GERMS
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Annual Report 2006

NICD

NHLS

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Cover page photograph: GERMS-SA Principal Investigator meeting, 7 November 2006, NICD/ NHLS Sandringham campus, Johannesburg

FOREWORD

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This second annual report of GERMS-SA surveillance marks a new phase for infectious disease surveillance in South Africa, the strengthening and maturing of a system that was begun in 1999, and presentation of information that will only grow in importance to all public health practitioners and their partners. This report is the first to identify trends in rates of disease and therefore multiplies the value and potential impact of the information so carefully collected.

The findings of this report has potential value to many South Africans—to providers who can benefit from documentation of local antibiotic resistance trends, to microbiologists who seek to understand and characterize the pathogens causing disease, and to policy makers who will benefit from an evidence-based estimation of the burden of disease and deaths in their country. Perhaps most importantly, establishment of long-lasting high quality surveillance data allows the public health community to identify high-risk populations who might benefit from targeted interventions and to develop, implement and evaluate the effectiveness of disease prevention efforts and policies. This will only increase in importance with successive annual reports. Surveillance is not just “bean counting”—it is so much more.

We have a similar surveillance system in the United States, the Active Bacterial Core surveillance (ABCs) system, a national laboratory- and population-based surveillance system for infectious pathogens of public health importance. Established in 4 sites in 1995, ABCs tracks invasive infections due to group A and B streptococci, *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis*. Over the last 11 years, ABCs not only expanded in its coverage of U.S. population represented by the system— ABCs is now conducted in 10 geographically disparate sites comprised of approximately 39 million persons or 13% of the country—but by the diseases tracked, types of additional studies undertaken, and impact of the data generated from the system.

To the mutual benefit of ABCs and GERMS-SA, we have established a supportive relationship between the two “sister” surveillance systems. This promises to continue to be a beneficial partnership over the years as we share practical lessons learned from the development and implementation of population-based surveillance, and scientific and epidemiologic findings from the data. We at ABCs hope to continue to foster this relationship, working together to identify infectious disease threats and approaches to monitor and decrease morbidity and mortality of these threats that ignore country borders.

INTRODUCTION

GERMS-SA (Group for Enteric, Respiratory and Meningeal disease Surveillance in South Africa) is a national laboratory-based surveillance programme for bacterial and fungal diseases (1). One of the key objectives is to provide accurate quality-controlled strategic information to policy-makers for the diseases under surveillance.

Diseases under surveillance include:

- **Epidemic-prone diseases** to facilitate outbreak identification and subsequent intervention or control measures, e.g. *Neisseria meningitidis*, *Salmonella enterica* serotype Typhi, *Shigella* spp., *Vibrio cholerae*, diarrhoeagenic *Escherichia coli.*
- **Vaccine-preventable diseases** to monitor the impact of vaccines on the pathogens under surveillance
  - Incidence of disease in targeted populations for vaccines currently included in the Expanded Programme on Immunisation (EPI), e.g. conjugate *H. influenzae* type b vaccine.
  - Estimates of disease burden and the potential benefits of new vaccines to motivate for introduction of such vaccines into the EPI, e.g. invasive pneumococcal infections.
- **Opportunistic infections** associated with HIV infection, e.g. cryptococcosis, *Pneumocystis* pneumonia, invasive non-typhoidal *Salmonella enterica* infections and invasive pneumococcal infections, to provide an indirect marker of the impact of the Operational Plan for Comprehensive Care, Management and Treatment of HIV-infected and AIDS-affected patients in South Africa (CCMT).

One of the strengths of the GERMS-SA laboratory-based surveillance network is the combination of quality epidemiologic data obtained from enhanced surveillance sites and supplementary laboratory data on all submitted cases nationally; this enables generation of population-based disease rates to monitor national trends. The ability to phenotypically and genotypically characterise submitted isolates at a central public health laboratory, the National Institute for Communicable Diseases (NICD), provides information on antibiotic susceptibility profiles of pathogens responsible for key clinical syndromes such as pneumonia, meningitis and enteric infections. In addition, typing of strains and molecular epidemiologic data deepen our understanding of links between cases and disease trends. This annual report aims to summarise the core strategic data from 2006 surveillance activities.

METHODS

Area of Coverage
One hundred and twenty clinical microbiology laboratories across the country participated in the GERMS-SA surveillance programme in 2006. These diagnostic laboratory facilities are located in every province of the country and include the public, private, military and mining sectors.

Population under Surveillance
Given that almost all clinical microbiology laboratories participated in the GERMS-SA surveillance programme, it was assumed that the laboratory surveillance network served the entire South African population (mid year population > 47 million, as estimated by Statistics South Africa).

Case Definitions
Any of the following laboratory-confirmed cases (all age groups) diagnosed at health care facilities within South Africa were considered surveillance cases (Table 1). Residence within the defined surveillance area (South Africa) was not specified in the case definitions.

Case identification and case data/ isolate collection
Participating laboratories identified surveillance cases and submitted the corresponding isolate or specimen, along with a standardised laboratory case report form (containing basic demographic data) to the NICD, Johannesburg. Surveillance officers at enhanced surveillance sites (15 sites in 9 provinces in 2006) completed standardised clinical case report forms (included antimicrobial use, patient outcome, vaccination, HIV status and previous hospital admission data) by interview or record review.

Pathogen	Site of specimen	Acceptable laboratory diagnostic test	Recurrent case (in the same patient)
Cryptococcus spp.	Any site	• India ink positive or • Cryptococcal antigen (CRAG) test positive or • Culture positive	• Readmission with laboratory confirmation or • Laboratory confirmation > 30 days after first confirmed lab diagnosis, where admission data is unavailable
Pneumocystis jirovecii	Respiratory tract	• Immunofluorescent antibody (IFA) test positive or • PCR positive	• Laboratory confirmation > 30 days after first confirmed lab diagnosis
Salmonella enterica (including *Salmonella* Typhi)	Any site	• Culture positive	• Laboratory confirmation > 21 days after first confirmed lab diagnosis
Shigella spp.	Any site	• Culture positive	• Laboratory confirmation > 21 days after first confirmed lab diagnosis
Diarrhoeagenic *Escherichia coli*	Lower gastrointestinal tract (stool or rectal swab)	• Culture positive	• Not specified
Vibrio spp.	Any site	• Culture positive	• Not specified
Streptococcus pneumoniae	Any normally sterile body site	• Culture positive or • Latex agglutination test positive and supporting evidence (consistent Gram stain or PCR positive)	• Laboratory confirmation > 21 days after first confirmed lab diagnosis
Haemophilus spp.	Any normally sterile body site	• Culture positive or • Latex agglutination test positive and supporting evidence (consistent Gram stain or PCR positive)	• Laboratory confirmation > 21 days after first confirmed lab diagnosis
Neisseria meningitidis	Any normally sterile body site	• Culture positive or • Latex agglutination test positive and supporting evidence (consistent Gram stain or PCR positive)	• Laboratory confirmation > 21 days after first confirmed lab diagnosis

Table 1: GERMS-SA case definitions for laboratory-confirmed cases diagnosed at health care facilities within South Africa.

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Ethics

Ethics approval for essential communicable disease surveillance activities of the NICD was obtained from the Committee for Research on Human Subjects (Medical), University of the Witwatersrand, Johannesburg. In addition, ethics approval for GERMS-SA enhanced surveillance site activities was obtained from local ethics review boards at participating sites. Informed consent was obtained by trained surveillance officers upon interview of patients. HIV testing was performed where HIV status was unknown, consent was obtained and pre- and post-test counselling was possible.

Laboratory characterisation

Four participating NICD reference units characterised the submitted isolates (Table 2). Bacteria and fungi were identified according to standardised microbiological procedures. Antimicrobial susceptibility testing was performed with reference to Clinical and Laboratory Standards Institute (CLSI) performance standards (2); in addition, Etest® (AB-Biodisk, Solna, Sweden) methodology was used. *Salmonella* spp. were serotyped according to the Kauffman-White Scheme, using specific antisera (Mast Diagnostics, Merseyside, UK; BioMérieux, Marcy-l'Étoile, France). *Shigella* spp. were serotyped using slide agglutination with specific antisera (Denka Seiken, Tokyo, Japan). Diarrhoeagenic *E. coli* were serotyped using specific antisera (Statens Serum Institute, Copenhagen, Denmark) and further classified by identification of typical virulence genes (3-5). *Cryptococcus neoformans* and *Cryptococcus gattii* were differentiated using canavanine-glycine-bromothymol (CGB) agar (6;7). *Pneumocystis jirovecii* was identified by direct immunofluorescence microscopy (Light Diagnostics Pneumocystis DFA, Chemicon International, USA) on submitted respiratory tract specimens, concentrates of specimens or prepared slides (8). Pneumococci were serotyped on the basis of the Quellung reaction, as determined with specific pneumococcal antisera (Statens Serum Institut, Copenhagen, Denmark) (9). Meningococcal serogroup was determined using slide agglutination with monoclonal antisera to capsular polysaccharides A, B, C, X, Y, Z, and W135 (Murex Biotech Limited, Dartford, Kent, UK). Strains not reacting with these antisera were sent to the Meningitis Laboratory, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention (CDC), Atlanta, United States, for serogrouping. Slide agglutination for serotyping *Haemophilus influenzae* was performed using agglutinating sera for types a–f (Murex Biotech Limited, Dartford, Kent, UK). Serotyping results for all *H. influenzae* isolates were confirmed by PCR (10).

Data management

Case laboratory and clinical data were captured onto Epi Info software (version 6.04d, CDC, Atlanta, USA) at the NICD. Surveillance databases were accessed for analysis in March 2007; hence, data contained within this report are preliminary. Incidence rates were calculated by dividing the number of cases reported each year from 1 January to 31 December by mid-year population estimates for each year supplied by Statistics South Africa (Stats SA). In both 2005 and 2006, the estimated population of South Africa was approximately 47 million. National and

NICD Reference Unit	Pathogen	Phenotypic characterisation	Genotypic characterisation (selected isolates only)
Enteric Diseases Reference Unit	*Salmonella* spp., *Shigella* spp., *Vibrio cholerae*, diarrhoeagenic *Escherichia coli*	Genus/ species identification, antimicrobial susceptibility testing, serotyping	Molecular relatedness (PFGE, MLVA), virulence gene determination (PCR)
Mycology Reference Unit	*Cryptococcus* spp.	Genus/ species identification, antimicrobial susceptibility testing (selected cases)	Molecular typing
Parasitology Reference Unit	*Pneumocystis jirovecii*	Semi-quantitative estimation of organism load	Molecular antimicrobial resistance determination
Respiratory and Meningeal Pathogens Reference Unit	*Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis*	Genus/ species identification, antimicrobial susceptibility testing, serotyping (or serogrouping)	Molecular typing (PCR, PFGE, MLST), molecular antimicrobial resistance determination

Table 2: NICD reference unit characterisation of submitted surveillance isolates (PFGE, pulsed-field gel electrophoresis; MLVA, multilocus variable tandem repeat analysis; MLST, multilocus sequence typing; PCR, polymerase chain reaction).

provincial indicators for 2006 derived from the ASSA (Actuarial Society of South Africa) 2003 AIDS and demographic model (http://www.assa.org/aidsmodel.asp) provided denominators for the population living with HIV/ AIDS (11). Incidence rates were calculated only for selected pathogens under surveillance; however, numbers of cases were reported for all pathogens. Where p values are reported, these were calculated using the Mantel-Haenszel chi-squared test (Epi Info version 6.04d, CDC, Atlanta, USA); p values < 0.05 were considered significant.

Surveillance Audits
The objective of audits performed in 2006 was (i) to estimate the proportion of laboratory-confirmed cases reported to the surveillance system at the sites audited or (ii) to detect additional cases at laboratory sites where an interruption in surveillance procedures was documented. Participating laboratories were audited by comparing the number of cases detected by the laboratory (derived from a line list obtained from searching the computerised laboratory information system or paper-based laboratory records) to the number of cases notified to GERMS-SA. Cases detected on surveillance audit were added to the database and are included in the surveillance reports which follow.

Funding sources
Surveillance work was primarily funded by the NICD, a branch of the National Health Laboratory Service (NHLS). Enhanced surveillance activities were partly funded by cooperative agreements with the CDC, Atlanta, USA.

OPERATIONAL REPORT

Surveillance audits
In 2006, 19 surveillance audits were performed for various sites and for varying time periods. At 12 enhanced surveillance sites, the proportion of cases reported to GERMS-SA during the time period audited ranged from 50-100%; this proportion varied by pathogen. At sites where an interruption in participation in surveillance activities had been noted, audits revealed that <40% of cases had been reported.

Coordination meetings
Surveillance officer meeting, 1 February 2006
This meeting was attended by six surveillance officers from three Gauteng enhanced surveillance sites (Chris Hani Baragwanath Hospital, Johannesburg Hospital and Pretoria Academic/ Dr George Mukhari Hospital). Indicators of workload, correctness of clinical case data and site-specific problems were discussed; subsequent interventions included appointment of an additional surveillance officer at each site.

Surveillance officer meeting, 7-10 March 2006
This meeting, convened at the NICD, was attended by eleven surveillance officers from six provinces. The meeting included two days of training, discussion of surveillance indicators, case report forms and the inclusion of *Pneumocystis jirovecii* cases into the surveillance programme. Surveillance officers and data capture clerks attended a Good Clinical Practice Course following the meeting.

Surveillance officer meeting, 5-6 November 2006
The meeting, convened at the NICD in Johannesburg, was attended by 18 surveillance officers from 8 provinces, NICD coordinators, and Dr Chris Van Beneden and Dr Beth Arthington-Skaggs (CDC, USA). Feedback from projects undertaken during 2005-2006, discussion of new project proposals and data collection issues and presentation of surveillance indicators was covered during the meeting. The surveillance officers also attended the first day of the Principal Investigator Meeting.

Principal investigator meeting, 6-7 November 2006
The two day principal investigator meeting, convened at the NICD in Johannesburg, was attended by over 100 local, national and international delegates and representatives from the Department of Health. Representatives from African surveillance networks included Dr Anthony Scott (Wellcome Trust Career Development Fellow in Tropical Medicine, Wellcome Trust/ KEMRI Collaborative Programme, Kilifi, Kenya), Mr Tura Galgalo (Head, Microbiology Reference Laboratory, National Public Health Laboratory Services (NPHLS), Kenya) and Mr Luis Morais (Training Fellow in Microbiology, Manhiça Health Research Centre, Mozambique). Surveillance and research achievements emanating from the GERMS-SA programme were presented by NICD workers and site coordinators. Sessions dedicated to presentation of proposals for new projects as well as novel methods of analysis for existing GERMS-SA data allowed the group to decide on priorities for the upcoming year. Public health advocacy was identified as a key function of the GERMS-SA programme. An open discussion session enabled the group to identify practical measures to regularly communicate strategic information to those who need to know, e.g. Department of Health.

Site Visits

Date	Province	Laboratory	Site
19-20 January 2006	Western Cape	NHLS GSH	Groote Schuur/ Red Cross Hospital
		NHLS Tygerberg	Tygerberg Hospital
		NHLS Greenpoint	Karl Bremer Hospital
4-6 April 2006	Eastern Cape	NHLS Mthatha	Nelson Mandela Academic/ Mthatha Provincial Hospital
28 March 2006	Northern Cape	NHLS Kimberley	Kimberley Hospital
31 May-2 June 2006	KwaZulu-Natal	KZNPHL KEH	King Edward VIII Hospital
		KZNPHL Addington	Addington Hospital
		KZNPHL PMMH	Prince Mshiyeni Memorial Hospital
		KZNPHL RKK	RK Khan Hospital
12 May 2006	Gauteng	NHLS DGM	Dr George Mukhari Hospital
1 June 2006	Gauteng	NHLS Leratong	Leratong Hospital
14 June 2006	Gauteng	NHLS CHBH	Chris Hani Baragwanath Hospital
28-30 June 2006	Mpumalanga	NHLS Rob Ferreira	Rob Ferreira Hospital
		NHLS Barberton	Barberton Hospital
		NHLS Themba	Themba Hospital
12 July 2006	North West	NHLS Rustenberg	Rustenberg Hospital
31 July 2006	North West	Goldfields Carletonville	Leslie Williams Memorial Hospital
7 August 2006	North West	-	Duff Scott Hospital
		Anglogold Health Services	Westvaal Hospital
16-18 August 2006	Limpopo	NHLS Tshilidzini	Tshilidzini Hospital
		NHLS Mankweng	Mankweng Hospital
		NHLS Polokwane	Polokwane Hospital
4 September 2006	Gauteng	NHLS PAH/ TDH	Pretoria Academic/ Tshwane District Hospital
18 October 2006	Gauteng	NHLS JH	Johannesburg Hospital
19 October 2006	Gauteng	NHLS CHBH	Chris Hani Baragwanath Hospital
23 November 2006	Free State	NHLS Universitas	Universitas Hospital
		NHLS Pelonomi	Pelonomi Hospital
24 November 2006	Northern Cape	NHLS Kimberley	Kimberley Hospital

Table 3: GERMS-SA site visits between 1 January and 31 December 2006.

SURVEILLANCE REPORTS

Salmonella enterica serotype Typhi

Enteric Diseases Reference Unit

Non-invasive isolates from stool or rectal swabs may reflect screening for the carrier state or follow-up of typhoid fever patients after treatment (Table 4). Serological methods of diagnosis, e.g. Widal test and modifications using a rapid slide agglutination test are still widely used for diagnosis (not reflected in this report). The total number of reported isolates may not reflect actual numbers of cases in South Africa for the year; hence, incidence rates have not been calculated. Culture is the preferred method of diagnosis as it provides important information on antimicrobial resistance. No isolates were received from the Northern Cape or North West provinces. One *Salmonella* Paratyphi A and one *Salmonella* Paratyphi B isolate was received from Gauteng and the Free State respectively. Higher isolate numbers from KwaZulu Natal and Eastern Cape may reflect endemic disease in these provinces. Typhoid fever typically peaks between 6 and 14 years of age. The number of isolates from younger age groups, particularly in infants under one year of age, is of concern (Figure 1). The *Salmonella* Paratyphi A isolate was obtained from a 59 day old infant and the *Salmonella* Paratyphi B isolate was obtained from a 46 year old adult male. No significant monthly variation in disease was noted in 2006 (Figure 2), indicating that no major outbreaks were detected. Certain antimicrobials are tested for epidemiological purposes only and should not be used for treatment of typhoid fever (Table 5). All isolates received in 2006 were susceptible to ciprofloxacin, the treatment of choice, although the occurrence of nalidixic acid resistance is cause for concern. Nalidixic acid resistance may be used as a marker for quinolone resistance; it is indicative of the potential for an organism to develop fluoroquinolone resistance. Response to ciprofloxacin may be poor in the presence of nalidixic acid resistance (12). Both *Salmonella* Paratyphi isolates were fully susceptible to all antimicrobial agents tested.

Province	Invasive *Salmonella* Typhi	Non-invasive *Salmonella* Typhi
Eastern Cape	44	7
Free State	1	0
Gauteng	12	4
KwaZulu-Natal	14	1
Limpopo	3	3
Mpumalanga	9	5
Northern Cape	0	0
North West	0	0
Western Cape	20	1
South Africa	**103**	**21**

Table 4: Number of invasive and non-invasive *Salmonella* Typhi isolates (n=124) reported to EDRU by province, South Africa, 2006.

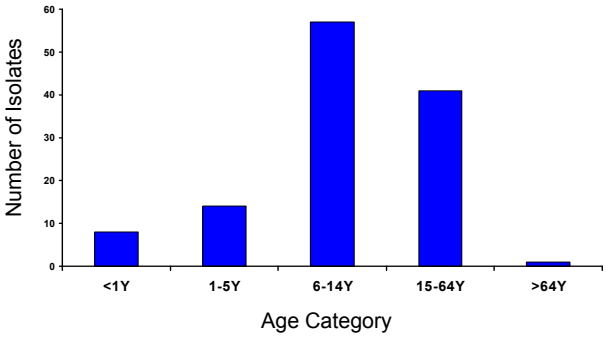

Figure 1: Number of *Salmonella* Typhi isolates reported to EDRU (n=124) by age category (age category unknown for 3 isolates), 2006.

Antimicrobial tested	Susceptible (%)	Resistant (%)
Ampicillin	60.5	39.5
Cotrimoxazole	64.5	35.5
Chloramphenicol	93.4	5.6
Nalidixic acid	96.8	3.2
Ciprofloxacin	100.0	0.0
Tetracycline	58.1	41.9
Kanamycin	100.0	0.0
Streptomycin	62.9	37.1
Imipenem	100.0	0.0
Ceftriaxone	100.0	0.0

Table 5: Results of antimicrobial susceptibility testing for all *Salmonella* Typhi isolates (n=124) received by EDRU, 2006.

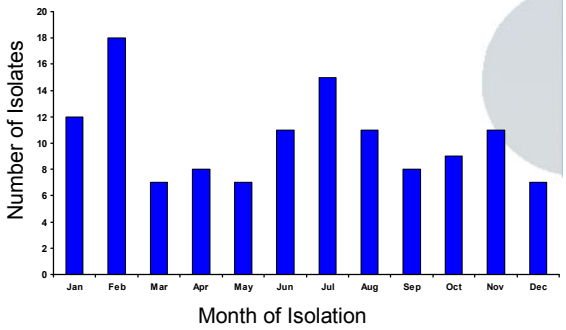

Figure 2: Number of *Salmonella* Typhi isolates reported to EDRU by month of isolation, 2006.

Non-typhoidal *Salmonella enterica* (NTS)
Enteric Diseases Reference Unit

Numbers of NTS received from each province are reflected in table 6, 7 and 8 show age specific incidence rates and specimen sites respectively.

Certain antimicrobial agents were tested against NTS isolates for epidemiological reasons only and should not be used for treatment (Table 9). Of those NTS isolates tested, 461 (26.3%) were noted to be extended spectrum beta-lactamase (ESBL) producers. Nalidixic acid resistance is a cause for concern because it is a marker of increasing resistance to the quinolones and is associated with poor response to fluoroquinolone treatment in clinical cases (12). Nalidixic acid resistance, in combination with ESBL production, was identified in 376 (21.4%) NTS isolates. Pentavalent resistance (resistance to five or more antimicrobial agents) was observed in 876 (50%) isolates. Multi-drug resistant serotypes included *Salmonella* Typhimurium, *Salmonella* Isangi, *Salmonella* Muenchen and a newly recognised multi-drug resistant isolate, *Salmonella* Eppendorf.

The number of *Salmonella* Virchow isolates was unusually high compared with previous years (Table 10); this was associated with a food-borne outbreak of salmonellosis in Mpumalanga.

A lack of monthly variation may reflect the nosocomial nature of many cases, as well as disease associated with HIV infection (Figure 3).

Province	Invasive non-typhoidal *Salmonella enterica*	Non-invasive non-typhoidal *Salmonella enterica*
Eastern Cape	91	118
Free State	24	36
Gauteng	568	200
KwaZulu-Natal	132	196
Limpopo	7	34
Mpumalanga	43	85
Northern Cape	0	15
North West	16	58
Western Cape	97	154
South Africa	**978**	**896**

Table 6: Number* of invasive and non-invasive non-typhoidal *Salmonella* isolates (n=1874) reported to EDRU by province, South Africa, 2006.
*Incidence rates were not been calculated as there may be regional differences in specimen collection practices

Age Category (years)	Cases	
	Number	Incidence rate
<1	173	16.3
1 - 5	98	1.9
6 - 14	34	0.4
15 - 64	513	1.7
>64	14	0.6
Total	**832**	**1.8**

Table 7: Case numbers and incidence rates for invasive* non-typhoidal *Salmonella* reported to EDRU by age category, 2006. *Incidence rates for non-invasive non-typhoidal *Salmonella* have not been calculated because not all cases of gastroenteritis due to non-typhoidal *Salmonella* may be cultured in clinical practice.

Specimen	n	%
CSF	26	1.5
Blood culture	831	47.5
Stool	761	43.5
Other	133	7.5
Total	**1751**	

Table 8: Number of invasive and non-invasive non-typhoidal *Salmonella* isolates reported to EDRU by anatomical site of isolation*, 2006.
*Note that many cases had multiple isolates, including those with isolates from an invasive site and a second isolate from stool.

Antimicrobial tested	Susceptible (%)	Intermediately resistant (%)	Resistant (%)
Ampicillin	45.6	0.1	54.3
Cotrimoxazole	49.3	0.0	50.7
Chloramphenicol	61.4	0.7	37.9
Nalidixic acid	62.3	0.0	37.7
Ciprofloxacin	99.5	0.1	0.4
Tetracycline	56.4	4.6	39
Kanamycin	68.5	12.2	19.3
Streptomycin	54.8	0.0	45.2
Imipenem	100.0	0.0	0.0
Ceftriaxone	73.8	0.1	26.1

Table 9: Results of antimicrobial susceptibility testing for invasive and non-invasive non-typhoidal *Salmonella* isolates (n=1751) received by EDRU, 2006.

Province	Dublin	Enteritidis	Isangi	Typhimurium	Virchow
Eastern Cape	2	8	73	56	1
Free State	3	5	0	42	0
Gauteng	18	72	56	508	2
KwaZulu-Natal	5	14	94	134	3
Limpopo	0	4	4	12	0
Mpumalanga	9	6	4	53	23
Northern Cape	0	2	0	8	0
North West	0	3	8	56	0
Western Cape	7	10	38	130	1
South Africa	**44**	**124**	**277**	**999**	**30**

Table 10: Commonest invasive and non-invasive non-typhoidal *Salmonella* serotypes (n=1474) reported to EDRU by province, 2006.

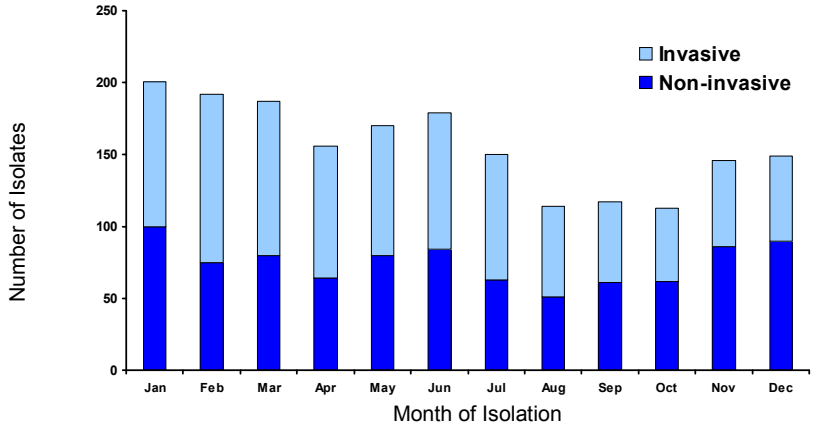

Figure 3: Number of non-invasive and invasive non-typhoidal *Salmonella* isolates reported to EDRU by month of isolation, 2006.

Shigella spp.
Enteric Diseases Reference Unit

A higher number of non-invasive isolates submitted from the Western Cape (Table 11) may be due to local clinical practice (i.e. more stool specimens submitted for diagnosis) as there was no predominance of any serotype for a given month or metropolitan area (full data not shown). It is evident that the predominant burden of disease is in the under five-year age group (Table 12). Higher isolation rates between January and March in 2006 suggest seasonality (Figure 4). The majority of isolates submitted were from stool (n=1045), but 59 isolates were identified from blood cultures and other sterile sites. Nine isolates originated from other non-sterile sites.

Certain antimicrobials were tested for surveillance purposes only and should not be used for treatment (Table 13). Four of the isolates tested were found to produce extended spectrum beta-lactamases (ESBL). Quinolone resistance remains low. A known outbreak of *Shigella sonnei* phase II in the Northern Cape is represented by only four submitted isolates (Table 14); this is an under-representation of the actual number of cases. The predominance of *Shigella flexneri* 2a is typical of developing countries, whereas *Shigella sonnei* is isolated more frequently in the developed world and is represented by a single serotype that can undergo phase variation.

Province	Invasive Shigella	Non-invasive Shigella
Eastern Cape	1	120
Free State	4	48
Gauteng	22	206
KwaZulu-Natal	14	182
Limpopo	0	20
Mpumalanga	1	38
Northern Cape	0	32
North West	0	17
Western Cape	13	395
South Africa	**55**	**1058**

Table 11: Number of invasive and non-invasive *Shigella* isolates (n=1113) reported to EDRU by province, South Africa, 2006.

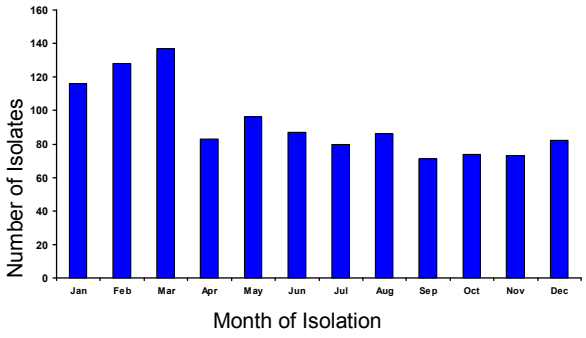

Figure 4: Number of non-invasive and invasive *Shigella* isolates reported to EDRU by month of isolation, 2006

Age Category (years)	Cases	
	Number	Incidence rate
<1	127	12.0
1 - 5	422	8.4
6 - 14	95	1.1
15 - 64	358	1.2
>64	41	1.7
Total	**1043**	**2.2**

Table 12: Case numbers* and incidence rates for *Shigella* (invasive and non-invasive) reported to EDRU by age category (age unknown in 70/1113), 2006.
*Cases may be under-reported due to local clinical practices.

Antimicrobial tested	Susceptible (%)	Intermediately resistant (%)	Resistant (%)
Ampicillin	48.7	0.3	51.0
Cotrimoxazole	17.6	0.0	82.4
Chloramphenicol	60.6	1.2	38.2
Nalidixic acid	98.6	0.1	1.3
Ciprofloxacin	99.8	0.1	0.1
Tetracycline	46.4	0.8	52.8
Kanamycin	99.5	0.1	0.4
Streptomycin	40.9	0.0	59.1
Imipenem	100	0.0	0.0
Ceftriaxone	99.5	0.0	0.5

Table 13: Results of antimicrobial susceptibility testing for all *Shigella* isolates (n=1113) received by EDRU, 2006.

Province	*S. dysenteriae* type 1	*S. flexneri* type 1b	*S. flexneri* type 2a	*S. flexneri* type 6	*S. sonnei* phase II
Eastern Cape	0	33	43	4	14
Free State	0	7	21	3	11
Gauteng	0	34	89	20	29
KwaZulu-Natal	1	46	48	19	27
Limpopo	0	4	5	2	2
Mpumalanga	0	9	10	8	0
Northern Cape	0	10	8	1	4
North West	0	5	4	0	1
Western Cape	1	108	104	30	49
South Africa	**2**	**256**	**332**	**87**	**137**

Table 14: Commonest* invasive and non-invasive *Shigella* serotypes (n = 814) reported to EDRU by province, 2006.
*Including *Shigella dysenteriae* type 1

Diarrhoeagenic *Escherichia coli* (DEC)
Enteric Diseases Reference Unit

Current clinical microbiology laboratory standard operating procedures are selective for detection of enteropathogenic *E. coli* (EPEC) (Table 15). The single enterohaemorrhagic *E. coli* (EHEC) isolate received from Gauteng (serotype O111) and the two Shiga-toxigenic *E. coli* (STEC) isolates received from Western Cape and Gauteng (both serotype O117) require specific note. No further history was available for the child with EHEC. Both children with STEC presented with dysentery; the identified genotypic pattern (*stx*1 positive, *eae* negative) in combination with serotype O117 has not been associated with haemolytic uraemic syndrome (13). There was no known epidemiological linkage between these cases, but a high degree of clonality has been recognised in these isolates previously using molecular techniques. The preferential use of MacConkey agar with sorbitol for identifying *E. coli* O157 may result in EHEC infection due to other serotypes not being diagnosed.The predominance of isolates received in children under the age of one year may reflect culturing practices; infants are more likely to have stools taken for culture due to the devastating effects of diarrhoea in children of this age (Table 16). Isolate numbers received are too few to comment on seasonal distribution (Figure 5). The commonest enteropathogenic *E. coli* serotypes include O119, O55, O111, O142 and O127 (Table 17). The occurrence of serotype O55 is of interest as it has previously been shown that enterohaemorrhagic *E. coli* O157 evolved from this serotype (14). Common enteroaggregative *E. coli* (EAggEC) serotypes identified included O128ABC (n = 4), O127 (n=3), O125ABC (n=2) and O147 (n=2). No more than two isolates of any particular serotype of enterotoxigenic *E. coli* were received; serotypes included O11, O110, O115, O128 and variants, and O55, which is traditionally associated with EPEC. The single isolate of enteroinvasive *E. coli* (EIEC) received was serotyped as O28A.

Province	EAggEC	EHEC	EIEC	EPEC	ETEC	STEC
Eastern Cape	7	0	0	35	3	0
Free State	0	0	0	2	1	0
Gauteng	6	1	1	26	1	1
KwaZulu-Natal	2	0	0	0	0	0
Limpopo	0	0	0	3	0	0
Mpumalanga	5	0	0	5	1	0
Northern Cape	0	0	0	0	0	0
North West	9	0	0	15	3	0
Western Cape	1	0	0	1	0	1
South Africa	**30**	**1**	**1**	**87**	**9**	**2**

Table 15: Number* of diarrhoeagenic *Escherichia coli* isolates (n=130) reported to EDRU by province, South Africa, 2006 (EAggEC, enteroaggregative *E. coli*; EHEC, enterohaemorrhagic *E. coli*; EIEC, enteroinvasive *E. coli*; EPEC, enteropathogenic *E. coli*; ETEC, enterotoxigenic *E. coli*; STEC, Shiga-toxigenic *E. coli*).

*Incidence rates have not been calculated as numbers are not viewed as being fully representative

Age category (years)	EAggEC	EHEC	EIEC	EPEC	ETEC	STEC
<1	15	0	0	55	5	2
1 - 5	12	1	0	24	2	0
6 – 14	0	0	0	0	0	0
15 - 65	2	0	0	2	0	0
>65	0	0	0	1	0	0
Age unknown	1	0	1	5	2	0
Total	**30**	**1**	**1**	**87**	**9**	**2**

Table 16: Number of diarrhoeagenic *E. coli* isolates (n=130) reported to EDRU by age category, 2006.

Serotype	Number of isolates
0119	25
055	18
0111	10
0142	8
0127	7

Table 17: Commonest enteropathogenic *E. coli* serotypes, as reported to EDRU, 2006.

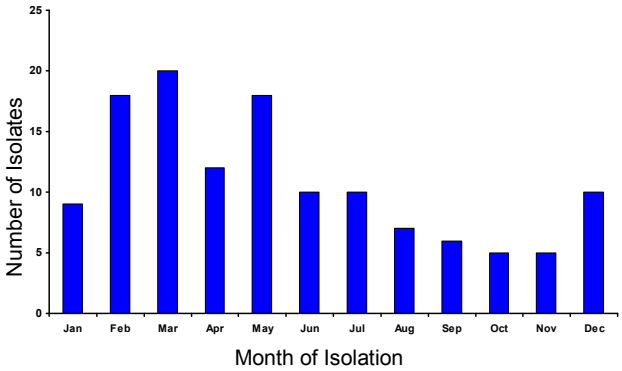

Figure 5: Number of diarrhoeagenic *E. coli* isolates reported to EDRU by month of isolation, 2006.

Vibrio cholerae
Enteric Diseases Reference Unit

No *Vibrio cholerae* isolates from cases in South Africa were detected in 2006.

Cryptococcus spp.
Mycology Reference Unit

A total of 6372 incident cases of cryptococcosis were reported during 2006. Four hundred and thirty seven recurrent episodes were recorded. In total, 5917 isolates were received by MRU, of which 5555 (94%) were viable. *C. gattii* was detected in 136 of 4929 culture positive incident cases (2.7%).

The overall incidence rate in the South African general population was 13/100,000; this is a minimum disease burden estimate. Using projected/ estimated denominators from the Medical Research Council report on the Demographic Impact of AIDS in South Africa, the incidence of cryptococcosis amongst all HIV-infected individuals was 113/100,000 cases, and amongst people sick with AIDS was 10/1000 AIDS cases (11).

The provincial incidence rates for 2005 and 2006 reveal an increase in incidence rates in every province (Table 18). There is a trend to higher incidence rates within urban centres of South Africa (Figure 6). *C. gattii* was identified predominantly from cases presenting in the northern parts of South Africa (Figure 7). The highest incidence of cryptococcosis was in the 35-39 year age group (Figure 8); where gender was known (6205/6372, 97%), 55% of cases occurred in

Province	2005		2006	
	n	Cases/ 100 000	n	Cases/ 100 000
Eastern Cape	447	7	1230	17
Free State	227	9	300	10
Gauteng	1571	16	1947	21
KwaZulu-Natal	882	9	1393	14
Limpopo	123	2	221	4
Mpumalanga	348	11	453	14
Northern Cape	50	1	64	7
North West	206	6	391	10
Western Cape	332	7	373	8
South Africa	**4186**	**9**	**6372**	**13**

Table 18: Number of cases and incidence rates of *Cryptococcus* spp. as reported to MRU by province, South Africa, 2005 and 2006.

(Continued on page 15)

(Continued from page 14)

females. In children under 12 years of age, 93 cases were identified. Most incident cases (92%) were diagnosed with meningitis (laboratory tests on cerebrospinal fluid positive for *Cryptococcus* spp.), and 4.4% with fungaemia (Table 19). The remainder of cases (n=17) originated through positive cultures of the pleural fluid and other sites. Of 1486 incident cases presenting to enhanced surveillance sites and with completed clinical case report forms at the time of analysis, 507 cases (34%) died in hospital.

Interpretation of findings

Incidence rates of cryptococcosis amongst the general population in every province of South Africa were higher than 2005 rates. This appears not to be an artifact of reporting as preliminary analysis reveals that the increase in numbers is occurring at hospitals that were included in 2005 data. Given evidence from a population-based surveillance study conducted in Gauteng (2002-2004) that shows that incidence of cryptococcosis may be a surrogate marker for AIDS prevalence (15), it is reasonable to infer that the numbers of AIDS cases in South Africa have increased since 2005. Mortality rates amongst cryptococcosis patients admitted to enhanced surveillance sites are exceedingly high.

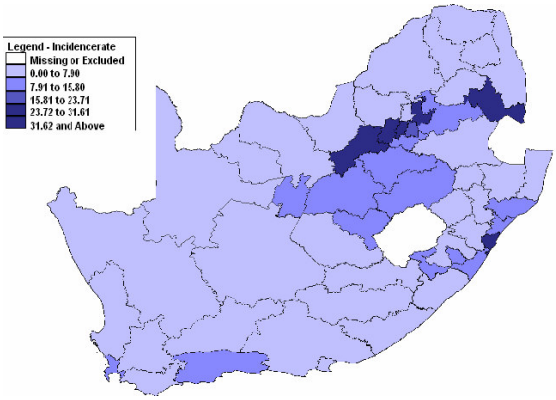

Figure 6: Chloropleth distribution map of incidence of cryptococcosis by health district in South Africa, 2006 (based on preliminary data, excluding Eastern Cape audit cases).

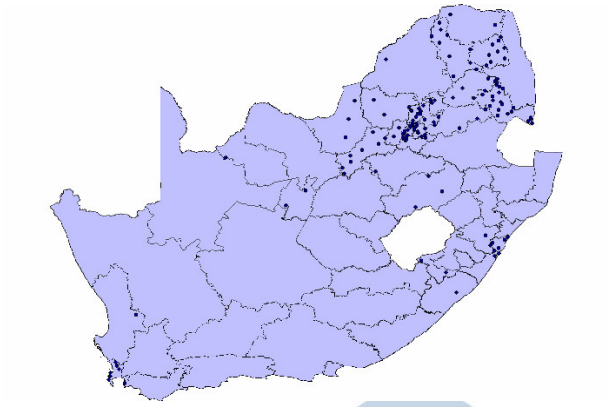

Figure 7: Cases of *Cryptococcus gattii* (n=134) by health district of South Africa, 2006 (based on preliminary data).

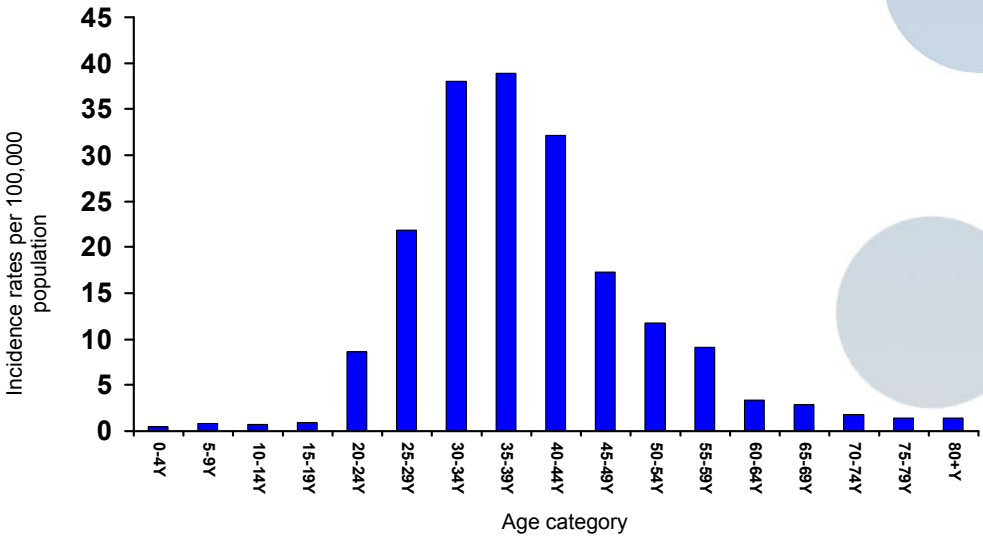

Figure 8: Age-related incidence of cryptococcosis in the general population, South Africa, 2006 (n= 6372, ages unknown in 10% [657/ 6372] cases).

Site of specimen	n	%
CSF	5883	92.3
Blood	282	4.4
Other	17	0.3
Unknown	190	3.0
Total	**6372**	

Table 19: Number and percentage of cases of cryptococcal disease as reported to MRU by specimen type, South Africa, 2006.

Pneumocystis jirovecii
Parasitology Reference Unit

Sentinel site surveillance started in May 2006. Laboratories (including the Parasitology Reference Unit (PRU), NICD) that offer *Pneumocystis jirovecii* pneumonia (PCP) diagnostic tests were requested to notify GERMS-SA if cases were confirmed.

Cases diagnosed at PRU from 1 January 2006 have been retrospectively included in this report. Table 20 shows laboratory-confirmed cases of PCP accumulated for the period January–December, 2006. These data show an incomplete picture of the burden of PCP, for a number of reasons:

- laboratory diagnosis of PCP is restricted to relatively few large, mainly tertiary hospital, laboratories;
- in practice, diagnosis is often made on clinical and radiological grounds, rather than being laboratory-based, even when laboratory facilities are available;
- optimal respiratory sampling (e.g. bronchoalveolar lavage or saline-induced sputum) is seldom readily available, and therefore sensitivity of detection is often compromised.

Despite these limitations, the access to specimens from different areas of the country is useful for examining genetic diversity of strains and for monitoring molecular markers that may be relevant to cotrimoxazole resistance .

Province	**2006**
Eastern Cape	25
Free State	6
Gauteng	177
KwaZulu-Natal	7
Limpopo	0
Mpumalanga	17
Northern Cape	0
North West	0
Western Cape	52
South Africa	**284**

Table 20: Number of *Pneumocystis* pneumonia (PCP) cases reported to PRU by province, South Africa, 1 January – 31 December 2006.

Neisseria meningitidis
Respiratory and Meningeal Pathogens Reference Unit

In 2006, 591 cases of meningococcal disease were reported to RMPRU. Rates of disease remained stable in Gauteng and Western Cape provinces, but Eastern Cape, Free State, Mpumalanga, Northern Cape and North West all reported more cases than the previous year (2005) (Table 21). In keeping with the seasonal pattern of disease, the number of cases reported increased during the winter and spring months (Figure 9) (16). Of all cases reported to RMPRU, cerebrospinal fluid (CSF) was the most common specimen yielding meningococci (Table 22).

The burden of serogroup W135 disease in Gauteng Province stabilised in 2006, with total rates of disease similar to those of last year (approximately 4/100,000), and most of that disease being due to W135 (257/314, 82%) (Table 23). Cases of W135 disease were reported from all provinces. The preponderance of serogroup B disease in Western Cape Province was still noted: 26/49 (53%) of all cases serogrouped.

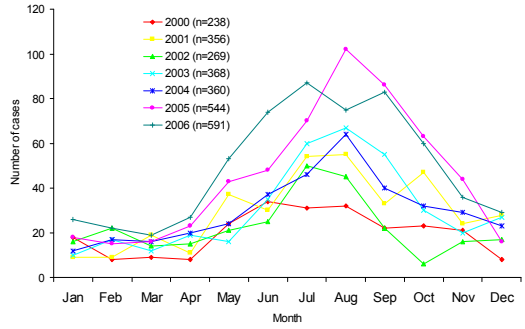

Figure 9: Number of cases of meningococcal disease in South Africa as reported to RMPRU by month and year (2000-2006).

Burden of disease was greatest in children less than five years of age. Age and serogroup - specific incidence rates show that infants were at greatest risk of disease for all serogroups (Figure 10).
Preliminary analysis of case fatality rates, as calculated in enhanced surveillance sites where in-hospital outcome is specifically looked for, was 26/197 (13%). This rate was similar compared to last year (42/216, 19%; p=0.09).

Only 18/467 (4%) isolates had penicillin MICs > 0.06µg/ml, and would be considered non-susceptible. The clinical relevance of increasing MICs is unclear, and penicillin is, at present, still being recommended as the drug of choice for therapy for confirmed meningococcal disease.

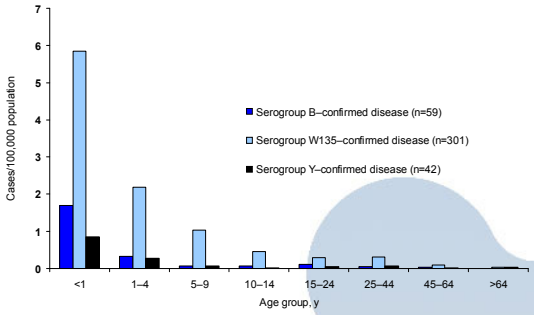

Figure 10: Reported age-specific incidence rates for confirmed serogroups B, W135 and Y, South Africa, 2006 (of 591 cases reported, 556 had known age, and 474 had viable isolates available for serogrouping).

Province	2005		2006	
	n	Cases/ 100,000	n	Cases/ 100,000
Eastern Cape	10	0.14	22	0.31
Free State	25	0.85	45	1.52
Gauteng	359	3.98	360	3.91
KwaZulu-Natal	25	0.26	20	0.21
Limpopo	12	0.21	8	0.14
Mpumalanga	21	0.65	27	0.83
Northern Cape	7	0.78	14	1.54
North West	15	0.39	26	0.68
Western Cape	70	1.51	69	1.45
South Africa	**544**	**1.16**	**591**	**1.25**

Table 21: Number of cases and incidence rates of meningococcal disease as reported to RMPRU by province, South Africa, 2005 and 2006.

Site of specimen	n	%
CSF	436	74
Blood	152	26
Other	3	0.5
	591	

Table 22: Number and percentage of cases of meningococcal disease as reported to RMPRU by specimen type, South Africa, 2006.

Province	Serogroup								
	No isolate available	A	B	C	W135	X	Y	Non-groupable	Total
Eastern Cape	2	0	7	3	5	0	5	0	22
Free State	8	0	5	3	16	1	12	0	45
Gauteng	46	3	20	17	257	0	17	0	360
KwaZulu-Natal	13	0	0	2	3	0	2	0	20
Limpopo	5	0	0	1	2	0	0	0	8
Mpumalanga	6	1	3	1	15	0	1	0	27
Northern Cape	6	0	1	1	4	0	2	0	14
North West	11	0	1	3	10	0	1	0	26
Western Cape	20	0	26	10	7	0	5	1	69
South Africa	**117**	**4**	**63**	**41**	**319**	**1**	**45**	**1**	**591**

Table 23: Number of cases of meningococcal disease reported to RMPRU by serogroup and province (n=591, 474 (80%) with isolates for further testing), South Africa, 2006.

Haemophilus influenzae
Respiratory and Meningeal Pathogens Reference Unit

The total number of cases of *Haemophilus influenzae* invasive disease reported in 2006 to RMPRU was 300. Of these 207 (69%) had viable isolates for further testing and 71/207 (34%) were confirmed as serotype b (Table 24). Serotype b isolates were more likely to be isolated from CSF than non-typeable *H. influenzae* (34/71 vs. 7/102, p<0.001) (Table 25).

Since the introduction of the *H. influenzae* serotype b (Hib) conjugate vaccine into the Expanded Programme on Immunisation (EPI) for South Africa in 1999, there has been a reduction in cases reported due to this serotype (17). In 2006, a total of 48 cases of Hib were reported in children <5 years (Figure 11). Non-typeable strains were the most common *H. influenzae* causing disease in infants (Figure 12). The apparent increase in Hib in 2003 is probably related to improvements in surveillance (Figure 13) (17). Since 2003 rates of Hib disease as recorded by our surveillance network in infants <1 year of age have stabilised, and although there seems to be an increase in 2006, this is not significant (p=0.3, chi-squared test for trend, 2003 to 2006).

Seventeen percent of serotype b strains were resistant to ampicillin (all producing beta lactamase), 12 of 71 isolates tested, while 13% (13/102) of non-typeable strains were resistant (p=0.4).

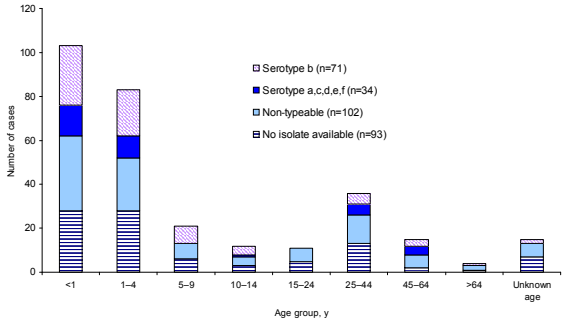

Figure 11: Number of cases of *Haemophilus influenzae* reported to RMPRU by serotype and age group, South Africa, 2006 (of 300 cases reported, 285 had known age, and 207 had viable isolates available for serotyping)

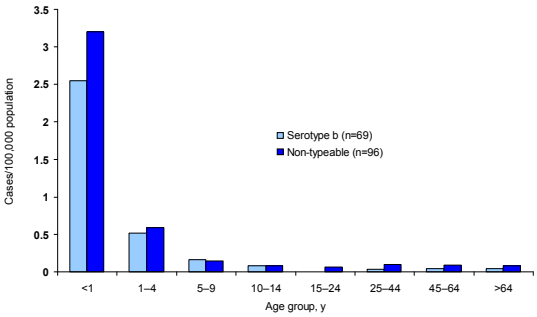

Figure 12: Reported age-specific incidence rates of serotype b and non-typeable *Haemophilus influenzae* disease, South Africa, 2006 (of 300 cases reported, 285 had known age, and 207 had viable isolates available for serotyping)

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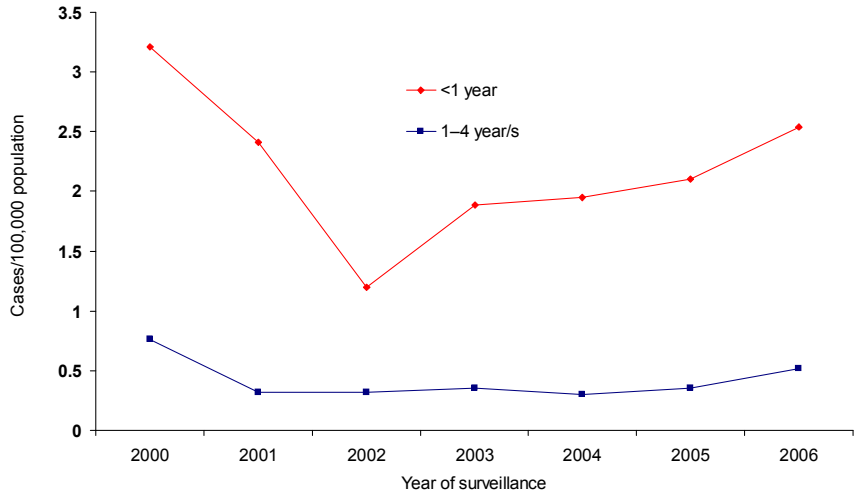

Figure 13: Incidence rates of *Haemophilus influenzae* serotype b disease in children <5 years, South Africa, 2000-2006

Province	Serotype								
	No isolate available	a	b	c	d	e	f	Non-typeable	Total
Eastern Cape	3	0	2	0	0	0	1	2	8
Free State	5	0	4	0	0	0	1	7	17
Gauteng	39	9	30	0	2	1	11	61	153
KwaZulu-Natal	25	1	16	0	0	0	3	11	56
Limpopo	0	0	1	0	0	0	0	0	1
Mpumalanga	1	0	2	0	0	0	0	1	4
Northern Cape	3	1	4	0	0	0	0	0	8
North West	2	0	0	0	0	0	0	1	3
Western Cape	15	1	12	1	0	0	2	19	50
South Africa	**93**	**12**	**71**	**1**	**2**	**1**	**18**	**102**	**300**

Table 24: Number of cases of *Haemophilus influenzae* disease reported to RMPRU by serotype and province (n=300, 207 (69%) with isolates for further testing), South Africa, 2006

Site of specimen	Serotype b		Serotypes a, c, d, e, f		Non-typeable		No isolate available	
	n	%	n	%	n	%	n	%
CSF	34	48	11	32	7	7	17	18
Blood	36	51	23	68	90	88	63	68
Other	1	1	0	0	5	5	13	14
Total	**71**		**34**		**102**		**93**	

Table 25: Number and percentage of cases of *Haemophilus influenzae* disease as reported to RMPRU by specimen type, South Africa, 2006

Streptococcus pneumoniae
Respiratory and Meningeal Pathogens Reference Unit

The same trends of reported invasive pneumococcal disease were documented in 2006, with disease rates by province varying widely (Table 26). The age group at highest risk of disease in South Africa was infants <1 year of age (Figure 14). The majority of episodes reported to RMPRU were diagnosed from positive blood culture specimens (Table 27).

Overall, penicillin non-susceptible isolates have not increased from 2005 (1106/3422, 32% in 2006 compared to 1131/3656, 31% in 2005, p=0.2), and this ranges from 23% to 39% in different provinces (Table 28). Non-susceptible isolates were common in children less than 1 year (283/600, 47%), and proportions were similar to those in 2005 (287/645, 44%), p=0.3 (Figure 15).

PREVENAR® (7-valent conjugate pneumococcal vaccine) was launched in South Africa in the private sector in 2005 by Wyeth South Africa (Pty) Ltd, and is at present the only vaccine for the prevention of pneumococcal disease in children < 2 years. The proportion of disease in 2006 in children <5 years due to the seven serotypes in the vaccine (4, 6B, 9V, 14, 18C, 19F and 23F), and serotype 6A (ongoing evidence for cross-protection within this serogroup (18)), in South Africa is more than 70% according to our data (Table 29).This supports advocacy from clinicians and parents for the vaccine price to be reduced and the possible inclusion of this vaccine in the EPI in the future.

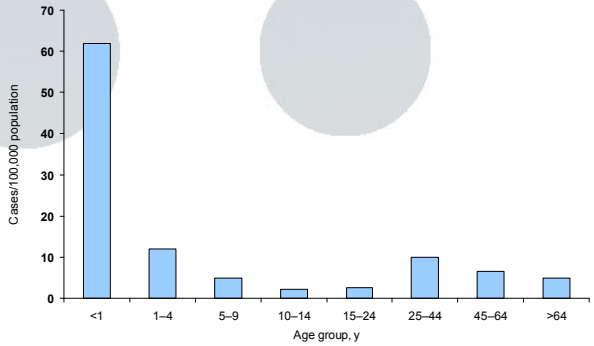

Figure 14: Reported age-specific incidence rates for invasive pneumococcal disease, South Africa, 2006 (3922 cases reported, age known in 3649).

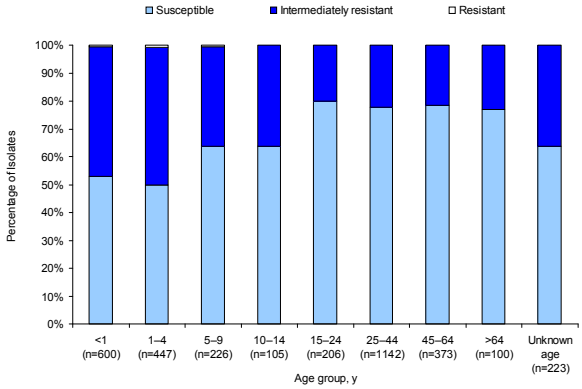

Figure 15: Number of cases of IPD reported to RMPRU in 2006 by age group and susceptibility to penicillin (3922 cases reported, 3422 with viable isolates).

Province	2005		2006	
	n	Cases/100 000	n	Cases/100 000
Eastern Cape	218	3.10	187	2.65
Free State	214	7.25	228	7.70
Gauteng	2260	25.06	2070	22.49
KwaZulu-Natal	465	4.82	462	4.75
Limpopo	73	1.30	102	1.80
Mpumalanga	229	7.11	209	6.44
Northern Cape	32	3.55	37	4.07
North West	114	2.98	139	3.61
Western Cape	502	10.80	488	10.27
South Africa	**4107**	**8.76**	**3922**	**8.28**

Table 26: Number of cases and incidence rates of invasive pneumococcal disease as reported to RMPRU by province, South Africa, 2005 and 2006.

Site of specimen	n	%
CSF	1300	33
Blood	2404	61
Other	218	6
	3922	

Table 27: Number and percentage of cases of invasive pneumococcal disease as reported to RMPRU by specimen type, South Africa, 2006.

Province	Susceptible		Intermediately resistant		Resistant		No isolate available
	n	%	n	%	n	%	n
Eastern Cape	106	67	53	33	0	0.0	28
Free State	161	76	50	24	0	0.0	17
Gauteng	1158	66	583	33	2	0.1	327
KwaZulu-Natal	264	63	154	37	2	0.5	42
Limpopo	63	70	27	30	0	0.0	12
Mpumalanga	111	60	72	39	1	0.5	25
Northern Cape	25	74	9	26	0	0.0	3
North West	96	77	29	23	0	0.0	14
Western Cape	332	73	121	27	3	0.7	32
South Africa	**2316**	**68**	**1098**	**32**	**8**	**0.2**	**500**

Table 28: Percentage of penicillin non-susceptible isolates from IPD cases reported to RMPRU in 2006 by province, South Africa.

Province	7-valent serotypes (4, 6B, 9V, 14, 18C, 19F and 23F)	Serotype 6A	Total isolates available for serotyping	% of IPD due to 7-valent serotypes including 6A
Eastern Cape	27	5	43	74
Free State	42	9	76	67
Gauteng	327	54	546	70
KwaZulu-Natal	85	16	137	74
Limpopo	10	1	18	61
Mpumalanga	32	7	49	80
Northern Cape	8	0	11	73
North West	12	6	21	86
Western Cape	80	23	143	72
South Africa	**623**	**121**	**1044**	**71**

Table 29: Percentage of cases reported in 2006 in children less than 5 years of age caused by the serotypes contained in the 7-valent vaccine, South Africa.

DISCUSSION

The overall purpose of the GERMS-SA network is to provide a laboratory-based infrastructure for national surveillance of bacterial and fungal diseases which are considered important from a public health perspective. The surveillance programme has evolved since its inception in 1999; currently, surveillance is performed for nine bacterial and fungal pathogens causing pneumonia, meningitis and enteric infections. The pathogen-specific reports contained within the results section of this Annual Report provide an overview of important disease trends detected by the system in 2006.

To contextualise the reported findings, the strengths and weaknesses of a laboratory-based surveillance approach need to be acknowledged (19). A case definition which requires laboratory confirmation greatly enhances the specificity of detected cases but simultaneously limits the sensitivity of the system to detect cases; the case numbers contained within this report are recognised to be minimum estimates of disease. Other limitations of the GERMS-SA surveillance programme have also been recognised. The case definition does not specify residence within South Africa; a small minority of cases may represent imported cases which may lead to over-estimation of disease incidence. Surveillance audits were not randomly performed (most surveillance audits were done at the time of site visits) and were performed for limited time periods; this may have led to erroneous differences in regional distribution of cases. A complete surveillance audit was performed only for the Eastern Cape Province in 2006. Regional differences in surveillance data may also be explained by differing patient access to health care, variable clinician specimen-taking practices and laboratory infrastructure; this requires further investigation. Temporal differences may be explained by variable participation in surveillance activities by laboratories within the network, and epidemic, seasonal and cyclical variations in disease.

The flexibility of the surveillance programme has been demonstrated by the addition of new pathogens in recent years (e.g. cryptococcosis (2005), *Pneumocystis* pneumonia (2006). A critical review of the pathogens currently under surveillance by the network and the methods used to fulfil surveillance objectives as well as a formal evaluation of the surveillance system are short to medium-term goals for the future. The GERMS-SA network provides necessary ties between clinical microbiologists and public health practitioners. Closer links with policy makers need to be forged to ensure that surveillance information is used for action.

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