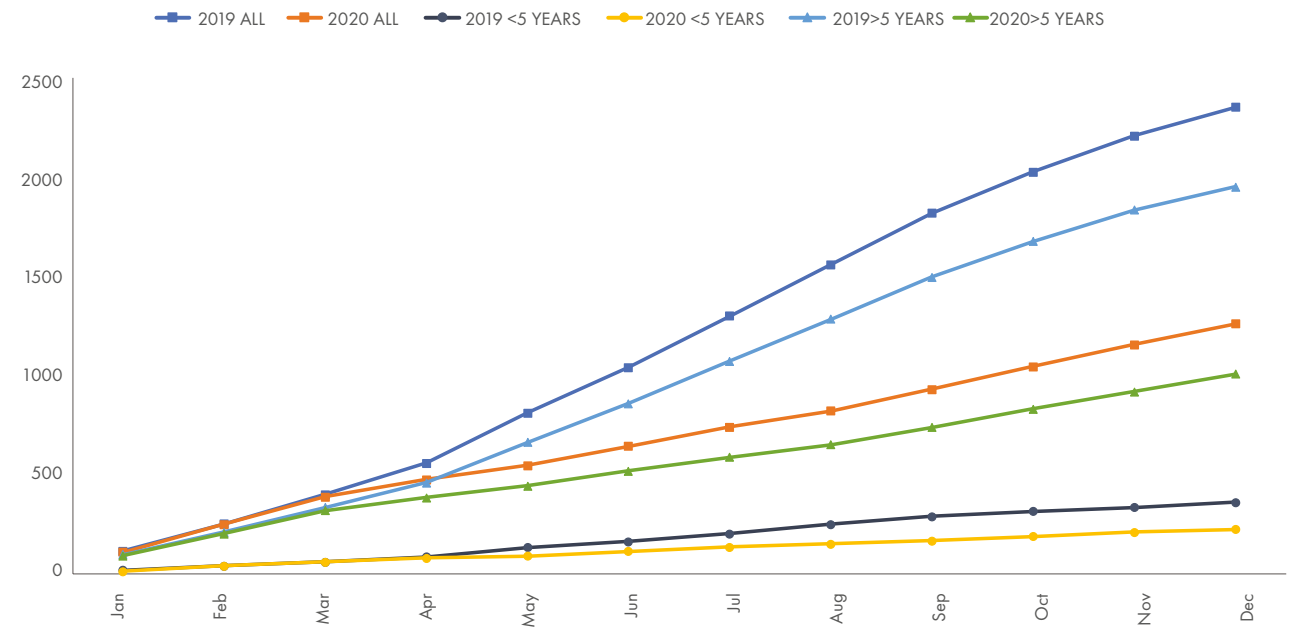
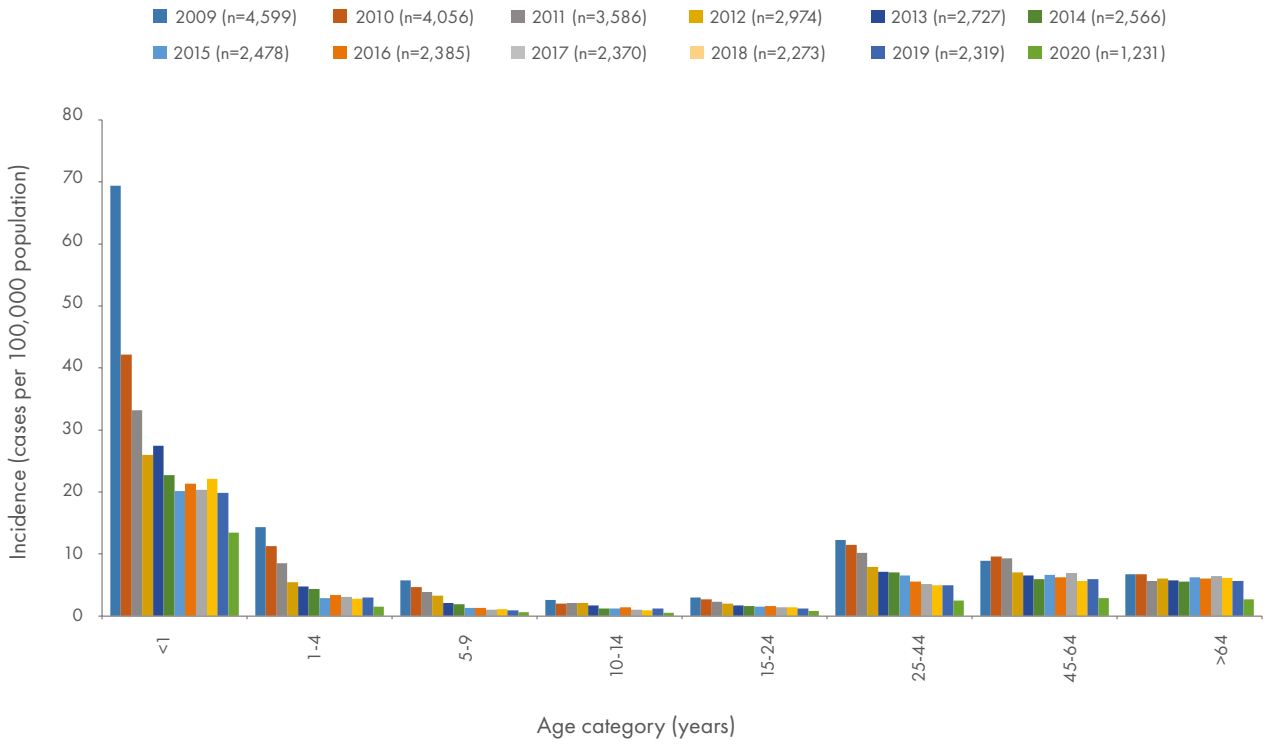


Table 14. Number and percentage of cases of invasive pneumococcal disease reported to GERMS-SA by specimen type, South Africa, 2019 and 2020, n=3 614

Site of specimen	2019		2020	
	n	%	n	%
Cerebrospinal fluid	699	30	341	27
Blood	1 485	63	818	65
Other	168	7	103	8
Total	**2 352**		**1 262**	

Figure 15: Age-specific incidence rates* for laboratory-confirmed, invasive pneumococcal disease, reported to GERMS-SA, South Africa, 2009 through 2020, n=35 023.



2009: N=4 760 age unknown for n=161; 2010: N=4 197, age unknown for n=141; 2011: N=3 804, age unknown for n=218; 2012: N=3 222, age unknown for n=248; 2013: N=2 865, age unknown for n=138; 2014: N=2 731, age unknown for n=165; 2015: N=2 635, age unknown for n=157; 2016: N=2 433, age unknown for n=48; 2017: N=2 440, age unknown for n=70; 2018: N=2 315, age unknown for n=42; 2019: N=2 359, age unknown for n=40; 2020: N=1 262, age unknown for n=31.

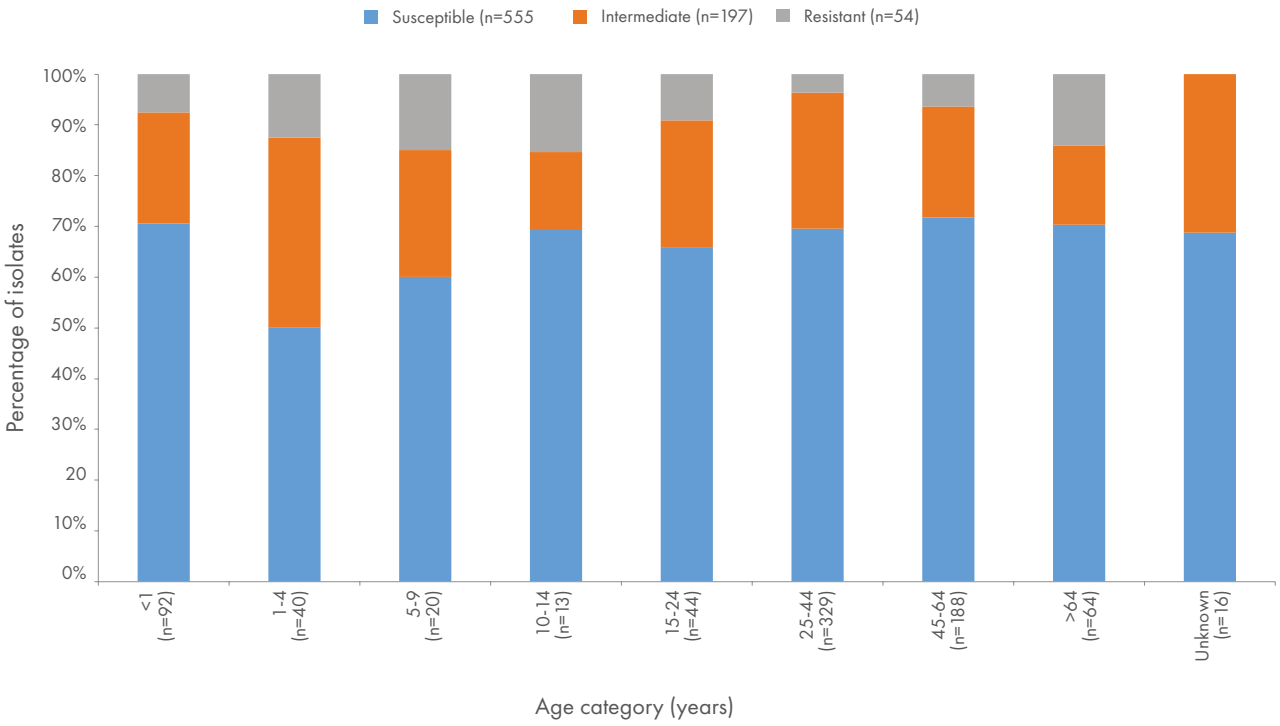
*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Table 15: Number and percentage of penicillin susceptible and non-susceptible isolates from invasive pneumococcal disease cases reported to GERMS-SA by province, South Africa, 2020, n=1 262

Province	Isolate not available	Susceptible*		Intermediate*		Resistant*	
	n	n	%	n	%	n	%
Eastern Cape	54	56	67	20	24	8	10
Free State	25	29	78	5	14	3	8
Gauteng	160	154	70	50	23	15	7
KwaZulu-Natal	55	22	48	17	37	7	15
Limpopo	16	22	59	14	38	1	3
Mpumalanga	20	15	68	7	32	0	0
Northern Cape	10	12	75	2	13	2	13
North West	24	10	77	3	23	0	0
Western Cape	92	235	71	79	24	18	5
South Africa	**456**	**555**	**69**	**197**	**24**	**54**	**7**

*2016 CLSI breakpoints for penicillin (oral penicillin V) were used: susceptible, ≤0.06mg/L; intermediately resistant, 0.12-1mg/L; resistant, ≥2mg/L.

Figure 16. Number of laboratory-confirmed, invasive pneumococcal disease cases, reported to GERMS-SA, by age group and penicillin susceptibility, South Africa, 2020, n=1 262 (n=806 with viable isolates)



*2016 CLSI breakpoints for penicillin (oral penicillin V) were used: susceptible, ≤0.06mg/L; intermediately resistant, 0.12-1mg/L; resistant, ≥2mg/L.

Table 16. Number and percentage of invasive pneumococcal cases reported amongst children less than 5 years of age caused by the serotypes contained in the 7-valent, 10-valent and 13-valent pneumococcal conjugate vaccines, South Africa, 2020, n=224 (n=132 with viable isolates)

Province	Total isolates available for serotyping	7-valent serotypes*		Serotype 6A#		10-valent serotypes**		13-valent serotypes***	
		n	%	n	%	n	%	n	%
Eastern Cape	9	1	11	0	0	1	11	1	11
Free State	8	1	13	0	0	1	13	1	13
Gauteng	44	6	14	0	0	6	14	8	18
KwaZulu-Natal	13	4	31	0	0	4	31	4	31
Limpopo	9	0	0	0	0	0	0	0	0
Mpumalanga	8	2	25	0	0	2	25	4	50
Northern Cape	5	1	20	0	0	1	20	2	40
North West	1	0	0	0	0	0	0	0	0
Western Cape	35	5	14	0	0	5	14	7	20
South Africa	**132**	**20**	**15**	**0**	**0**	**20**	**15**	**27**	**20**

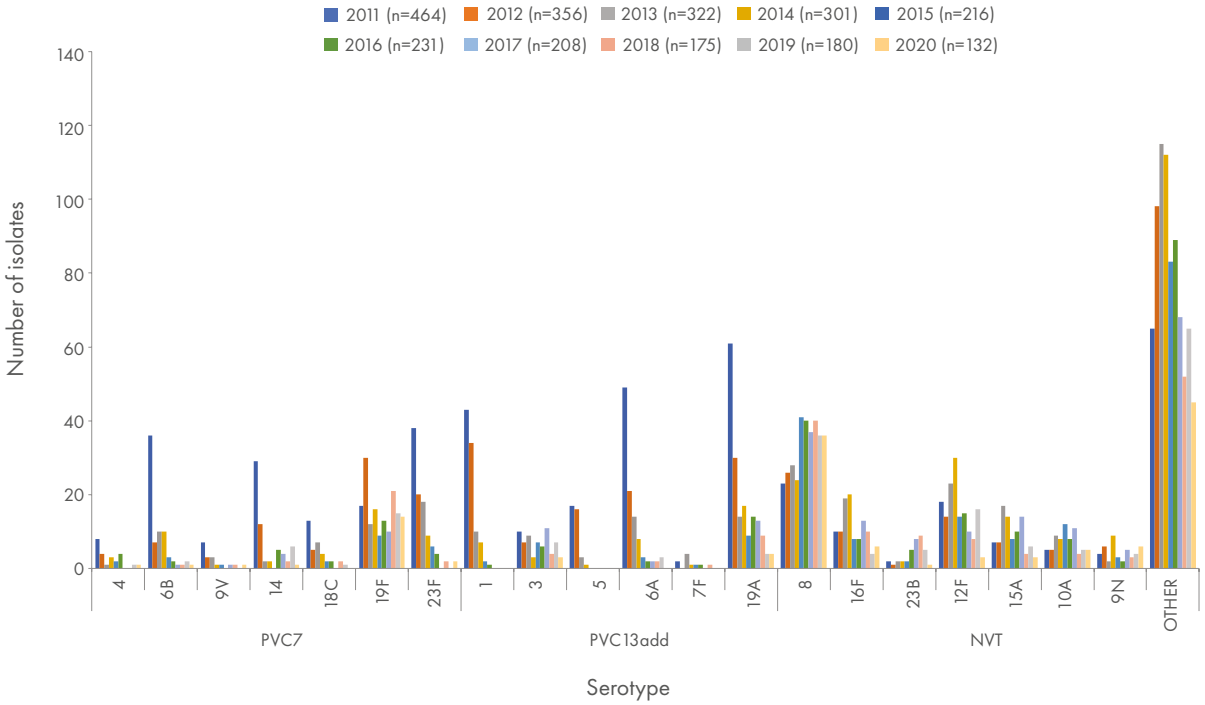
All serotypes included in each of the categories: 7-valent serotypes*: 4, 6B, 9V, 14, 18C, 19F, 23F
10-valent serotypes**: 4, 6B, 9V, 14, 18C, 19F, 23F, 1, 5, 7F
13-valent serotypes***: 4, 6B, 9V, 14, 18C, 19F, 23F, 1, 5, 7F, 19A, 3, 6A
Cross-protection with 6B has been demonstrated

Table 17. Number and percentage of invasive pneumococcal cases reported amongst children less than 5 years of age caused by the serotypes contained in the 7-valent, 10-valent and 13-valent pneumococcal conjugate vaccines, South Africa, 2020, n=1 007 (n=658 with viable isolates)

Province	Total isolates available for serotyping	7-valent serotypes*		Serotype 6A#		10-valent serotypes**		13-valent serotypes***	
		n	%	n	%	n	%	n	%
Eastern Cape	72	18	25	2	3	19	26	31	43
Free State	29	5	17	1	3	6	21	9	31
Gauteng	165	24	15	3	2	25	15	57	35
KwaZulu-Natal	33	7	21	0	0	7	21	13	39
Limpopo	28	4	14	1	4	4	14	12	43
Mpumalanga	14	2	14	0	0	2	14	6	43
Northern Cape	11	0	0	0	0	0	0	0	0
North West	11	0	0	1	9	0	0	2	18
Western Cape	295	32	11	1	0	38	13	93	32
South Africa	**658**	**92**	**14**	**9**	**1**	**101**	**15**	**223**	**34**

All serotypes included in each of the categories: 7-valent serotypes*: 4, 6B, 9V, 14, 18C, 19F, 23F
10-valent serotypes**: 4, 6B, 9V, 14, 18C, 19F, 23F, 1, 5, 7F
13-valent serotypes***: 4, 6B, 9V, 14, 18C, 19F, 23F, 1, 5, 7F, 19A, 3, 6A
Cross-protection with 6B has been demonstrated

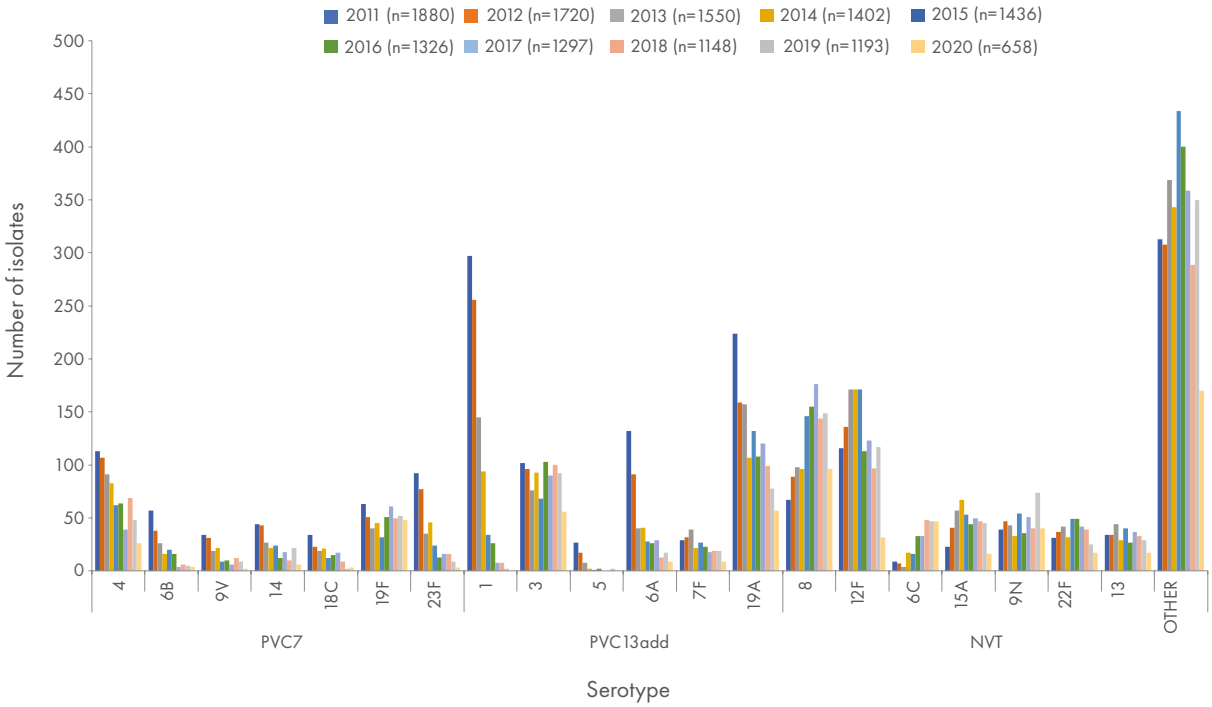
Figure 17A: Most common pneumoccocal serotypes causing laboratory-confirmed, invasive pneumococcal disease, reported to GERMS-SA, in children <5 years, South Africa, 2011-2020



2011: N=695, n=231 without viable isolates; 2012: N=512, n=156 without viable isolates; 2013: N=498, n=176 without viable isolates; 2014: N=465, n=164 without viable isolates; 2015: N=382, n=166 without viable isolates; 2016: N=401, n=168 without viable isolates; 2017: N=374, n=167 without viable isolates; 2018: N=386, n=211 without viable isolates; 2019: N=361, n=181 without viable isolates; 2020: N=224, n=92 without viable isolates

Foot note: PCV7: seven-valent pneumococcal conjugate vaccine; PCV13add: additional serotypes in the thirteen-valent pneumococcal conjugate vaccine; NVT: non-vaccine serotypes

Figure 17B: Most common pneumoccocal serotypes causing laboratory-confirmed, invasive pneumococcal disease, reported to GERMS-SA, in adults and children >5 years, South Africa, 2011-2020



2011: N=2 891, n=1011 without viable isolates; 2012: N=2 462, n=742 without viable isolates; 2013: N=2 229, n=679 without viable isolates; 2014: N=2 101, n=699 without viable isolates; 2015: N=2 097, n=661 without viable isolates; 2016: N=1 986, n=660 without viable isolates; 2017: N=1 996, n=699 without viable isolates; 2018: N=1 871, n=723 without viable isolates; 2019: N=1 952, n=759 without viable isolates; 2020: N=1 007, n=349 without viable isolates.

Foot note: PCV7: seven-valent pneumococcal conjugate vaccine; PCV13add: additional serotypes in the thirteen-valent pneumococcal conjugate vaccine; NVT: non-vaccine serotypes

Discussion

IPD incidence reduced by almost half from 2019, likely as a result of the implementation of COVID-19 containment measures from March 2020. This phenomenon has been seen in multiple countries (5). Reductions in disease were noted across all age-categories, and all provinces of South Africa. Penicillin and ceftriaxone susceptibility of IPD isolates remained similar to 2019, with higher rates in young children. Serotype 8 was the most predominant serotype in both young children and those >5 years, and the PCV-13 serotype 19F was also predominant in both age categories. Many IPD patients were either HIV-coinfected, and/or had at least one underlying condition predisposing them to infection. In-hospital mortality from IPD remains high and a third of patients who survived IPD meningitis suffered sequelae. Serotype distribution of IPD is diverse, however one fifth of IPD disease in children and one third in older children/adults was caused by serotypes in PCV13. It is concerning that of the children eligible for PCV-13 vaccination who developed IPD due to PCV-13 serotypes, 64% had not received any doses of PCV-13 vaccine. Clinicians should continue to encourage parents/guardians to have their children vaccinated timeously and to present to clinics for catch-up vaccinations if any vaccine doses have been missed.

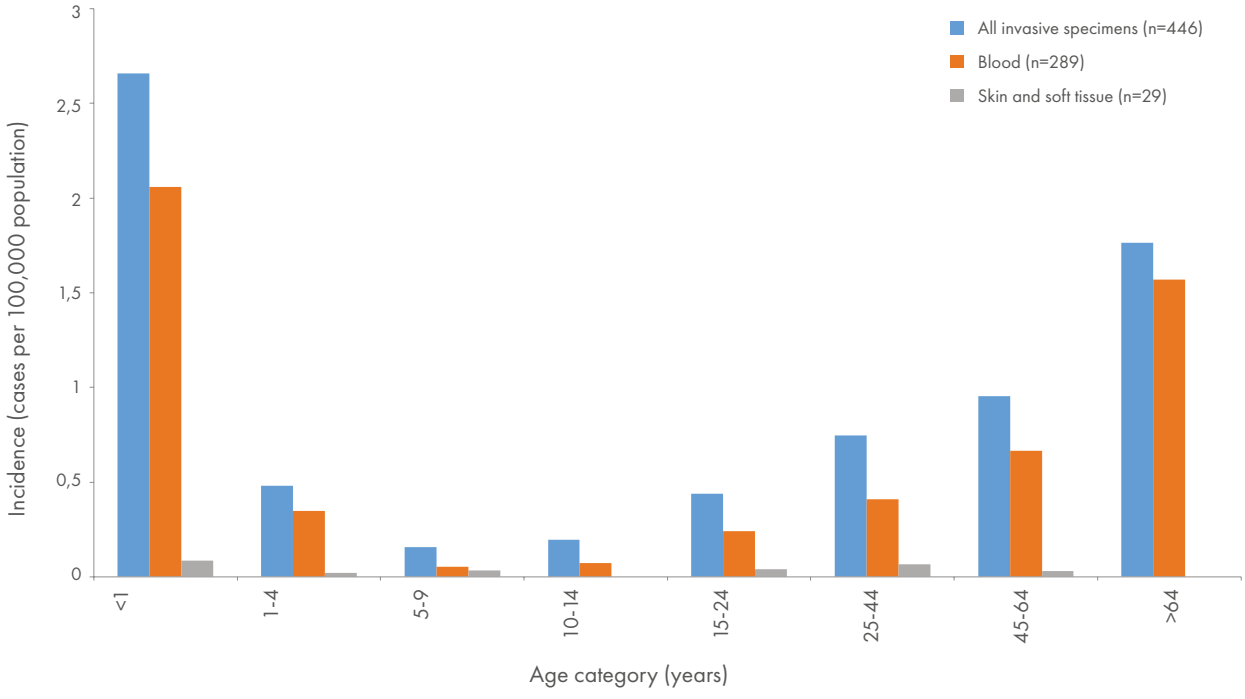
Group A *Streptococcus (Streptococcus pyogenes)*

Results

Forty-nine percent (216/443) of isolates meeting the GERMS-SA case definition for laboratory confirmed invasive group A *Streptococcus* (group A strep) were sent to the reference laboratory for further characterisation (Table 2). Invasive group A strep case definition includes individuals with group A strep isolated from sterile site specimens, as well as isolates from non-sterile site specimens with a diagnosis of septic shock or necrotising fasciitis. Incidence of invasive group A strep was highest in infants (2.7 per 100 000) with a second peak in those aged >64 years (1.8 per 100 000) (Figure 18). Most cases were reported from the Western Cape Province (215/446, 48%), followed by Gauteng (91, 20%), Eastern Cape (59, 13%) and KwaZulu-Natal (48, 11%) Provinces. More invasive group A strep disease occurred in males (248/446, 56%) than females. Sixty-five percent (289/446) of cases were identified on blood culture, followed by 18% (79/446) from bone (Table 18). Of those isolates available for antimicrobial susceptibility testing, 96% (214/222) were susceptible to penicillin (MIC<0.06µg/ml) and 96% (214/222) were susceptible to erythromycin (MIC<0.25µg/ml) (Table 19).

At enhanced surveillance sites, 52% (120/230) of invasive group A strep cases had clinical data available. (Table 4) Patients were admitted for a median of 5 days (interquartile range (IQR) 3-12), and 22% (25/115) died in hospital. Most patients with invasive group A strep had wound infections (45/120, 38%), followed by cellulitis and necrotising fasciitis (17%, 20 cases each). Thirty-five percent (25/71) of patients with HIV tests results available were HIV-infected. (Table 4) Common risk factors for invasive group A strep included blunt trauma in the past two weeks (14/120, 12%), concurrent skin infections (12/120, 10%) and recent surgery (11/120, 9%).

Figure 18. Age-specific incidence rates* for laboratory-confirmed, invasive group A streptococcal disease, reported to GERMS-SA, South Africa, 2020, n=446



*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Table 18. Number and percentage of cases of invasive group A streptococcal disease reported to GERMS-SA by specimen type and age category, South Africa, 2020, n=446 (age unknown for n=28)

Site of specimen	Age <5 years		Age ≥5 years	
	n	%	n	%
Cerebrospinal fluid/brain	7	13	6	2
Blood	40	75	232	64
Skin and soft tissue	2	4	22	6
Bone	1	2	76	21
Other*	3	6	29	8
Total	**53**		**365**	

*Skin and soft tissue includes superficial skin swabs with an accompanying diagnosis of necrotising fasciitis or toxic shock syndrome.
**Other includes invasive specimens from respiratory and gastrointestinal tracts.

Table 19. Number and percentage of penicillin and erythromycin susceptible and non-susceptible isolates from invasive group A streptococcal disease cases reported to GERMS-SA, South Africa, 2020, n=446

Antimicrobial agent	Isolate not available	Susceptible*		Intermediate*		Resistant*	
	n	n	%	n	%	n	%
Penicillin	224	214	96	8	4	0	0
Erythromycin	224	214	96	0	0	8	4

*2016 CLSI breakpoints for penicillin (oral penicillin V) were used: susceptible, ≤0.06mg/L; intermediately resistant, 0.12-1mg/L; resistant, ≥2mg/L.

Discussion

Invasive group A strep mostly affects infants and the elderly, with origin of the disease spreading mostly from the skin. In-hospital mortality is high. Isolates are highly susceptible to first line antimicrobial agents, penicillin and erythromycin. This was the first year that clinical data was collected from persons with invasive group A strep and we encourage clinical laboratories to continue sending all invasive group A strep isolates meeting the case definition to the NICD for further characterisation.

Group B Streptococcus *(Streptococcus agalactiae)*

Results

Seven hundred and fifty-three invasive group B streptococcal infections (group B strep) were reported through the GERMS-SA surveillance network, of which 360 (48%) isolates were received for further characterisation. (Table 2) Incidence for early-onset group B strep (<7 days) was 0.24 per 1 000 live births and 0.17 per 1 000 live births for late-onset (7-90 days) invasive disease (Table 20). Gauteng reported the highest incidence of early-onset group B strep (0.46 per 1 000 live births), while Western Cape Province reported the highest incidence of late-onset group B strep (0.42 per 1 000 live births) (Table 20). In infants, invasive group B strep incidence was 42 per 100 000 population and decreased rapidly by month of age (Figure 19A). Whilst in persons >1 year of age, overall incidence of invasive group B strep was 0.35 per 100 000, peaking at 0.96 per 100 000 in those >64 years of age (Figure 19B). In infants, most cases were isolated from blood (413/490, 84%) or cerebrospinal fluid (74/490, 15%) (Table 21). However, in persons >1 year of age, blood (143/205, 70%) and genitourinary tract specimens (36/205, 18%) were most frequent (Table 22). Disease occurred more frequently in females (387/734, 53%) than males. Of the specimens available for serotyping, serotype III was the most predominant (159/356, 45%), followed by serotype Ia (86, 24%) (Table 23). Serotypes III and Ia were the most predominant serotypes causing invasive disease in early- and late-onset group B strep (Figure 20). In persons >90 days of age, invasive group B strep was more evenly distributed across the serotypes. (Figure 20). Ninety-seven percent (330/340) of invasive group B strep isolates were susceptible to penicillin (MIC<0.12mg/l) and 83% (283/340) were susceptible to gentamycin.

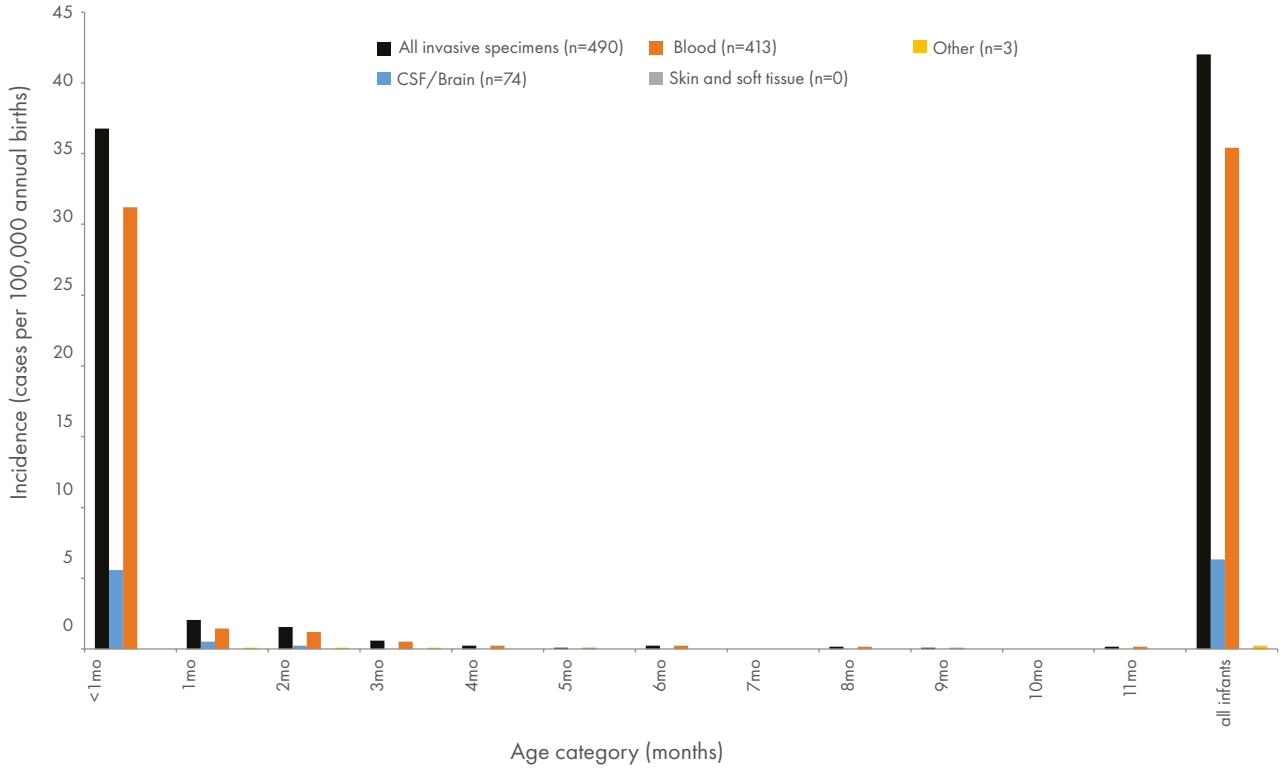
Fifty-four percent (206/378) of invasive group B strep cases at enhanced surveillance sites had clinical data available. (Table 4) Median days for admission were 8 (interquartile range (IQR) 2-15). Twenty-four percent (46/194) of persons with invasive group B strep died, including 22% (26/119) of neonates. Underlying maternal risk factors for developing neonatal invasive group B strep included: 34% (29/85) with premature rupture of membranes prior to birth, 19% (14/74) with prolonged rupture of membranes (>18 hours prior to delivery), and 11% (9/82) with pre-eclampsia. Neonatal risk factors for developing invasive group B strep included 46% (45/98) with prematurity (<37 weeks gestation), 24% (23/97) who had been intubated, and 23% (23/98) with very low birth weight (<1500g).

Table 20. Number of cases and incidence rates of invasive group B streptococcal disease reported to GERMS-SA by province and age category*, South Africa, 2020, n=753**

Province	Early onset (<7 days)		Late onset (7-90 days)		Age category ≥1 year	
	n	Incidence (per 1000 live births***)	n	Incidence (per 1000 live births***)	n	Incidence (per 100 000 population)
Eastern Cape	18	0,13	16	0,11	11	0,17
Free State	11	0,21	10	0,19	3	0,1
Gauteng	121	0,46	83	0,31	68	0,45
KwaZulu-Natal	67	0,25	23	0,09	37	0,33
Limpopo	9	0,07	10	0,08	6	0,1
Mpumalanga	8	0,08	3	0,03	6	0,13
Northern Cape	0	0	3	0,12	4	0,32
North West	3	0,04	1	0,01	2	0,05
Western Cape	39	0,34	48	0,42	68	0,99
South Africa	276	0,24	197	0,17	205	0,35

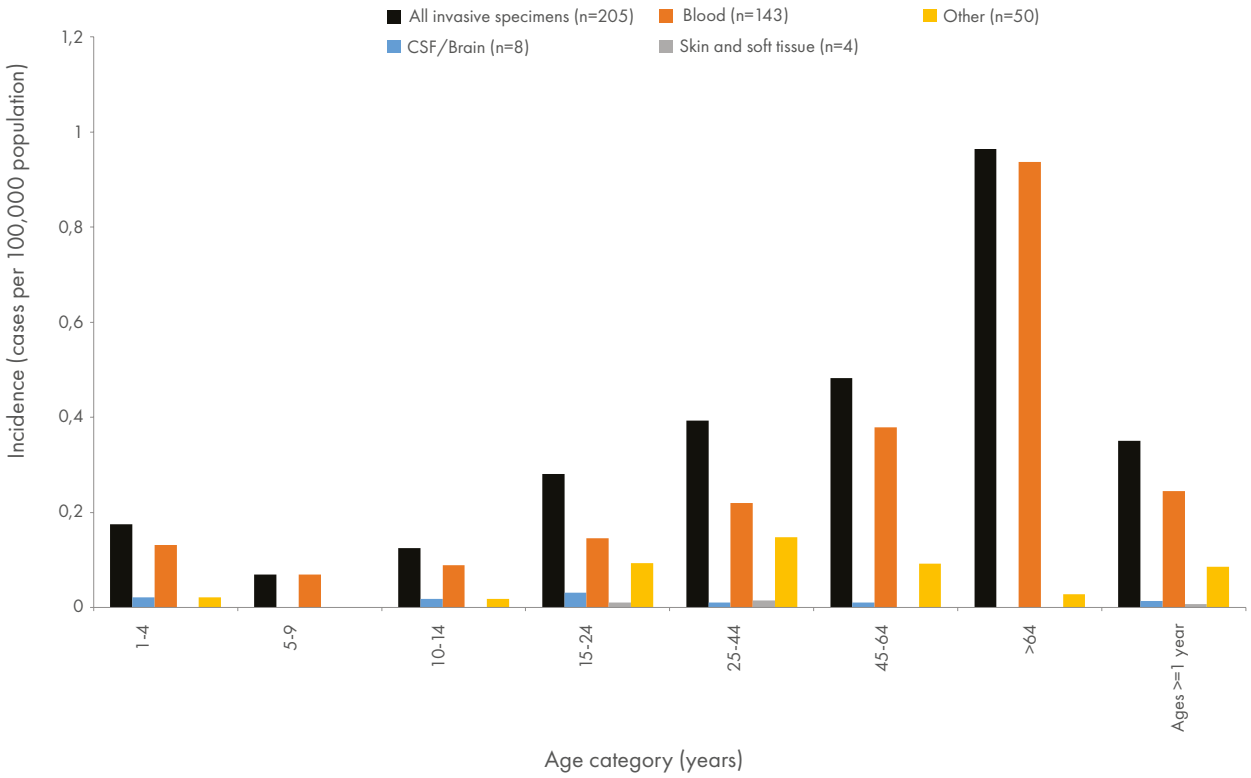
*N=17 cases in infants >90 days and less than one year excluded from above.
**Age unknown for n=58.
***Mid-year population denominators for <1 year olds were used, as live birth denominators for 2020 were unavailable at time of print.

Figure 19A. Age-specific incidence rates* for laboratory-confirmed, invasive group B streptococcal disease in children <1 year of age, reported to GERMS-SA, South Africa, 2020, n=753 (n=490 in children <1 year, age unknown for n=58)



*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Figure 19B. Age-specific incidence rates* for laboratory-confirmed, invasive group B streptococcal disease in persons >=1 year of age, reported to GERMS-SA, South Africa, 2020, n=753 (n=205 in persons >1 year, age unknown for n=58)



*Incidence rates were calculated based on population denominators provided by Statistics South Africa, and are expressed as cases per 100 000 population.

Table 21. Number and percentage of cases of invasive group B streptococcal disease reported to GERMS-SA by specimen type and age category*, South Africa, 2020, n=753

Site of specimen	Age <1 year		Age >1 years	
	n	%	n	%
Cerebrospinal fluid/brain	74	15	8	4
Blood	413	84	143	70
Skin and soft tissue	0	0	4	2
Genitourinary	0	0	36	18
Other**	3	1	14	6
Total	**490**		**205**	

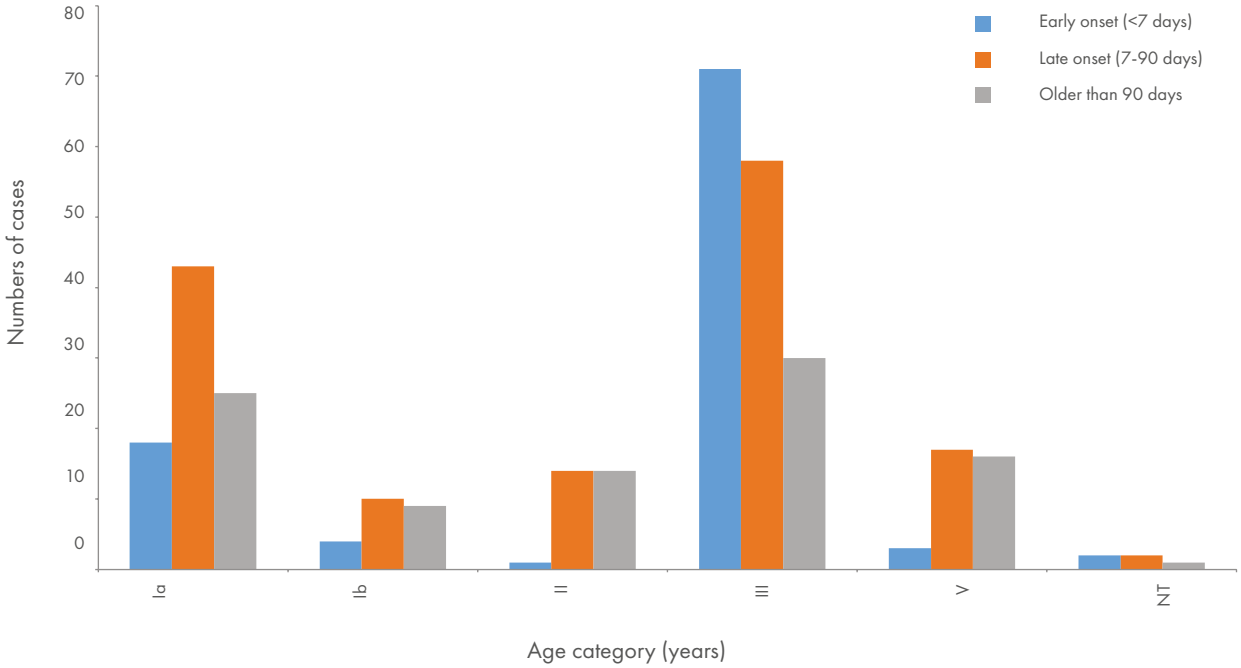
*Age unknown for n=58. **Other includes invasive specimens from bone, respiratory and gastrointestinal tracts.

Table 22. Serotype distribution of invasive group B streptococcal disease reported to GERMS-SA by province, South Africa, 2020, n=753 (all ages)

Province	Total isolates available for serotyping	Ia		Ib		II		III		V	
		n	%	n	%	n	%	n	%	n	%
Eastern Cape	25	7	28	1	4	1	4	13	52	2	8
Free State	11	2	18	1	9	2	18	6	55	0	0
Gauteng	123	30	24	8	7	7	6	54	44	13	11
KwaZulu-Natal	57	10	18	3	5	5	9	28	49	8	14
Limpopo	22	4	18	2	9	1	5	8	36	3	14
Mpumalanga	11	2	18	0	0	2	18	5	45	2	18
Northern Cape	2	0	0	0	0	0	0	1	50	1	50
North West	4	1	25	0	0	0	0	2	50	1	25
Western Cape	101	30	30	8	8	11	11	42	42	6	6
South Africa	**356**	**86**	**24**	**23**	**6**	**29**	**8**	**159**	**45**	**36**	**10**

In addition, there were five non-typeable (two from Gauteng and one each from Eastern Cape, KwaZulu Natal and Western Cape) and 18 isolates were not serotyped.

Figure 20. Numbers of cases of laboratory-confirmed, invasive group B streptococcal disease by serotype, reported to GERMS-SA, South Africa, 2020, n=753 (isolates unavailable for 397 cases, typing not done for 18 cases)



Discussion

In South Africa, incidence of early- and late-onset group B strep seems low, with large variations by province. This could possibly be due to under-ascertainment of cases through poor blood culture practices, particularly amongst neonates, in many areas. Serotype distribution is similar to that reported by other countries, with serotype III and Ia predominating. The organism remains susceptible to first-line antimicrobial agents targeting neonatal sepsis. Mortality is high across all age bands and factors associated with preterm birth are present amongst a large proportion of neonates with invasive group B strep. This was the first year of collecting clinical information on invasive group B strep cases at selected sites. Going forward clinical laboratories are encouraged to send all group B strep isolates meeting the GERMS case definition to the NICD so that further characterisation and serotyping of isolates can be done.

Enteric fever (typhoid and paratyphoid fever): *Salmonella enterica* serotype Typhi and *S. enterica* serotypes Paratyphi A, Paratyphi B and Paratyphi C

Results

Eighty-three cases of laboratory-confirmed enteric fever were identified through the surveillance programme in 2020.
This includes *Salmonella* Typhi isolated from all sample sites, of which 80% (66/83) were indicative of invasive disease. There were no cases of enteric fever caused by *S. enterica* serotypes Paratyphi A, Paratyphi B or Paratyphi C. Although typhoid fever cases were reported from all provinces except Northern Cape (Table 24), the majority (69%, 57/83) of cases were reported from two provinces: Western Cape (30/83, 36%) and Gauteng (27/83, 33%). The number of cases was highest in children aged 5 to 14 years (26/83, 31%), followed by adults aged 35 to 44 years (14/83, 17%) and 25 to 34 years (12/83, 14%), as shown in Table 25. More cases were reported in October than any other month, but there was no marked seasonality (Figure 21). Seventeen percent of isolates tested were resistant to ciprofloxacin, but all isolates tested were susceptible to azithromycin (Table 26), following CLSI breakpoints.

Twenty-six (31%) cases were reported from ESS, and 23/26 (88%) had additional information of variable completeness available. Nine case-patients (9/23, 39%) were younger than 15 years. HIV status was known for 13 cases (13/23, 56%), of which six (46%) were HIV-infected. Empiric antimicrobial therapy was prescribed in 59% (13/22) of the cases, most commonly third generation cephalosporins (69%). A single death was reported (1/23, 4%).

Table 23. Number of cases of invasive and non-invasive *Salmonella* Typhi reported to GERMS-SA, South Africa, 2020, n = 83 (including audit reports, missing isolates, mixed and contaminated cultures)

Province	Non-invasive *Salmonella* Typhi	Invasive *Salmonella* Typhi	Total
Eastern Cape	1	4	5
Free State	1	2	3
Gauteng	5	22	27
KwaZulu-Natal	3	4	7
Limpopo	0	5	5
Mpumalanga	0	3	3
Northern Cape	0	0	0
North West	0	3	3
Western Cape	7	23	30
South Africa	**17**	**66**	**83**

Table 24. Number and percentage of cases of *Salmonella* Typhi reported to GERMS-SA by age category, South Africa, 2020, n = 83 (including audit reports)

Age category (years)	n	%
0 - 4	11	13
14-May	26	31
15 - 24	10	12
25 - 34	12	14
35 - 44	14	17
45 - 54	6	7
55 - 64	2	2
≥ 65	2	2
Total	**83**	

Figure 21. Number of non-invasive and invasive cases of *Salmonella* Typhi reported to GERMS-SA by month, South Africa, 2020, n = 83

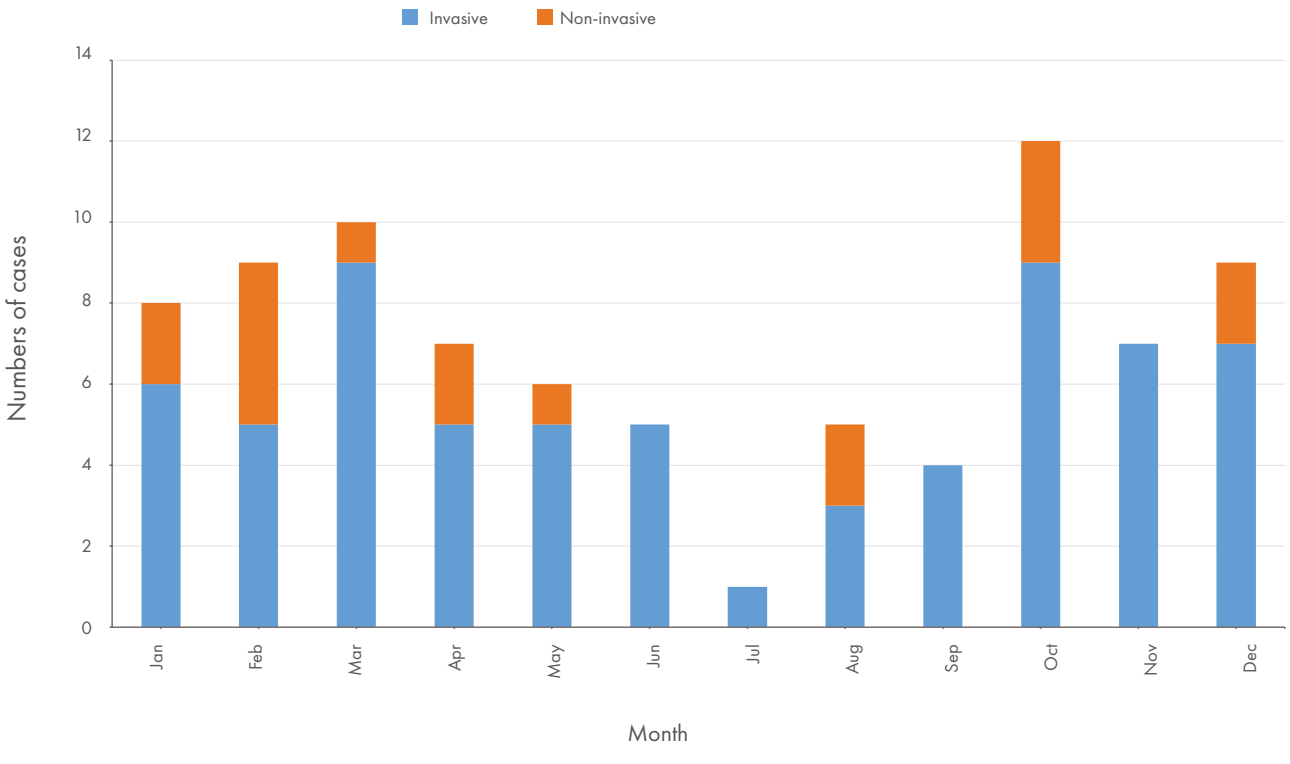
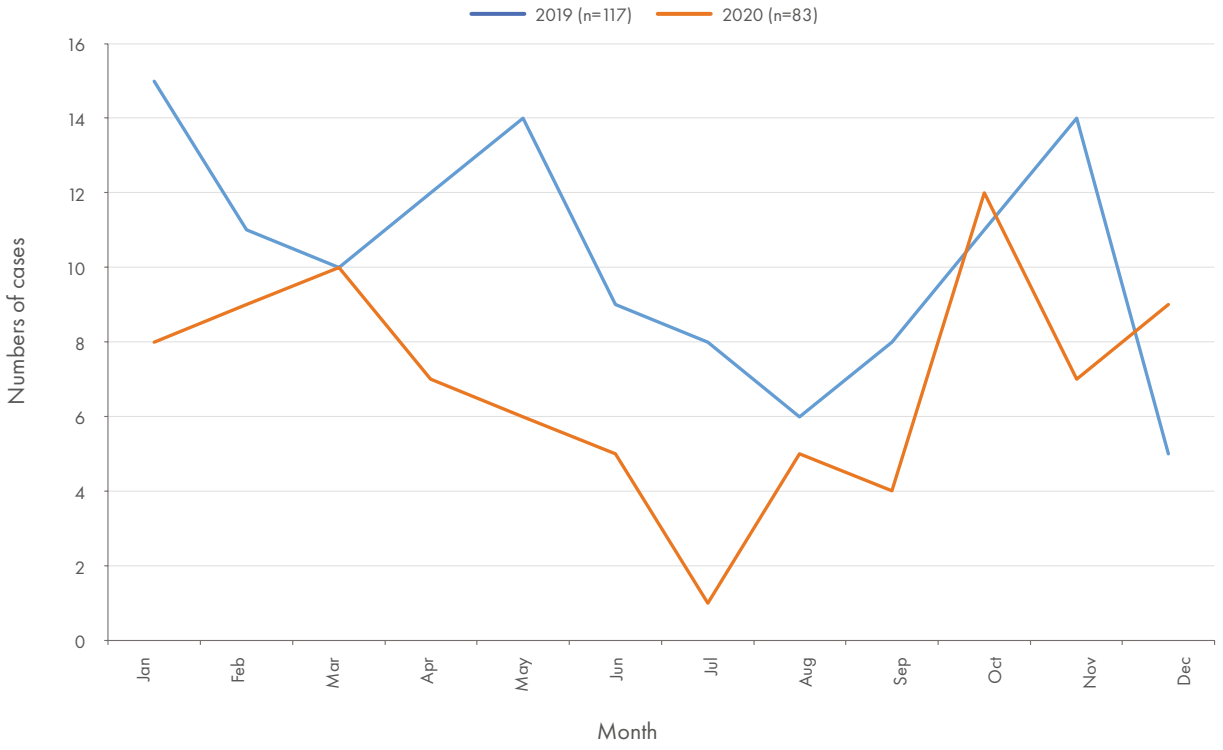


Table 25. Ciprofloxacin and azithromycin susceptibility* of *Salmonella* Typhi isolates received by GERMS-SA, South Africa, 2020, n = 69

Antimicrobial agent	Susceptible (%)	Resistant (%)
Ciprofloxacin	57 (83%)	12 (17%)
Azithromycin	69 (100%)	0

*According to CLSI breakpoints

Figure 22. Number of cases of *Salmonella* Typhi reported to GERMS-SA by month and year, South Africa, 2019 – 2020



Discussion

Typhoid fever remains endemic in South Africa. Following the typhoid outbreaks in 2005-2006, the number of culture-confirmed cases annually has remained stable at <150 cases per year. Fewer cases were reported in 2020 (n = 83) than in 2019 (n = 117), with unusually low numbers following implementation of lockdown restrictions in late March 2020; case numbers began to increase again in August (Figure 22). The age distribution of cases is similar to that reported in previous years, with children aged 5 to 14 years being most affected.

Most cases are typically sporadic, but small clusters have also been identified. Although imported travel-related cases are reported, the majority of cases are locally acquired reflecting ongoing, albeit it low-level, transmission.

Salmonella Typhi isolates from both invasive and non-invasive sites are included in these analyses, as both add to the burden of infection in South Africa and thus represent a public health risk. The diagnosis of enteric fever remains challenging; heightened clinical awareness and appropriate laboratory tests are critical in identifying cases. Culture remains the gold standard for confirming enteric fever, therefore the prevailing clinician testing behaviour heavily influences the likelihood of detecting cases.

Although the number of cases at ESS was small (n=26), there are two noteworthy findings: more than half of the patients were HIV-infected, and the in-hospital case-fatality ratio for cases at ESS was low (4%).

Greater numbers of cases reported from Gauteng and Western Cape provinces may reflect healthcare-seeking behaviour and prevailing clinician-testing behaviour. The number of reported *Salmonella* Typhi isolates is regarded as an underestimate, and thus incidence rates were not calculated. Although the proportion of isolates showing resistance to ciprofloxacin (17%) is similar to recent years, this remains a major concern. *Salmonella* Typhi should also routinely be tested against azithromycin, which is an alternative oral antibiotic option for treating disease caused by ciprofloxacin-resistant strains. Ceftriaxone may also be used as an alternative therapy, but need to be administered parenterally. Paratyphoid fever remains uncommon in South Africa, with no cases reported in 2020.

Non-typhoidal *Salmonella* (NTS)

Results

A total of 2 306 cases of nontyphoidal salmonellosis were reported through the surveillance programme in 2020. This includes nontyphoidal *Salmonella* isolated from all sample sites, of which 36% (823/2 306) were indicative of invasive disease.

The highest numbers of cases of invasive disease were reported from Gauteng (292/823, 35%), followed by Western Cape (151/823, 18%) and Eastern Cape (104/823, 13%) provinces (Table 27). Gauteng also reported the highest number of cases of non-invasive disease (29%, 437/1483), followed by KwaZulu-Natal (32%, 324/1 483), and Western Cape (291/1 483, 20%) provinces. As in previous years, although seasonal prevalence was noted for non-invasive disease (increased numbers of cases of non-invasive disease reported in the earlier months of the year, and lower numbers in the winter months); no seasonal pattern was noted with invasive disease (Figure 23).

Non-invasive disease was highest in children younger than five years (406/1483, 27%) followed by persons aged 35 to 44 years (180/1483, 12%) and 25 to 34 years (177/1483, 12%), as shown in Table 28. Invasive disease was most common in persons aged 35 to 44 years (187/823, 24%) followed by those aged 25 to 34 years (161/823, 20%) and children younger than five years (116/823, 14%). Most invasive cases were identified from blood cultures (93%, 762/823) (Table 29).

A total of 1 790 viable isolates were received; this included isolates submitted as part of routine laboratory-based surveillance as well as isolates submitted for outbreak investigation purposes. Serotyping was completed for 1 447 isolates (83%). Although more than 100 serotypes were identified, two serotypes accounted for 73% of the cases: *S.* Enteritidis (751/1 447, 52%) and *S.* Typhimurium (311/1 447, 21%). The next most common serotypes were *S.* Dublin, *S.* Virchow, and *S.* Isangi (Table 30). Proportions of the serotypes differed among provinces: *S.* Enteritidis was the most common serotype in all provinces except for Eastern Cape Province, where *S.* Typhimurium was pre-dominant (Figure 24). Antimicrobial susceptibility testing was not routinely performed, but offered on request.

A total of 408 invasive disease cases were reported from ESS, accounting for 50% of the total number of invasive disease cases reported through the surveillance programme, and 314/408 (77%) had additional information of variable completeness available. Sixty percent of case-patients were aged 25 to 54 years, and 15% were younger than 5 years. HIV status was known for 248 patients (79%), of which 185 (75%) were HIV-infected (Tables 4 and 30). Among the age groups, HIV seropositivity was highest in patients 25 to 54 years, and lowest in those aged 5 to 14 years followed by those older than 65 years (Figure 25). A CD4 cell count close to the time of diagnosis was available for 89% of the HIV-infected patients, with a median of 42 cells/µl (interquartile range 16-120 cells/µl). The CD4 count was <200 cells/µl in 85% of HIV-infected patients (Figure 26). Primary risk factors for invasive nontyphoidal salmonellosis, other than HIV, were reported in 13% cases (40/314), most commonly malignancy. Empiric antimicrobial therapy was prescribed in 91% of cases with information available (280/307), most commonly third generation cephalosporins (51%). The in-hospital case-fatality ratio for patients at ESS was 30% (93/309), being highest in those aged ≥65 years (48%) and lowest in those aged 25-34 years (15%) (Figure 27).

Table 26. Number of cases of invasive and non-invasive nontyphoidal salmonellosis reported to GERMS-SA by province, South Africa, 2020, n = 2 306 (including audit reports)

Province	Non-invasive, nontyphoidal salmonellosis	Invasive nontyphoidal salmonellosis	Total
Eastern Cape	134	104	238
Free State	142	34	176
Gauteng	437	292	729
KwaZulu-Natal	324	94	418
Limpopo	32	33	65
Mpumalanga	31	43	74
Northern Cape	19	26	45
North West	73	46	119
Western Cape	291	151	442
South Africa	**1 483**	**823**	**2306**

Figure 23. Number of cases of non-invasive (n = 1 483) and invasive (n = 823) nontyphoidal *Salmonella* reported to GERMS-SA by month, South Africa, 2020

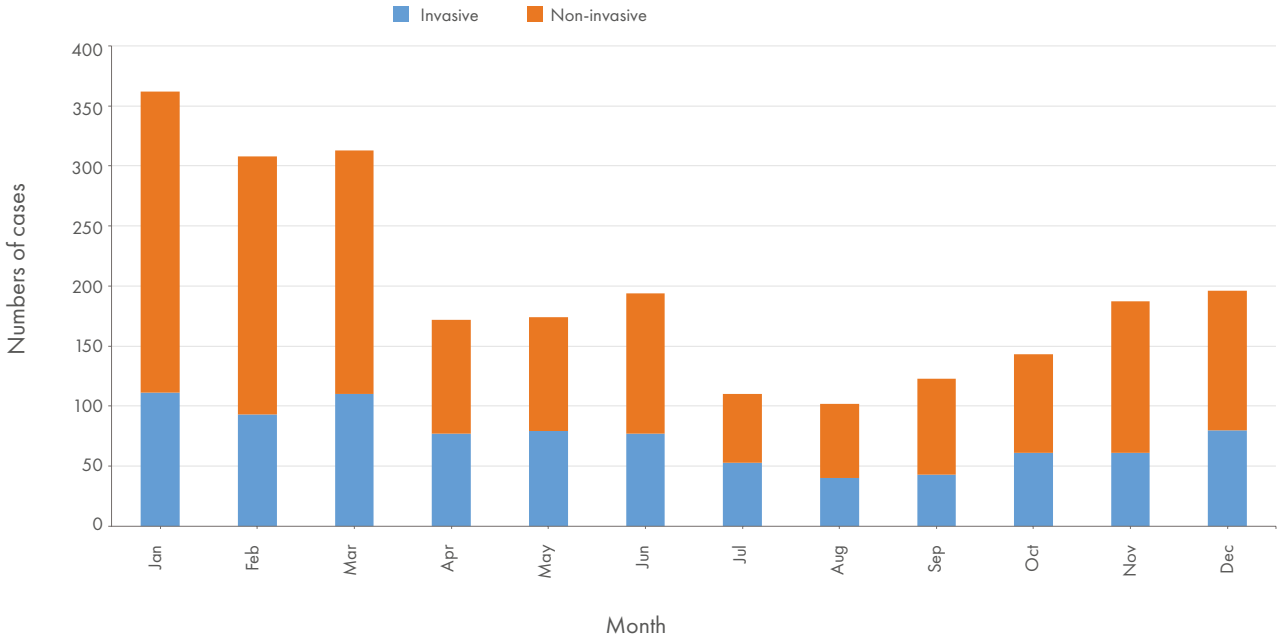


Table 27. Number of cases of invasive and non-invasive nontyphoidal salmonellosis reported to GERMS-SA by age category, South Africa, 2020, n = 2 306 (including audit reports)

Age category (years)	Non-Invasive	Invasive	Total
0 - 4	406	116	522
14-May	152	29	181
15 - 24	95	47	142
25 - 34	177	161	338
35 - 44	180	197	377
45 - 54	152	97	249
55 - 64	141	76	217
≥ 65	146	78	224
Unknown age	34	22	56
Total	**1 483**	**823**	**2306**

Table 28. Number of cases of nontyphoidal salmonellosis reported to GERMS-SA by primary anatomical site of isolation, South Africa, 2020, n = 2 306 (including audit reports)

Specimen	n	%
CSF	32	1,4
Blood culture	762	33
Stool	1208	52,4
Other	304	13,2
Total	**2 306**	**100**

Table 29. Five most common nontyphoidal *Salmonella* serotypes causing nontyphoidal salmonellosis, reported to GERMS-SA by province, South Africa, 2020, n= 1 447*

Province	*S.* Enteritidis	*S.* Typhimurium	*S.* Dublin	*S. Virchow*	*S.* Isangi
Eastern Cape	54	66	14	0	1
Free State	72	34	1	3	1
Gauteng	247	66	6	13	11
KwaZulu-Natal	122	40	13	3	2
Limpopo	21	11	0	2	5
Mpumalanga	23	4	0	2	2
Northern Cape	11	6	0	0	0
North West	43	8	0	0	3
Western Cape	158	76	7	4	0
South Africa	**751**	**311**	**41**	**27**	**25**

*Includes nontyphoidal *Salmonella* isolates from invasive and non-invasive cases

Table 30. Invasive nontyphoidal Salmonella cases at ESS by age group and HIV serostatus, South Africa, 2020, n = 314

Age Category (years)	Number of ESS cases	HIV serostatus documented		HIV-seropositive		HIV-seronegative	
		n	%	n	%	n	%
0-4	46	29	63	9	31	20	69
14-May	10	5	50	0	0	5	100
15-24	16	12	75	8	67	4	33
25-34	59	54	92	47	87	7	13
35-44	90	82	91	72	88	10	12
45-54	39	35	90	30	86	5	14
55-64	30	23	77	18	78	5	22
≥65	21	8	38	1	13	7	88
Unknown	3	0	0	0	0	0	0
Total	**314**	**248**	**79**	**185**	**75**	**63**	**25**

Figure 24. Proportions of the five most common nontyphoidal *Salmonella* serotypes causing nontyphoidal salmonellosis reported to GERMS-SA, by province, South Africa, 2020

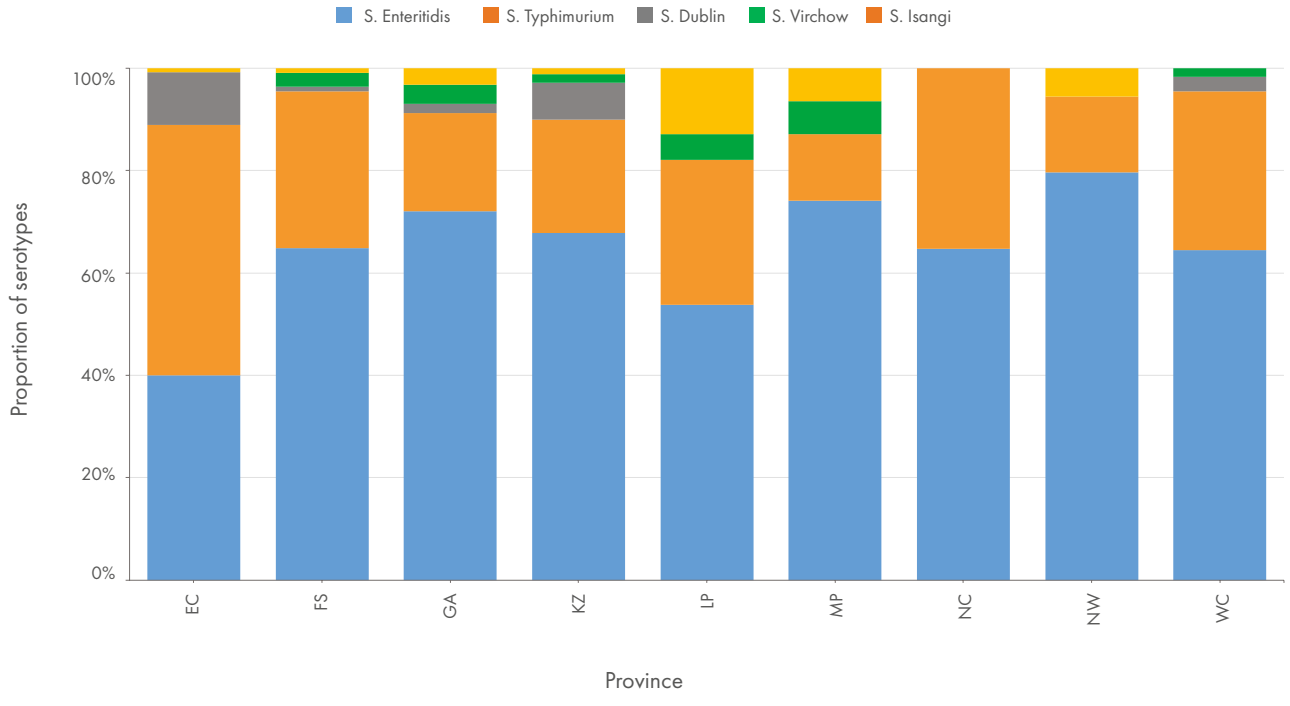


Figure 25. Number of cases of invasive nontyphoidal *Salmonella* reported to GERMS-SA at ESS, by age group and HIV serostatus, South Africa, 2020, n=248

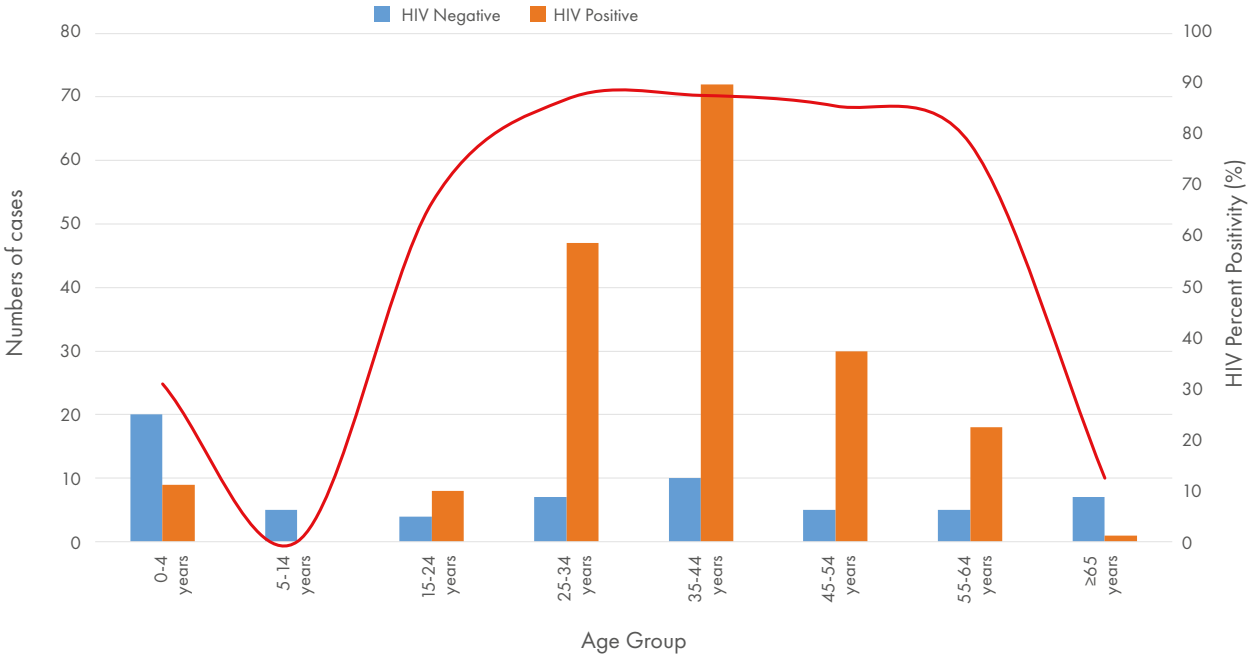


Figure 26. CD4 cell count of HIV-infected case-patients with invasive nontyphoidal *Salmonella* reported to GERMS-SA at ESS, South Africa, 2020 (n = 165)

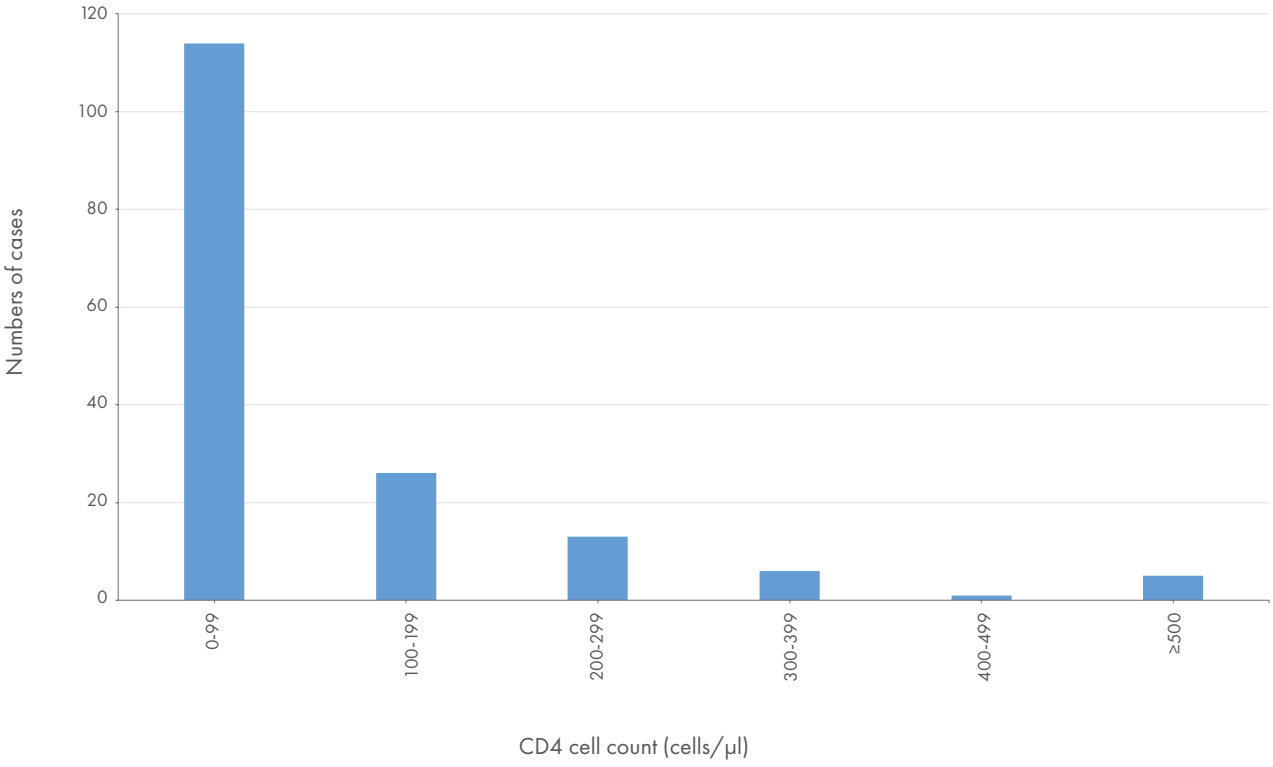


Figure 27. Outcome of cases of invasive nontyphoidal *Salmonella* reported to GERMS-SA at ESS, by age group, South Africa, 2020 (n = 309)

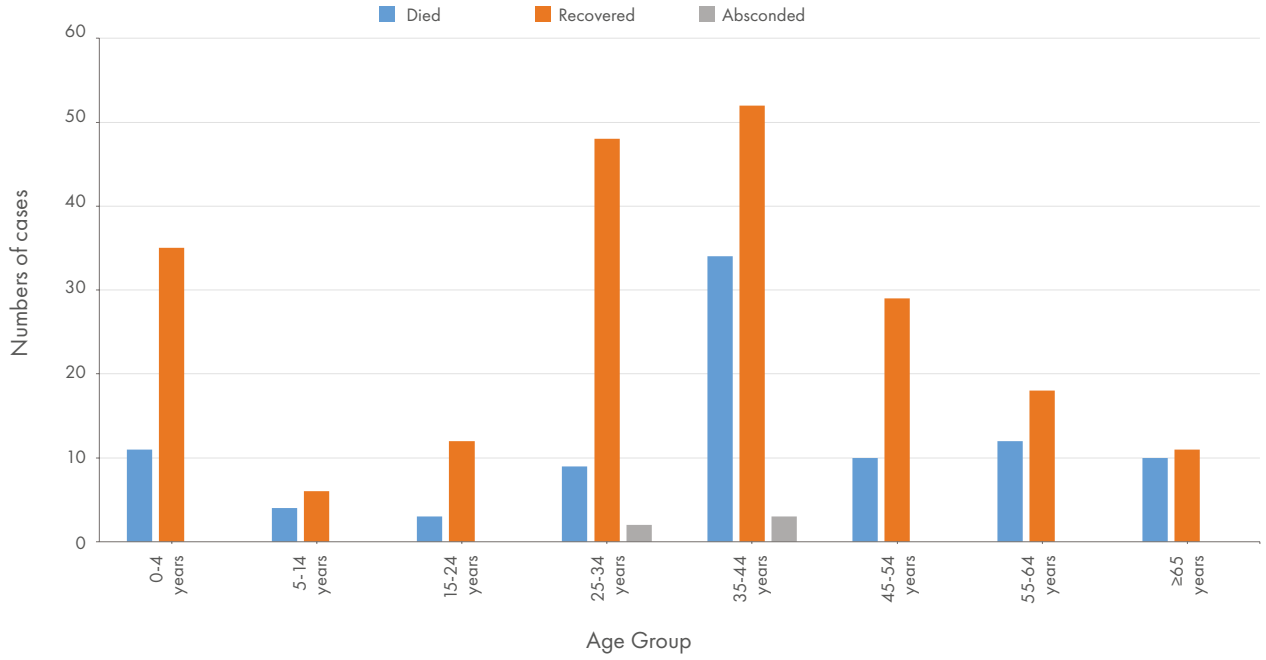
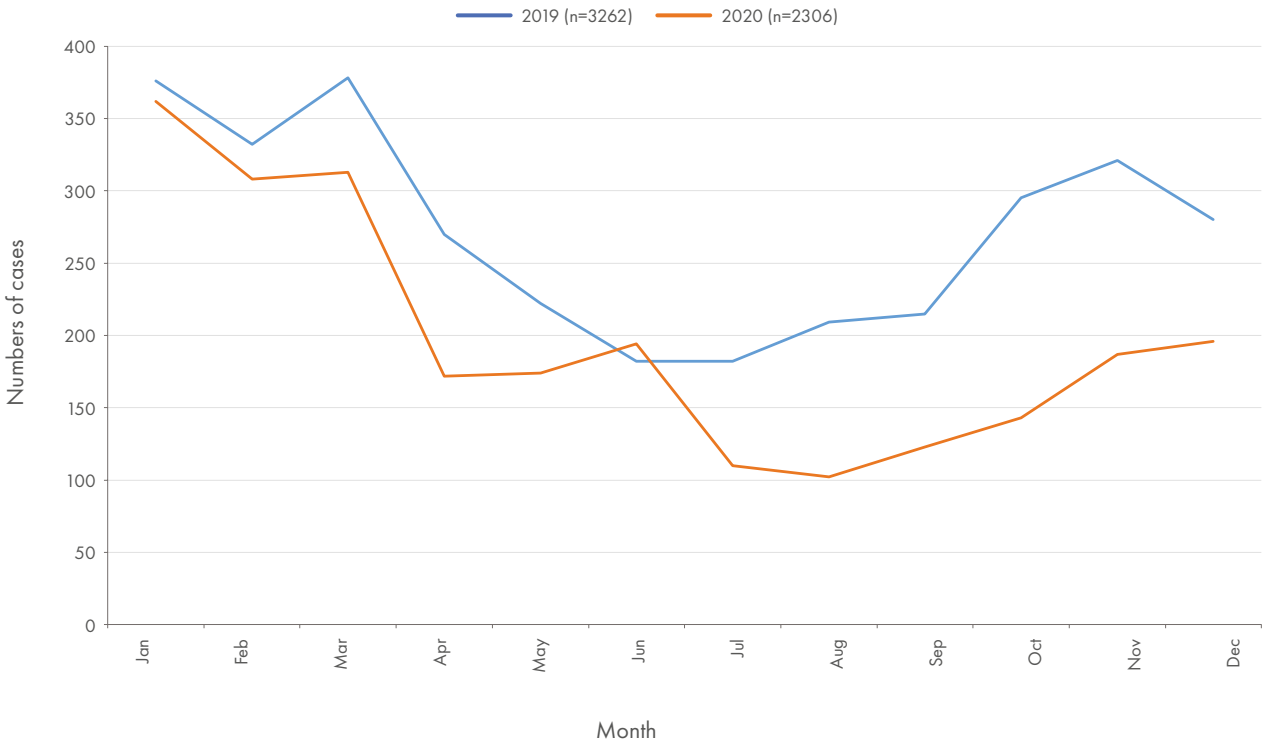


Figure 28. Number of cases of nontyphoidal Salmonella reported to GERMS-SA, by month and year, South Africa, 2019 - 2020



Discussion

Nontyphoidal salmonellosis is usually foodborne and typically manifests as acute gastroenteritis. Invasive disease is usually associated with HIV infection or the presence of other risk factors.

Fewer cases were reported in 2020 (n = 2 306) than in 2019 (n = 3 262), but the pattern suggestive of seasonality was largely preserved (Figure 28). As in previous years, although seasonal prevalence was noted for non-invasive disease (increased numbers in the earlier months of the year and low numbers in the winter months), invasive disease showed no seasonality.

Greater numbers of invasive disease reported from Gauteng, Western Cape and KwaZulu-Natal provinces may reflect healthcare-seeking behaviour and prevailing clinician-testing behaviour. Children younger than 5 years bear the highest burden of non-invasive disease, but invasive disease was reported more commonly in adults aged 35-44 years and 25-34 years (the age groups with the highest proportions of HIV-infected cases).

Data from cases at ESS showed that HIV remains the single most important risk factor for invasive disease, and that the majority of HIV-infected patients (85%) hospitalised with invasive nontyphoidal salmonellosis had advanced HIV disease (CD4 cell count <200/µl). As expected for invasive nontyphoidal salmonellosis, the in-hospital case-fatality ratio was high (30%).

S. Enteritidis was the predominant serotype, followed by *S.* Typhimurium, a pattern observed since 2012. Provincial differences in serotype proportions might reflect local transmission dynamics or undetected outbreaks, and require further investigation.

Shigella species

Results

A total of 698 cases of shigellosis was reported through the surveillance programme in 2020. Although this includes *Shigella* spp. isolated from all sample sites, in 95% (662/698) of the cases the isolate was recovered from stool or rectal swab samples, reflecting non-invasive dysentery or diarrhoea.

The highest number of shigellosis cases occurred in January through March (Figure 29). Forty-one percent of cases were reported from Western Cape province alone (288/698); Gauteng and KwaZulu-Natal provinces contributed 18% (126/698) and 17% (121/698) of the total cases respectively (Table 31).

Cases of shigellosis were highest in children younger than five years (241/698, 34%) followed by children 5 to 14 years of age (102/698, 15%) (Table 32). The proportion of invasive shigellosis cases remains low (5%), and as in previous years invasive disease was highest in children younger than five years (9/36, 25%).

A total of 435 viable isolates were received and serotyped; this included isolates submitted as part of routine laboratory-based surveillance as well as isolates submitted for outbreak investigation purposes. Two serotypes accounted for 53% of the cases: *S. flexneri* type 2a (161/435, 37%) and *S. sonnei* (69/435, 16%). The next most common serotypes were *S. flexneri* type 1b, *S. flexneri* type 4c and *S. flexneri* type 3a (Table 33). Proportions of the serotypes differed among provinces (Figure 30). The predominant serotype differed among provinces: *S. flexneri* type 2a predominated in five provinces, *S. sonnei* in 3 provinces and *S. flexneri* type 1b in one province. Antimicrobial susceptibility testing was not routinely performed, but offered on request.

Figure 29. Number of cases of non-invasive and invasive shigellosis reported to GERMS-SA by month, South Africa, 2020, n = 698 (including audit reports)

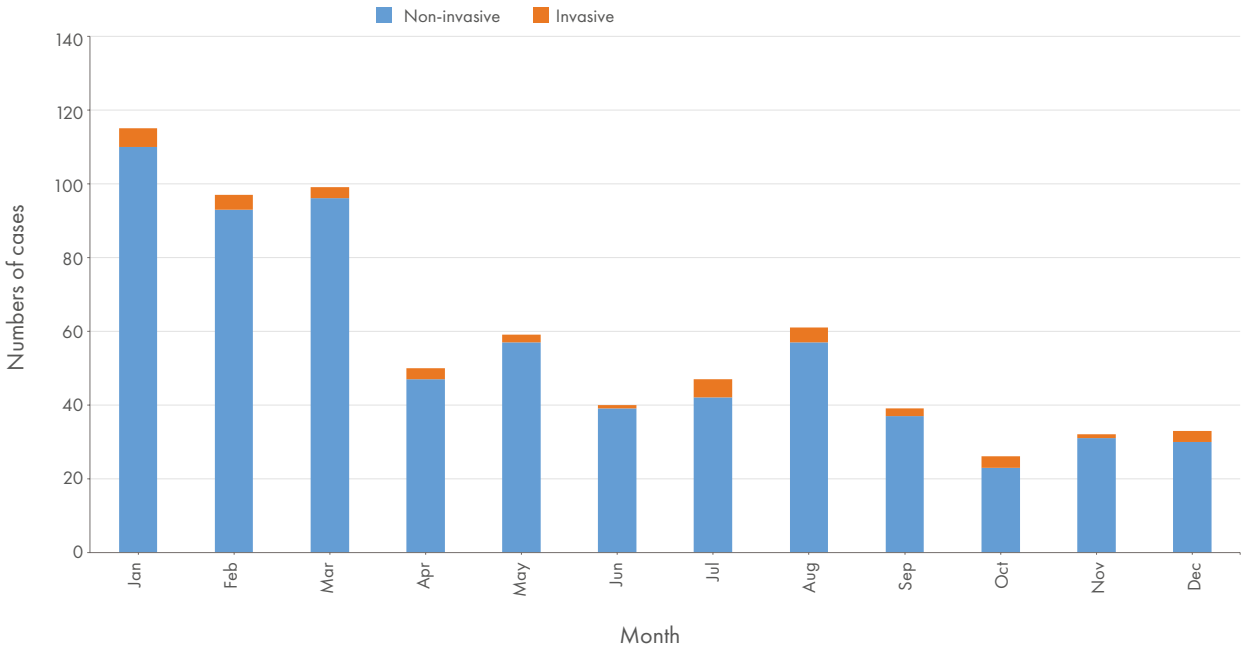


Table 31. Number of cases of invasive and non-invasive shigellosis reported to GERMS-SA by province, South Africa, 2020, n = 698 (including audit reports)

Province	Non-invasive shigellosis	Invasive shigellosis	Total
Eastern Cape	83	1	84
Free State	41	0	41
Gauteng	111	15	126
KwaZulu-Natal	117	4	121
Limpopo	5	1	6
Mpumalanga	6	3	9
Northern Cape	13	0	13
North West	10	0	10
Western Cape	276	12	288
South Africa	**662**	**36**	**698**

Table 32. Number of cases of invasive and non-invasive shigellosis reported to GERMS-SA by age category, South Africa, 2020, n = 698 (including audit reports)

Province	Non-invasive	Invasive	Total
0 - 4	232	9	241
5 - 14	101	1	102
15 - 24	38	0	38
25 - 34	78	4	82
35 - 44	81	6	87
45 - 54	37	6	43
55 - 64	35	2	37
≥ 65	51	7	58
Unknown age	9	1	10
Total	**662**	**36**	**698**

Table 33. Six most common *Shigella* serotypes causing shigellosis, reported to GERMS-SA by province, South Africa, 2020, n = 435*

Province	*S. flexneri* 2a	*S. sonnei*	*S. flexneri* 1b	*S. flexneri* 4c	*S. flexneri* 3a	*S. flexneri* 6
Eastern Cape	27	8	4	5	2	5
Free State	9	4	0	2	4	6
Gauteng	26	21	7	6	7	5
KwaZulu-Natal	33	16	14	3	2	2
Limpopo	0	2	0	0	0	0
Mpumalanga	0	1	3	0	0	0
Northern Cape	0	3	1	0	0	0
North West	0	3	0	0	0	1
Western Cape	66	11	23	27	20	5
South Africa	**161**	**69**	**52**	**43**	**35**	**24**

*Includes *Shigella* isolates from invasive and non-invasive cases

Figure 30. Proportions of the most common *Shigella* serotypes causing shigellosis reported to GERMS-SA, by province, South Africa, 2020

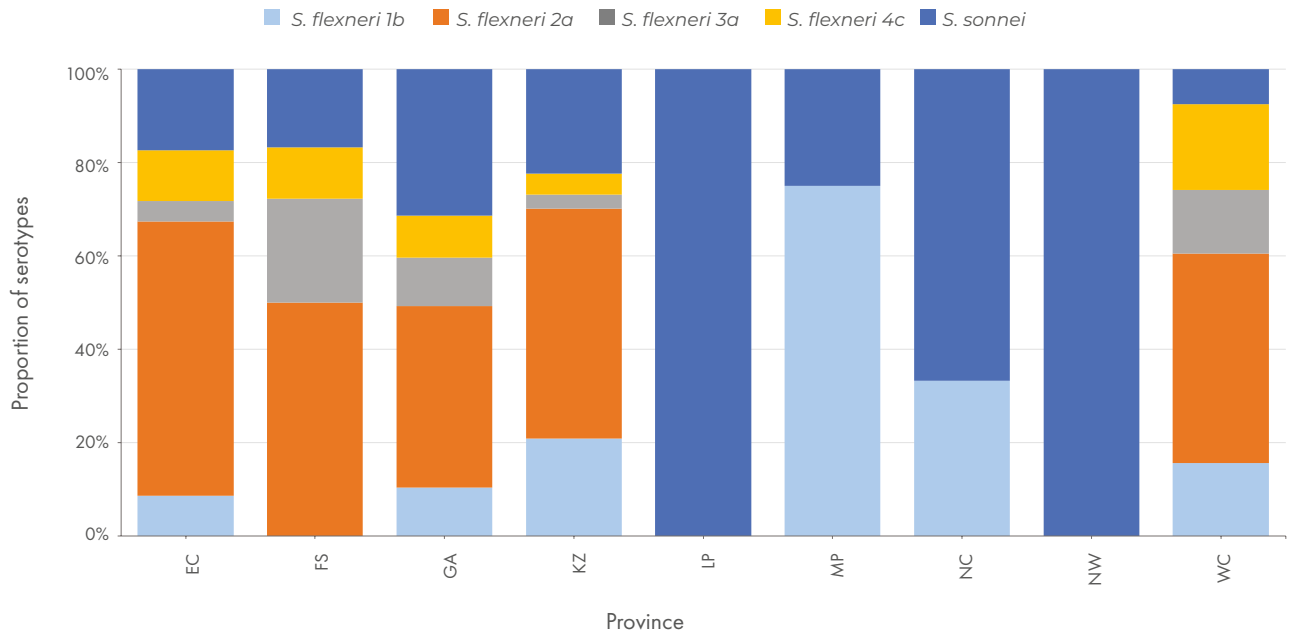
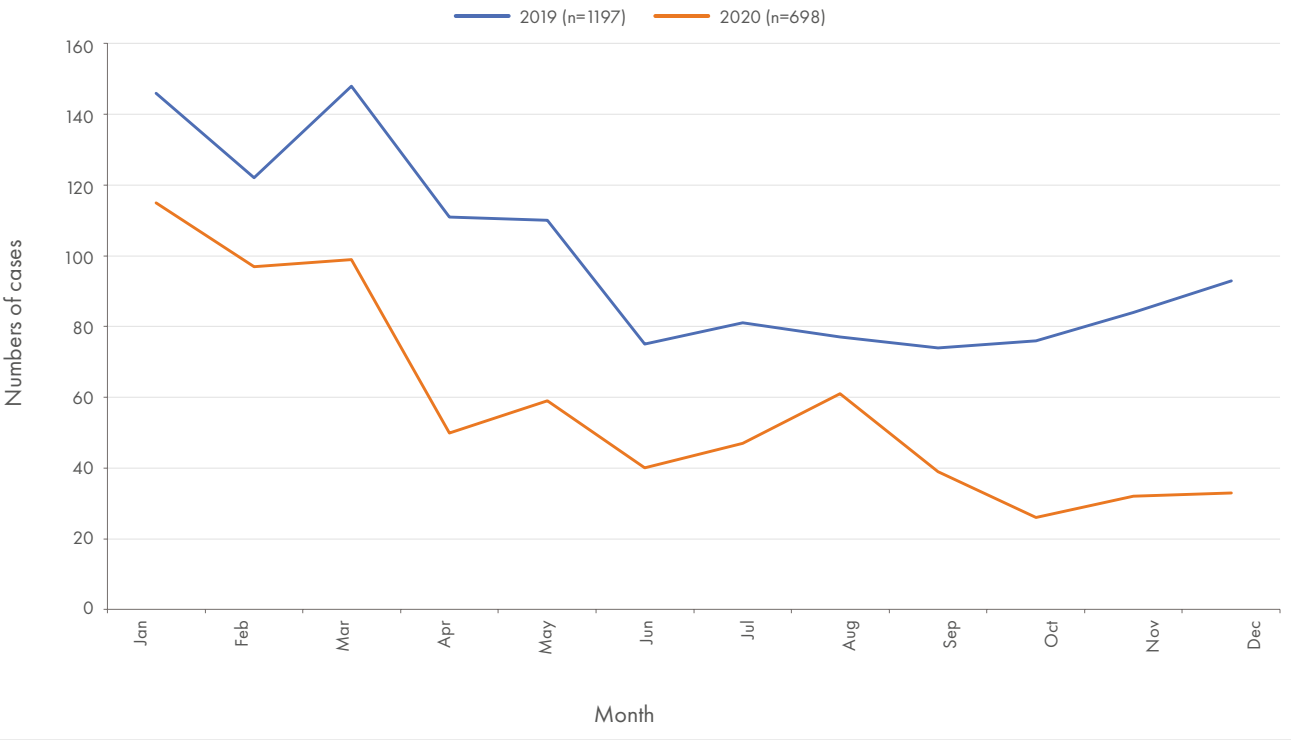


Figure 31. Number of cases of shigellosis reported to GERMS-SA, by month and year, South Africa, 2019 - 2020 (including audit reports)



Discussion

Although *Shigella* infection has been associated with waterborne outbreaks in South Africa, person-to-person transmission plays an important role. Children younger than five years bear the highest burden of shigellosis. The primary manifestation of disease due to *Shigella* is non-invasive dysentery or diarrhoea, and invasive disease is uncommon.

Fewer cases were reported in 2020 (n = 698) than in 2019 (n = 1 197), but the pattern suggestive of seasonality (increased numbers in the earlier months of the year and low numbers in the winter months) was largely preserved (Figure 31). This is in keeping with the seasonal pattern noted in previous years.

S. flexneri type 2a and *S. sonnei* were the predominant serotypes, in keeping with previous years. Provincial differences in serotype proportions might reflect local transmission dynamics or undetected outbreaks.

Campylobacter species

Results

Only cases of campylobacteriosis for which isolates were received from diagnostic laboratories are reported here. Audits were not performed, so cases for which isolates were not submitted are not included in the report.

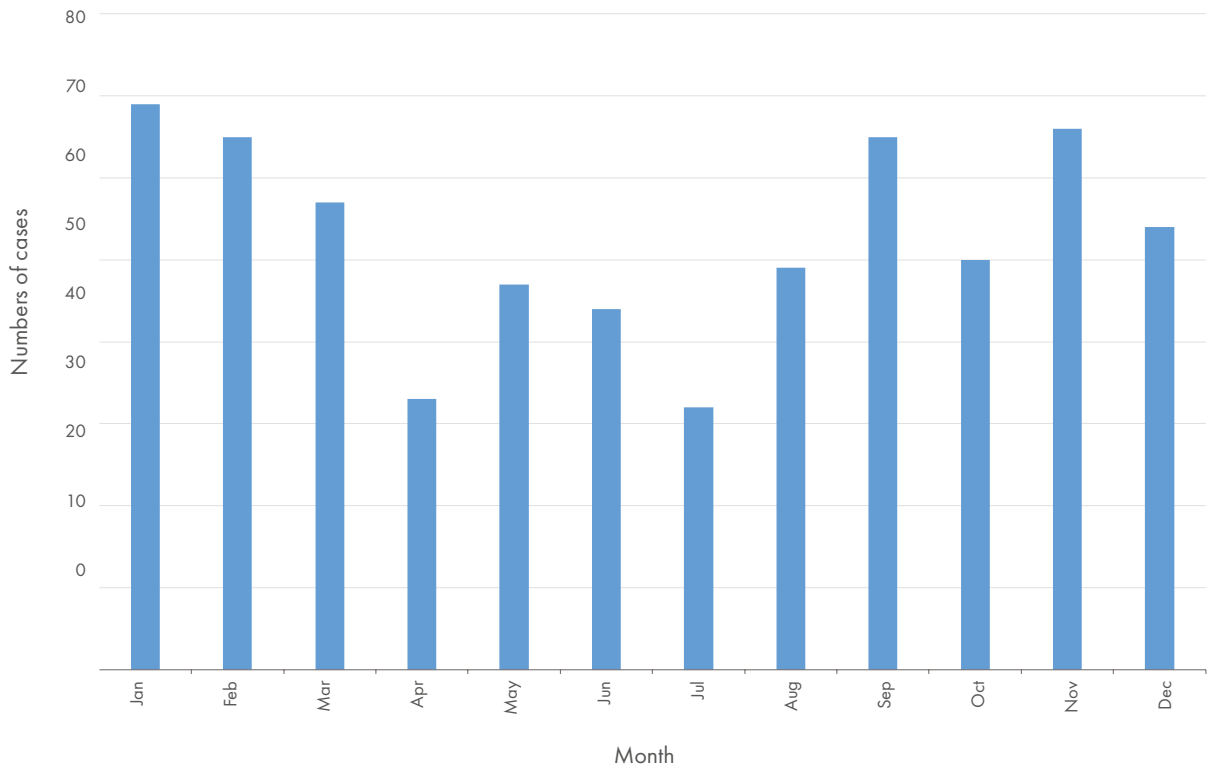
Of the 631 isolates of *Campylobacter* spp. submitted through the surveillance programme in 2020, 95% (599) were submitted by diagnostic laboratories in the private sector. This includes *Campylobacter* spp. isolated from all sample sites, but in 97% (615/631) of the cases the isolate was recovered from stool or rectal swab samples reflecting non-invasive diarrhoeal disease.

There was no apparent seasonal pattern (Figure 32). Western Cape province reported the highest number of cases (57%) followed by Gauteng province (35%); these two provinces alone accounted for 92% of the total cases (Table 34).

Case numbers were highest in children younger than five years (182/631, 29%), with proportions of cases in the other age groups ranging from 7 to 12% (Table 35).

Confirmatory speciation and antimicrobial susceptibility testing have not been completed.

Figure 32. Number of cases of campylobacteriosis reported to GERMS-SA by month, South Africa, 2020*



*Only cases of campylobacteriosis for which isolates were received from diagnostic laboratories are reported. Audits were not performed.

Table 34. Number of cases of invasive and non-invasive campylobacteriosis reported to GERMS-SA by province, South Africa, 2020, n = 631*

Province	Non-invasive	Invasive	Total
Eastern Cape	0	4	4
Free State	0	27	27
Gauteng	1	221	222
KwaZulu-Natal	0	4	4
Limpopo	0	0	0
Mpumalanga	0	0	0
Northern Cape	0	4	4
North West	1	8	9
Western Cape	14	347	361
South Africa	**16**	**615**	**631**

* Only cases of campylobacteriosis for which isolates were received from diagnostic laboratories are reported

Table 35. Number of *Campylobacter* spp. isolates received through GERMS-SA by age category, South Africa, 2020, n = 631

Age category (years)	n
0 - 4	182
5 - 14	77
15 - 24	55
25 - 34	63
35 - 44	62
45 - 54	42
55 - 64	55
≥ 65	76
Unknown	19
Total	**631**

Discussion

The number of *Campylobacter* spp. isolates submitted by public sector laboratories (32/631, 5%) is very low, and strikingly disproportionate to the size of the population served in comparison to the number of cases from the private sector. However, audits of NHLS CDW data were not performed and cases in the public sector are therefore underreported. Cases detected by audit will be reported in the next surveillance review, as will results of confirmatory speciation and antimicrobial susceptibility tests.

Listeriosis

Results

Listeriosis is classified as a category 1 notifiable medical condition. Reporting of all listeriosis cases through the notifiable medical conditions (NMC) platform by all healthcare workers and laboratorians is mandatory, and every notification is followed up by the Centre for Enteric Diseases team. For each case, this includes contacting the diagnostic laboratory to facilitate referral of isolate/s, and contacting relevant healthcare professionals or Department of Health officials to facilitate completion of specific listeriosis case investigation forms.

A total of 91 cases of listeriosis were notified through the NMC surveillance system in 2020. Three provinces reported 87% of the cases: Western Cape (31/91, 34%), Gauteng (30/91, 33%) and KwaZulu-Natal (18/91, 20%) (Table 36). Neonates ≤28 days accounted for 35% (32/91) of the cases, and 31% (28/91) of the cases were adults aged 15 -49 years (Table 37).

Thirty-four of the 91 cases (37%) were detected at ESS, but listeriosis case investigation forms were only completed for 10 cases (29%) at these sites.

Table 36. Number and percentage of cases of listeriosis reported from ESS by province, South Africa, 2020, n = 91

Province	Total cases	Cases reported from ESS		Completed case reports	
		n	%	n	%
Eastern Cape	6	3	50	2	67
Free State	4	2	50	0	0
Gauteng	30	17	57	4	24
KwaZulu-Natal	18	4	22	1	25
Limpopo	1	1	100	0	0
Mpumalanga	0	0	0	0	0
Northern Cape	1	1	100	0	0
North West	0	0	0	0	0
Western Cape	31	6	19	3	50
South Africa	**91**	**34**	**37**	**10**	**29**

Table 37. Number and percentage of cases of listeriosis reported from ESS by age group, South Africa, 2020, (n = 91)

Specimen	Total number of cases	Cases reported from ES site	
		n	%
Neonate (≤28 days)	32	11	34
Children (1month-14 years)	2	1	50
Adults (15-49 years)	28	13	46
Adults (50-64 years)	14	8	57
Elderly (≥65 years)	15	1	7
Total	91	**34**	**37**

Discussion

The number of listeriosis cases for 2020 (91) is below the expected range of annual cases (119-298) based on the estimated incidence of sporadic cases (2-5 cases per million population per year). The distribution of cases by province and age group is similar to that reported in 2019.

Vibrio cholerae

Results

Cholera is classified as a category 1 notifiable medical condition. Reporting of all cholera cases (laboratory-confirmed and clinically suspected) through the notifiable medical conditions (NMC) platform by all healthcare workers and laboratorians is mandatory, and every notification is followed up by the Centre for Enteric Diseases team. For each case, this includes contacting the diagnostic laboratory to facilitate referral of isolate/s, and contacting relevant healthcare professionals or Department of Health officials to facilitate completion of a specific cholera case investigation form.

Four cases of *Vibrio cholerae* infection were notified through the NMC surveillance system in 2020. Isolates were received for all cases, and in three was confirmed to be nontoxigenic non-O1, non-O139 V. cholerae. A single case of non-imported toxigenic *V. cholerae* O1 serotype Ogawa was detected in KwaZulu-Natal Province.

Discussion

A single case of cholera was reported in 2020, classified sporadic and locally acquired. No imported cases were detected. Cases of nontoxigenic non-O1 non-O139 *V. cholerae* were reported, but these are not considered to be cholera and do not warrant a public health response.

Rifampicin-susceptible Tuberculosis

Results

In 2020, due to COVID-19, we were only able to conduct surveillance from January to March and then from mid-October to December. During this period, only 151 sputum samples were collected from enrolled participants. Valid drug susceptibility results for INH were available for 98 isolates, for which 81 completed CRFs were available for analysis. Participants enrolled, were from five provinces (Eastern Cape, Gauteng, KwaZulu-Natal (KZN), Mpumalanga and North West). Majority of participants were male (57%). Seventy percent of the patients were HIV positive, and just over half (51%) were already on ART. Twenty-one percent reported to have at least one episode of previous TB infection, and five percent reported having two or more episodes of previous TB. Twenty-one percent (17/81) reported to have lived with a person diagnosed with TB in the last 12 months, and only one was screened, but was not tested for TB. Table 38 shows the comparison of risk factors by INH resistance. Majority of samples received were from North West (31%), followed by Gauteng (23%), KwaZulu Natal (21%) Eastern Cape (16%), and Mpumalanga (8%). A large proportion of samples (76%) were smear positive. Cultures were negative in 29% (44/151) of samples and 6% (9/151) were contaminated, precluding further analysis. Isoniazid resistance was detected in 18 samples; six were from North West, five from KZN, three from Mpumalanga, two from the Eastern Cape and Gauteng. The overall INH mono-resistance (IMR) prevalence was 18% (95% CI: 11% - 30%). Only two participants reported taking TB preventative therapy, one of these participants had INH resistance.

Table 38. Comparison of risk factors by INH resistance

	INH Sensitive	INH mono R	Full Cohort (n)	p Value*
All lab results	80 (82)	18(18)	98	
Patients with CRFs	65 (81)	16(19)	81	
Gender				
Male				0,083
Female	31 (39)	11 (61)	42(43)	
Unknown	49 (61)	7 (39)	56 (57)	
Age Category				0,644
<20 years	3 (4)	1 (6)	4 (4)	
20-34 years	27 (34)	6 (33)	33 (34)	
35-49 years	31 (39)	9 (50)	40 (41)	
50+ years	19 (24)	2 (11)	21 (21)	
Province (n=81)				0,243
Eastern Cape	11 917)	2 (13)	13 (16)	
Gauteng	18 (28)	1 (6)	19 (23)	
KwaZulu-Natal	13 (20)	4 (25)	17 (21)	
Mpumalanga	4 (6)	3 (19)	7 (8)	
North West	19 (29)	6 (38)	25 (31)	
Education (completed) (n=81)				0,056
None	2 (3)	1 (6)	3 (4)	
Primary	28 (43)	11 (69)	39 (48)	
Secondary	33 (51)	3 (19)	36 (44)	
Tertiary	2 93)	1 (6)	3 (4)	
Employment (n=81)				0,931
Full-time	9 (14)	2 (13)	11 (14)	
Part-time	4 (6)	0(0)	4 (5)	
Self-employed	3 (5)	0 (5)	3 (4)	
Unemployed	49 (75)	14 (88)	63 (78)	
Healthcare worker (n=81)				0,802
No	64 (98)	16 (100)	80 (99)	
Yes	1 (2)	0 (0)	1 (1)	
Miner (ever) (n=72)				0,792
No	56 (98)	15 (100)	71 (99)	
Yes	1 (2)	0 (0)	1 (1)	
Prisoner (ever) (n=81)				0,678
No	61 (94)	15 (94)	76 (94)	
Yes	4 (6)	1 (6)	5 (6)	
Alcohol frequency (n=81)				
Never/<1 month	45 (69)	13 (81)	58 (71)	0,359
1-4 times per month	9 (14)	0 (0)	9 (11)	
>1 per week	11 (17)	3 (19)	14 (17)	
Smoking (n=81)				
Former smoker	27 (42)	9 (56)	36 (44)	0,557
Never	17 (26)	4 (25)	21 (26)	
Smoker	21 (32)	3 (19)	24 (30)	
Recreational Drug Use (n=81)				0,370
No	59 (91)	13 (81)	72(89)	
Yes	6 (9)	3 (19)	9 (11)	

	INH Sensitive	INH mono R	Full Cohort (n)	p Value*
HIV status (n=81)				0,182
Negative	20 (31)	1 (6)	21 (26)	
Positive	43 (66)	14 (88)	57 (70)	
Unknown	23 (3)	1(6)	3 (4)	
Previous TB episodes (n=96)				0,107
None	62 (77)	10 (56)	72 (73)	
1	15 (19)	6 (33)	21 (21)	
>=2	3 (4)	2 (11)	5 (5)	
Previous IPT (n=51)				0,419
No	38 (97)	11 (92)	49 (96)	
Yes	1 (3)	1 (8)	2 (4)	
Lived with someone with TB (n=81)				0,734
No	52 (80)	12 (75)	64 (79)	
Yes	13 (20)	4 (25)	14 (21)	
Unknown	2 (1)	1 (3)	3 (1)	

Discussion

The majority of participants with TB were co-infected with HIV highlighting its continued importance in controlling the TB epidemic. Anti-retroviral treatment has been previously shown to reduce TB incidence, just over half of the participants were already part of the ARV program. The number of participants on TB preventative therapy (TPT) was extremely low, only two of the 57 HIV positive participants reported being on TPT. Age and gender distribution of the participants was in keeping with the National reports, showing male dominance. The overall prevalence of IMR (18%) is unusually higher than what was found in the National TB drug resistant survey 2012-2014 (5-8%), and higher than that observed in the previous year (9%), however, one needs to note the wide confidence intervals. Unfortunately, the low number of samples received during this surveillance year does not allow for any robust analysis of resistance rates and accurate comparison to previous years. The North West province continues to be the province with the highest number of INH mono resistant samples. The high smear positivity is indicative of transmission, particularly in the North West province. No significant risk factor for INH resistance was detected. Only one of the seventeen patients reported to have a close TB contact was screened, which reveals a gap in the care cascade that requires strengthening. However, the lack of screening in this specific year could also be due to the pressures (staff shortages etc.) of the COVID-19 pandemic. A large proportion of participants were unemployed (78%), an underappreciated factor that has an impact on health delivery. The findings of this surveillance has important public health importance, and even though the surveillance was conducted only at a few sites, the results obtained are useful and insightful to understand the epidemic and monitor trends.

Syndromic surveillance

Diarrhoeal surveillance

In 2020, diarrhoeal disease surveillance was conducted at two sentinel sites: Chris Hani Baragwanath Academic Hospital (CHBAH, Gauteng Province), and Pelonomi Hospital (PNH, Free State Province).

All children <5 years admitted to a sentinel hospital for the treatment of acute diarrhoea (as defined by the World Health Organization, and of ≤7 days duration) were approached for enrolment. Enrolment was conducted systematically from Monday to Friday (08:00 – 17:00), after informed consent was obtained from a parent or guardian. Demographic, clinical and outcome data were collected in a structured questionnaire by dedicated surveillance officers.

Stool specimens were collected for rotavirus (commercial EIA and standardised characterisation protocols) and enteric virus (commercial molecular detection kits and in-house real-time detection assays) screening at the Centre for Enteric Diseases, NICD.

Results

A total of 78 stool specimens were screened in 2020 with 1% (1/178) positive for rotavirus. Other enteric viruses were detected more frequently than rotavirus; the most common was adenovirus, followed by norovirus, astrovirus and sapovirus.

Discussion

The rotavirus detection rate for 2020 (1%) was much lower than that reported for 2019 (12%) and 2018 (11%). Enteric virus prevalence trends were similar to previous years, with adenovirus, norovirus, astrovirus and sapovirus dominating.

The global SARS-CoV-2 pandemic has had far reaching effects on all populations and countries and public health interventions to combat the spread of the pathogen have included non-pharmaceutical actions like hand washing, social distancing, regular cleaning of frequently touched surfaces and closing of schools and businesses. In addition to slowing the spread of SARS-CoV-2, these non-pharmaceutical interventions (NPIs) have also resulted in a decreased incidence of diarrhoeal disease in several countries.

In South Africa, a decrease in diarrhoeal disease during 2020 was also reported. The annual rotavirus season in South Africa typically occurs from late June to mid-August. However, by late July 2020 the annual rotavirus season had not yet started and only one stool specimen, collected in March 2020, tested positive for rotavirus. There were concerns that the apparent delay or absence of the 2020 rotavirus season could be due to surveillance program interruptions as a result of SARS-CoV-2 coupled with public fear of visiting healthcare facilities. We engaged with colleagues at the major private pathology laboratories across South Africa, enquiring as to whether there had been an increase in the number of stools submitted for rotavirus testing and/or an increase in rotavirus detection in recent months. All colleagues reported the same trends: reduced numbers of stools submitted for screening compared to 2019 and very few rotavirus-positive cases detected in 2020.

Zoonotic aetiologies in febrile adults in the Mnisi Community, Mpumalanga Province, South Africa, 2019

(data were not available for our 2019 Annual Review due to incomplete testing so we are reporting it in this 2020 review. There were no samples collected for 2020 because of COVID-19 impact on staff and workload.)

Introduction

The Mnisi area is a malaria endemic area in rural Mpumalanga and shares 75% of its boundaries with wildlife reserves. Contact between wildlife, livestock and humans is frequent. Zoonoses cause infectious diseases in humans who interact with livestock, domestic animals and vectors. A high prevalence of zoonotic infections was observed in a previous study at 3 public health clinics in Mnisi. A single sentinel site was established at the community health clinic in Hluvukani for the NICD surveillance programme in 2014. The aim of the study was to investigate selected zoonotic diseases in an agropastoral rural community in South Africa.

Methods

Consenting adult (≥18 years) volunteers presenting to the clinic with fever (>37.5 °C) or a history of fever, and on whom a malaria rapid test was done, were enrolled and a questionnaire administered. Acute and convalescent blood samples were collected and for serological tests were performed for leptospirosis, Q fever, brucellosis and tick bite fever (*Rickettsia*) (Table 39). In addition, microscopy was performed for *Babesia* and PCR detection was performed for malaria and toxoplasmosis.

Table 39. Panel of tests performed

Test	Test particulars	Samples tested	Interpretation of results
Q fever IgG ELISA	Panbio® *Coxiella burnetii* (Q fever) IgG ELISA (Standard Diagnostics Inc., Republic of Korea)	Convalescent serum samples, or acute samples where convalescent samples not available or haemolysed	Index values calculated using run-based cut-off values. As per manufacturer's recommendations
Leptospira IgM ELISA	Panbio® *Leptospira* IgM ELISA (Standard Diagnostics Inc., Republic of Korea).	Convalescent serum samples, or acute samples where convalescent samples not available or haemolysed	Index values calculated using run-based cut-off values. As per manufacturer's recommendations
Brucella IgG ELISA	Vircell® *Brucella* IgG ELISA (Vircell S.L., Spain)	Convalescent serum samples, or acute samples where convalescent samples not available or haemolysed	Index values calculated using run-based cut-off values. As per manufacturer's recommendations
Rickettsia IgM and IgG ELISA	Vircell® *Rickettsia* conorii ELISA IgM/IgG (Vircell S.L., Spain)	Convalescent serum samples, or acute samples where convalescent samples not available or haemolysed	Index values calculated using run-based cut-off values. As per manufacturer's recommendations
Malaria PCR	Multiplex PCR, targeting the four most common human Plasmodium species	Acute EDTA blood sample	Samples producing bands of the correct size/s, on gel electrophoresis
Toxoplasma PCR	*Toxoplasma* qPCR	Acute EDTA blood sample	A Ct value of <40
Babesia Microscopy	Blood smear preparation and staining with Giemsa for microscopy	Acute EDTA blood sample	Parasite identified based on morphological characteristics

Table 40. Laboratory results

Laboratory test	Number of patients positive/samples tested	Percentage positive
Leptospira IgM	2/65	3,00%
Brucella IgG	1/65	1,50%
Q fever IgM	2/67	3,00%
Q fever IgG	14/67	20,90%
Rickettsia IgM	3/67	4,50%
Rickettsia IgG	43/67	64,20%
Malaria PCR	0/78	0%
Toxoplasma PCR	*0/78*	0%
Babesia Microscopy	0/78	0%

Results

In 2019, a total of 79 adults with acute febrile illness were enrolled. Twenty-eight percent (22/79) did not return for follow up blood samples. Of those who did, the median time to return was 20 days (IQR 16-22 days). The median age was 35 years (IQR 25-53 years) and 77% (61/79) were female. The majority (77.2%) of participants resided in 5 villages namely Clara B (21/79), Eglington (11/79), Welverdiend (11/79), Anthol (10/79) and Kashorty (8/79).

All 79 patients had some contact with animals, 96% with chickens, 96% with dogs, 78% with cattle or goats, 62% with rodents. Sixty percent of patients reported previous tick bites and 42% flea bites. Only nine percent had attended a dip tank; each person had attended it for five years or longer. All participants reported eating meat in the past; 87% had eaten wild meat. Eighty-one percent had slaughtered animals (mostly chickens). Fifteen percent had consumed raw cow's milk (of which six had heated it), one consumed goat's milk and had heated it. No participants knew of abortions in their/ their neighbours' animals.

Illness duration ranged from 2-3 days (mean of 2.4 days). Six percent (5/79) of patients had no systemic symptoms. The majority presented with muscle pain (82%) followed by respiratory symptoms (30%), gastro-intestinal symptoms (19%), rash (7%) and bleeding (1%). Fifty-six percent (44/79) received an antibiotic at the clinic and 4% (3/79) were referred to the hospital.

Sixty-five participant samples were tested for the full spectrum of laboratory tests (Table 40), of which 47.7% (31/65) showed evidence of a recent/past infection/exposure to one of the zoonotic diseases tested and a further 21.5% (14/65) to two or more. At least 10.8% (7/65) of persons had evidence of recent zoonotic infection/exposure.

Discussion

Animal contacts are common, majority of patients seek health care early and antibiotic use was lower than the previous year. *Rickettsia* and Q fever infection or exposure was the most prevalent in the study population. *Leptospira* IgM seroprevalence was comparable over the last 4 years. No acute cases of malaria, toxoplasmosis or babesiosis were detected.

SUMMARY

GERMS-SA, an NICD laboratory-based surveillance programme, continues to report pathogen-specific trends. The COVID-19 disrupted ongoing surveillance in 2020 in various forms. For the majority of the year we did only medical record reviews to reduce face-to-face interaction of surveillance staff and patients. There was a large reduction in numbers of GERMS-SA cases probably due to non-pharmaceutical interventions as well as patients not wanting/able to access the hospitals during the three COVID-19 waves. Training and auditing of our surveillance officers data quality is continually done to improve data quality.

Opportunistic infections: For 2020, the laboratory-confirmed cryptococcosis incidence risk remained stable in all provinces but was overall lower than the previous year. The in-hospital case-fatality rate continues to be high (34%) despite at least one-third of patients receiving flucytosine-based induction regimens. Rifampicin-susceptible TB surveillance in four provinces, over a limited surveillance time-period, showed 70% of patients being HIV-infected and half already on anti-retroviral treatment. Screening of TB contacts requires strengthening but this may have been a consequence of health-care access during the pandemic. A large proportion of participants were unemployed (78%), an underappreciated factor that has an impact on health delivery. For non-typhoidal salmonellosis, data from cases at ESS showed that HIV remains the single most important risk factor for invasive disease, and that the majority of HIV-infected patients (85%) hospitalised with invasive nontyphoidal salmonellosis had advanced HIV disease (CD4 cell count <200/µl).

Vaccine-preventable diseases: The 2020 data continue to monitor trends in IPD and Hib, post-EPI vaccine introduction of PCV13 and Hib booster (2009). Incidence of invasive HI remains low. Infants have the highest incidence of HI, with Hib predominating over HNT in <1 and 1-4 year olds. Of children with Hib infection, many were not fully vaccinated with 3 doses of Hib vaccine, either due to skipping doses or they were too young to receive at least 3 doses. Overall case fatality from HI is high with a large proportion of patients with HI meningitis developing long-term sequelae. Reductions in invasive pneumococcal disease were noted across all age-categories, and all provinces of South Africa. Serotype 8 was the most predominant serotype in both young children and those >5 years, and the PCV-13 serotype 19F was also predominant in both age categories. In-hospital mortality from IPD remains high and a third of patients who survived IPD meningitis suffered sequelae. Serotype distribution of IPD is diverse, however one fifth of IPD disease in children and one third in older children/adults was caused by serotypes in PCV13. Sixty-four percent of the children eligible for PCV-13 vaccination who developed IPD due to PCV-13 serotypes, had not received any doses of PCV-13 vaccine! Clinicians should continue to encourage parents/guardians to have their children vaccinated timeously and to present to clinics for catch-up vaccinations if any vaccine doses have been missed. This was the first year of collecting clinical information on invasive group B strep cases at selected sites. The incidence of early- and late-onset group B strep seems low, with large variations by province, possibly due to under-ascertainment of cases through poor blood culture practices particularly amongst neonates. Serotype distribution is similar to that reported by other countries, with serotype III and Ia predominating. The organism remains susceptible to first line antimicrobial agents targeting neonatal sepsis. Mortality is high across all age bands and factors associated with preterm birth are present amongst a large proportion of neonates with invasive group B strep.

Epidemic-prone diseases: (Notifiable medical conditions): The incidence of invasive meningococcal disease in 2020 was half that in 2019. Serogroup B was the predominant serogroup in the Western Cape and Gauteng Provinces. Penicillin non-susceptibility continued to increase, however all isolates remained susceptible to third generation cephalosporins and ciprofloxacin. Enteric fever showed no seasonality. All isolates were susceptible to azithromycin and 17% were resistant to ciprofloxacin. Although *Shigella* infection has been associated with waterborne outbreaks in South Africa, person-to-person transmission plays an important role. Fewer cases of shigellosis was reported in 2020 than in 2019 but was in keeping with the seasonal pattern noted in previous years. The number of listeriosis cases for 2020 (91) is below the expected range of annual cases (119-298) based on the estimated incidence of sporadic cases (2-5 cases per million population per year). A single case of cholera was reported in 2020, classified sporadic and locally acquired. No imported cases were detected. Cases of nontoxigenic non-O1 non-O139 *V. cholerae* were reported, but these are not considered to be cholera and do not warrant a public health response. Invasive group A strep mostly affects infants and the elderly, with origin of the disease spreading mostly from the skin. In-hospital mortality is high. Isolates are highly susceptible to first line antimicrobial agents, penicillin and erythromycin.

Healthcare-associated infections: The number of CRE bacteraemia cases detected over the four provinces is relatively small. However, there has been an increase in 2019 and 2020 compared to 2017 and 2018 of these highly-resistant organisms, which has an impact on the public-sector health system in terms of patient outcomes and healthcare costs. Most cases were detected in Gauteng and KwaZulu-Natal. Plasmid mediated colistin resistance has not been detected amongst our isolates.

Syndromic surveillance

Diarrhoeal surveillance: Non-pharmaceutical interventions (NPIs) have resulted in a decreased incidence of diarrhoeal disease in several countries and in South Africa for 2020. Public and private laboratories reported the same trends: reduced numbers of stools submitted for screening compared to 2019 and very few rotavirus-positive cases detected in 2020.

Zoonotic aetiologies in febrile adults in the Mnisi Community, Mpumalanga Province, South Africa, 2019. We report data from 2019. Animal contacts are common, majority of patients seek health care early and antibiotic use was lower than the previous year. *Rickettsia* and Q fever infection or exposure was the most prevalent in the study population. *Leptospira* IgM seroprevalence was comparable over the last 4 years. No acute cases of malaria, toxoplasmosis or babesiosis were detected.

PUBLICATIONS

Peer-reviewed GERMS-SA and GERMS-SA-related publications 2020

1. Feldman C, Dlamini SK, Madhi SA, Meiring S, von Gottberg A, de Beer JC, et al. The cost-effectiveness of using pneumococcal conjugate vaccine (PCV13) versus pneumococcal polysac-charide vaccine (PPSV23), in South African adults. *PLoS One* . 2020; 15(1): e0227945.
2. Gladstone RA, Lo SW, Goater R, Yeats C, Taylor B, Hadfield J, Lees JA, Croucher NJ, van Tonder AJ, Bentley LJ, Quah FX, Blaschke AJ, Pershing NL, Byington CL, Balaji V, Hryniewicz W, Sigauque B, Ravikumar KL, Almeida SCG, Ochoa TJ, Ho PL, du Plessis M, Ndlangisa KM, Cornick JE, Kwambana-Adams B, Benisty R, Nzenze SA, Madhi SA, Hawkins PA, *et al.* Visualizing variation within global pneumococcal sequence clusters (GPSCS) and country population snapshots to contextualize pneumococcal isolates. *Microb Genomics* 2020 May;6:1–13.
3. Parikh SR, Campbell H, Bettinger JA, Harrison LH, Marshall HS, Martinon-Torres F, Safadi MA, Shao Z, Zhu B, von Gottberg A, Borrow R, Ramsay ME, Ladhani SN. The everchanging epidemiology of meningococcal disease worldwide and the potential for prevention through vaccination. *J Infect* 2020 October;81:483–498.
4. Chaguza C, Yang M, Cornick JE, du Plessis M, Gladstone RA, Kwambana-Adams BA, Lo SW, Ebruke C, Tonkin-Hill G, Peno C, Senghore M, Obaro SK, Ousmane S, Pluschke G, Collard JM, Sigaùque B, French N, Klugman KP, Heyderman RS, McGee L, Antonio M, Breiman RF, von Gottberg A, Everett DB, Kadioglu A, Bentley SD. Bacterial genome-wide association study of hypervirulent pneumococcal serotype 1 identifies genetic variation associated with neurotropism. *Commun Biol* 2020 October;3(1):559. doi: 10.1038/s42003-020-01290-9.
5. Perovic O, Ismail H, Quan V, Bamford C, Nana T, Chibabhai V, Bhola P, Ramjathan P, Swe Swe-Han K, Wadula J, Whitelaw A, Smith M, Mbelle N, Singh-Moodley A; for GERMS-SA. Carbapenem resistant Enterobacteriaceae in patients with bacteraemia at tertiary hospitals in South Africa, 2015 to 2018. *Eur J Clin Microbiol Infect Dis*. 2020 Jul;39(7):1287-1294. doi: 10.1007/s10096-020-03845-4. Epub 2020 Mar 2. PMID: 32124106.
6. Ismail H, Govender NP, Singh-Moodley A, Van Schalkwyk E, Shuping L, Moema I, Feller G, Mogokotleng R, Strasheim W, Lowe M, Mpembe R, Naicker S, Maphanga TG, De Abreu C, Is-mail F, Ismail N, Allam M, Ismail A, Singh T, Matuka O, Duba T & Perovic O. An outbreak of cutaneous abscesses caused by Panton-Valentine leukocidin-producing methicillin-susceptible *Staphylococcus aureus* among gold mine workers, South Africa, November 2017 to March 2018. *BMC Infect Dis.* 2020 Aug 24;20(1):621. doi: 10.1186/s12879-020-05352-5. PMID: 32831057; PMCID: PMC7446146.
7. Ian S Schwartz, Jose F Muñoz, Chris R Kenyon, Nelesh P Govender, Lisa McTaggart, Tsidiso G Maphanga, Susan Richardson, Pierre Becker, Christina A Cuomo, Juan G McEwen, Lynne Sigler. Blastomycosis in Africa and the Middle East: a comprehensive review of reported cases and re-analysis of historical isolates based on molecular data. *Clinical Infectious Diseases*. 2020 Aug 7:ciaa1100. doi: 10.1093/cid/ciaa1100. Epub ahead of print. PMID: 32766820
8. V Chibabhai, AG Duse, O Perovic, GA Richards. Collateral damage of the COVID-19 pandemic: Exacerbation of antimicrobial resistance and disruptions to antimicrobial stewardship pro-grammes? *S Afr Med J.* Published online 2020 Jun 1. https://doi.org/10.7196/SAMJ.2020.v110i7.14917
9. Choi M, Hegerle N, Nkeze J, Sen S, Jamindar S, Nasrin S, Sen S, Permala-Booth J, Sinclair J, Tapia MD, Johnson JK, Mamadou S, Thaden JT, Fowler VG Jr, Aguilar A, Terán E, Decre D, Mo-rel F, Krogfelt KA, Brauner A, Protonotariou E, Christaki E, Shindo Y, Lin Y-T, Kwa AL, Shakoor S, Singh-Moodley A, Perovic O, Jacobs J, Lunguya O, Simon R, Cross AS and Tennant SM (2020) The Diversity of Lipopolysaccharide (O) and Capsular Polysaccharide (K)

Antigens of Invasive Klebsiella pneumoniae in a Multi-Country Collection. *Front.Microbiol*. 2020 Jun 12; 11:1249. doi: 10.3389/fmicb.2020.01249

10. Biswas C, Wang Q, van Hal SJ, Eyre DW, Hudson B, Halliday CL, Mazsewska K, Kizny Gordon A, Lee A, Irinyi L, Heath CH, Chakrabarti A, Govender NP, Meyer W, Sintchenko V, Chen SC. Genetic Heterogeneity of Australian *Candida auris* Isolates: Insights From a Nonoutbreak Setting Using Whole-Genome Sequencing. *Open Forum Infect Dis.* 2020 May 7;7(5):ofaa158. doi: 10.1093/ofid/ofaa158. PMID: 32500091; PMCID: PMC7255648.
11. Magobo RE, Lockhart SL, Govender NP. Fluconazole-resistant *Candida parapsilosis* strains with a Y132F substitution in the ERG11 gene causing invasive infections in a neonatal unit, South Africa. *Mycoses.* 2020; 63(5):471-477. 5-year impact factor 2.824
12. Naicker SD, Mpembe RS, Maphanga TG, Zulu TG, Desanto D, Wadula J, Mvelase N, Maluleka C, Reddy K, Dawood H, Maloba M, Govender NP; for GERMS-SA. Decreasing fluconazole susceptibility of clinical South African *Cryptococcus neoformans* isolates over a decade. *PLoS Negl Trop Dis.* 2020;14(3):e0008137. 5-year impact factor 4.718
13. Magobo, R., Mhlanga, M., Corcoran, C., & Govender, N. Multilocus sequence typing of azole-resistant Candida auris strains, South Africa. *Southern African Journal of Infectious Diseases.* 2020; 35(1), 7 pages. doi:https://doi.org/10.4102/sajid.v35i1.116
14. Hoving JC, Brown GD, Gómez BL, Govender NP, Limper AH, May RC, Meya DB, the Working Group from the Workshop on AIDS-related Mycoses. AIDS-Related Mycoses: Updated Pro-gress and Future Priorities. *Trends Microbiol.* 2020;28(6):425-428.
15. Shroufi A, Govender NP, Meintjes G, Black J, Nel J, Moosa MS, Menezes C, Dawood H, Wilson D, Duran LT, Ajose O, Murphy RA, Harrison T, Loyse A, Ruffell C, Van Cutsem G. Time to embrace access programmes for medicines: lessons from the South African flucytosine access programme. *Int J Infect Dis.* 2020;95:459-461.
16. Oladele R, Akase IE, Fahal A, Govender NP, Honigl M, Gangneux JP, Chiller TM, Denning DW, Cornely OA and Chakrabarti A. Bridging the knowledge gap on mycoses in Africa; setting up a Pan-African Mycology Working Group. *Mycoses*. 2020 Mar;63(3):244-249.
17. Dramowski A, Velaphi S, Reubenson G, Bekker A, Perovic O, Finlayson H, Duse A, Rhoda NR, Govender NP. National Neonatal Sepsis Task Force launch: Supporting infection prevention and surveillance, outbreak investigation and antimicrobial stewardship in neonatal units in South Africa. *S Afr Med J* 2020;110(5):360-363.
18. Essel V, Tshabalala K, Ntshoe G, Mphaphuli E, Feller G, Shonhiwa AM, McCarthy KM, Ismail H, Stasheim W, Lowe M, Perovic O, Hlonipho M, Govender NP. A multisectoral investigation of a neonatal unit outbreak of *Klebsiella pneumoniae* bacteraemia at a regional hospital in Gauteng province, South Africa. *S Afr Med J* 2020 Jul 29;110(8):783-790. doi: 10.7196/SAMJ.2020.v110i8.14471. PMID: 32880307.
19. Perovic O, Ismail H, Quan V, Bamford C, Nana T, Chibabhai V, Bhola P, Ramjathan P, Swe Swe-Han K, Wadula J, Whitelaw A, Smith M, Mbelle N, Singh-Moodley A; for GERMS-SA. Carbapenem resistant Enterobacteriaceae in patients with bacteraemia at tertiary hospitals in South Africa, 2015 to 2018. *Eur J Clin Microbiol Infect Dis.* 2020 Jul;39(7):1287-1294. doi: 10.1007/s10096-020-03845-4. Epub 2020 Mar 2. PMID: 32124106.
20. Choi M, Hegerle N, Nkeze J, Sen S, Jamindar S, Nasrin S, Sen S, Permala-Booth J, Sinclair J, Tapia MD, Johnson JK, Mamadou S, Thaden JT, Fowler VG Jr, Aguilar A, Terán E, Decre D, Mo-rel F, Krogfelt KA, Brauner A, Protonotariou E, Christaki E, Shindo Y, Lin YT, Kwa AL, Shakoor S, Singh-Moodley A, Perovic O, Jacobs J, Lunguya O, Simon R, Cross AS, Tennant SM. The Diversity of Lipopolysaccharide (O) and Capsular Polysaccharide (K) Antigens of Invasive *Klebsiella pneumoniae* in a Multi-Country Collection. *Front Microbiol.* 2020 Jun 12;11:1249. doi: 10.3389/fmicb.2020.01249. PMID: 32595624; PMCID: PMC7303279.
21. Smith AM, Tau NP, Ngomane HM, Sekwadi P, Ramalwa N, Moodley K, Govind C, Khan S, Archary M, Thomas J. Whole-genome sequencing to investigate two concurrent outbreaks of *Salmonella* Enteritidis in South Africa, 2018. *Journal of Medical Microbiology*. 2020; 69:1303-1307. doi: 10.1099/jmm.0.001255.
22. Makungo UB, Ramutshila TE, Mabotja MC, Thomas J, Lekalakala-Mokaba R, Smith AM, Ebonwu J, Smouse SL, Khoza J, Ranoto Q, Muvhango N, Mosoma M, Phokane P, Ntshoe G, Calver K, Essel V, Ngobeni MF, McCarthy KM. Epidemiological investigation of a typhoid fever outbreak in the Sekhukhune District, Limpopo Province, South Africa - 2017. *Southern African Journal of Infectious Diseases.* 2020; 35(1), a107. https://doi.org/10.4102/sajid.v35i1.10.
23. Mashe T, Domman D, Tarupiwa A, Manangazira P, Phiri I, Masunda K, Chonzi P, Njamkepo E, Ramudzulu M, Sekesai M-Z, Smith AM, Weill F-X. Highly resistant cholera outbreak strain in Zimbabwe. *New England Journal of Medicine.* 2020; 383:687-689.
24. Thomas J, Govender N, McCarthy KM, Erasmus LK, Doyle TJ, Allam, M, Ismail A, Ramalwa N, Sekwadi P, Ntshoe G, Shonhiwa A, Essel V, Tau NP, Smouse SL, Ngomane M, Disenyeng B, Page NA, Govender NP, Duse AG, Stewart R, Thomas T, Mahoney D, Tourdjman M, Disson O, Thouvenot P, Maury MM, Leclercq A, Lecuit M, Smith AM, Blumberg LH. Outbreak of listeriosis in South Africa associated with processed meat. *New England Journal of Medicine.* 2020; 382:632-643.

ACKNOWLEDGEMENTS

GERMS-SA: John Black, Vanessa Pearce (EC); Masego Moncho, Motlatji Maloba (FS); Anwar Hoosen, Charl Verwey, Charles, Feldman, Colin Menezes, David Moore, Dina Pombo, Gary Reubenson, Grace Ntlemo, Jeannette Wadula, Jeremy Nel, Maphoshane Nchabeleng, Merika Tsitsi, Moamokgethi Moshe, Mohammed Said, Nicolette du Plessis, Rispah Chomba, Sarah Stacey, Theunis Avenant, Trusha Nana, Vindana Chibabhai (GA); Adhil Maharj, Douglas Wilson, Fathima Naby, Halima Dawood, Khine Swe Swe Han, Lisha Sookan, Nomonde Dlamini, Praksha Ramjathan, Prasha Mahabeer, Prathna Bhola, Romola Naidoo, Sumayya Haffejee, Surendra Sirkar, Yeishna Ramkillawan (KZN); Ken Hamese, Ngoaka Sibiya, Phetho Mangena, Ruth Lekalakala (LP); Greta Hoyland, Sindi Ntuli (MP); Pieter Jooste (NC); Ebrahim Variava, Ignatius Khantsi, Omphile Mekgoe (NW); Adrian Brink, Elizabeth Prentice, Kessendri Reddy, Andrew Whitelaw (WC); Ebrahim Hoosien, Inge Zietsman, Terry Marshall, Xoliswa Poswa (AMPATH); Chetna Govind, Juanita Smit, Keshree Pillay, Sharona Seetharam, Victoria Howell (LANCET); Catherine Samuel, Marthinus Senekal (PathCare); Andries Dreyer, Louis Marcus, Warren Lowman (Vermaak and Vennote); Anne von Gottberg, Anthony Smith, Azwifarwi Mathunjwa, Bhavani Moodley, Cecilia d'Abreu, Cecilia Miller, Cheryl Cohen, Farzana Ismail, Harry Moultrie, Husna Ismail, Jacqueline Weyer, Jackie Kleynhans, Jenny Rossouw, John Frean, Joy Ebonwu, Judith Mwansa-Kambafwile, Juno Thomas, Kate Bishop, Kerrigan McCarthy, Liliwe Shuping, Linda de Gouveia, Linda Erasmus, Lynn Morris, Lucille Blumberg, Marshagne Smith, Martha Makgoba, Michelle Groome, Mignon du Plessis, Mimmy Ngomane, Mokupi Manaka, Myra Moremi, Nazir Ismail, Nelesh Govender, Neo Legare, Nicola Page, Nombulelo Hoho, Olga Perovic, Phuti Sekwadi, Rindidza-ni Magobo, Rudzani Mashau, Ruth Mpembe, Sibongile Walaza, Siyanda Dlamini, Sunnieboy Njikho, Susan Meiring, Tiisetso Lebaka, Vanessa Quan, Wendy Ngubane (NICD).

NICD Centre staff:

CED: Bolele Disenyeng, Dimakatso Dzingayi, Emily Dloboyi, Elias Khomane, Jack Kekana, Jaime McDonald, Masindi Ramudzulu, Mzikazi Dickmolo, Nomsa Tau, Phuti Sekwadi, Portia Mogale, Rembulwani Netshikweta, Shannon Smouse, Sandrama Nadan, Tersia Kruger

CHARM: Agnes Sesoko, Amanda Shilubane, Boitumelo Kgoale, Boniwe Makwakwa, Daniel Desanto, Denver Jainarain, Ernest Tsotetsi, Gloria Molaba, Greg Greene, Ivy Rukasha, Juliet Paxton, Leandi Steynfaardt, Mabatho Mhlanga, Mbali Dube, Michelle Lowe, Mpho Thanjekwayo, Naseema Bulbulia, Nikiwe Valashiya, Nozuko Blasich, Ntombi Dube, Patrick Pitjeng, Phelly Matlapeng, Rosah Mabokachaba, Rotondwa Mudau, Rubeina Badat, Ruth Mogokotleng, Sabelle Jallow, Serisha Naicker, Siphiwe Kutta, Tsidiso Maphanga, Wilhelmina Strasheim

CRDM: Betty Tsosane, Dineo Mogale, Fahima Moosa, Happy Skosana, Judith Tshabalala, Kedibone Ndlangisa, Maimuna Carrim, Malefu Moleleki, Nicole Wolter, Noluthando Duma, Rivionia Nero, Sibusisiwe Zulu, Thabo Mohale, Thembi Mthembu, Thulisa Mkhencele

CTB: Ali Sicwetsha, Cecilia de Abreu, Danny Lathane, Dumisani Ngcamu, Elizabeth Kachingwe, George Ngconjana, Halima Said, Lavania Joseph, Lwazi Danisa, Minty van der Meulen, Nana Okozi, Ria de Villiers, Shaheed Vally Omar, Sikelela Nkosi, Thabisile Gwala, Vancy Letsoalo, Yasmin Gardee, Zaheda Bhyat

CEZPD: Chantel le Roux, Herman Geyer, Janusz Paweska, Kovashnee Naidoo, Malodi Sethedi, Naazneen Moolla, Sindy Virasamy

DPHSR: Emily Sikanyika, Irma Latsky, Tsakane Nkuna, Yoliswa Qulu

Provincial surveillance teams: Badikazi Matiwana, Sandisiwe Joyi (EC); Khasiane Mawasha, Thandeka Kosana (FS); Akhona Mzoneli, Chulumanco Nkosi, Dikeledi Leshaba, Fiona Timber, Hazel Mzolo, John Mothlasi, Molly Morapeli, Nthabiseng Motati, Ophtia Kaoho, Patience Ngube, Phindile Ngema, Phumelelo Mthimude, Rachel Nare, Venesa Kok, Vusi Ndlovu, Zodwa Kgaphola (GA); Indran Naidoo, Michelle Tanya Moodley, Nelisiwe Buthelezi, Nhlakanipho Malinga, Nkoshinathi Mbhele, Nokuthula Mkhize, Nondumiso Amahle Khoza, Nothando Mthembu, Thobeka Simelane Shandu (KZN); Tebogo Modiba (LP); Leomile Elizabeth Motaung, Lesley Ingle, Ndugiselo Muravha, Thandeka Ndlovu, Tumelo Thlomelang, Zanele Siwele, Gift Mnisi, Jacob Mabunda and Milliah Hlathi are HST staff (MP); Bernard Motsestse, Busisiwe Zungu, Kholiwe Mgidlana, Koketso Manaka, Paelsa Seutloali, Seiphati Matshogo, Tuelo Matotong, Tshwanelo Mahloko (NW); Charlene Isaacs, Cheryl Mentor, Lerato Qoza, Lucia Madolo, Nazila Shalabi, Nomvuyiso Yako, Nosisa Simanga, Phathiswa Rangyana, Priscilla Mouton, Yonela Zokufa, Zama Mfundisi, Zukiswa Kibi (WC).

GERMS-SA would like to thank laboratory staff and clinical staff at participating sites throughout South Africa for submitting case report forms and isolates, administrative staff at facilities across the country who have facilitated participation in the surveillance programme, surveillance officers at ESS for their tireless efforts, the patients who participated in surveillance activities, despite their illnesses, NICD staff working on the programme for their dedication and hard work, our international and local collaborators, including the NICD/NHLS management for their support of the programme, and Department of Health.

REFERENCES

1. Govender N, Quan V, Prentice E, von Gottberg A, Keddy K, McCarthy KM, et al. GERMS-SA: A national South African surveillance network for bacterial and fungal diseases. Johannesburg, South Africa. National Institute for Communicable Diseases; 2006. National Institute for Communicable Diseases. Communicable Disease Surveillance Bulletin, 2015, 13(2). Available from: https://www.nicd.ac.za/assets/files/CommDisBull%2013(2)-June%202015.pdf
2. Statistics South Africa. Mid-year population estimates, South Africa, 2015. P0302. 3 May 2016. Available from: http://www.statssa.gov.za/publications/P0302/P03022019.pdf.
3. Thembisa Model v3.2. Johnson LF, Dorrington RE, Moolla H. Progress towards the 2020 targets for HIV diagnosis and antiretroviral treatment in South Africa. Southern African Journal of HIV Medicine 2017; 18(1): a694.
4. Clinical and Laboratory Standards Institute (CLSI) (2016): Performance standards for antimicrobial susceptibility testing; Twenty-sixth informational supplement. CLSI document M100-S26. Wayne, PA: Clinical and Laboratory Standards Institute.
5. Brueggemann, A. B, Jansen van Rensburg, M. J, Shaw, D, McCarthy, N. D, Jolley, K. A et al Maiden, M. C. J.Changes in the incidence of invasive disease due to *Streptococcus pneumoniae, Haemophilus influenzae,* and *Neisseria meningitidis* during the COVID-19 pandemic in 26 countries and territories in the Invasive Respiratory Infection Surveillance Initiative: a prospective analysis of surveillance data. Lancet Digit Health. 2021 Jun;3(6):e360-e37010.1016/S2589-7500(21)00077-7