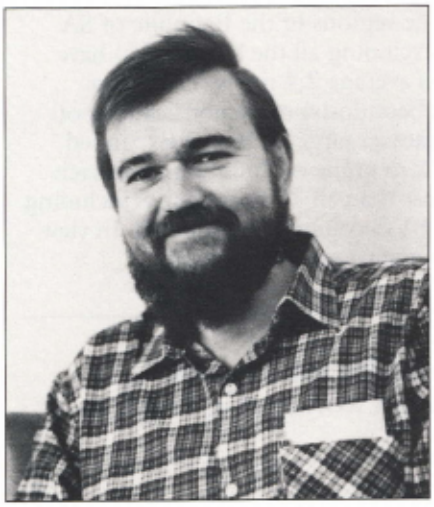
Measles in South Africa: A Comprehensive Interpretation of the Data. Part II. Morbidity-Mortality and Relationships to Age, Population Group, Sex and Geographical Distribution — P Ferrinho, E Buch



Ferrinho P
MBChB, DTM&H, MSc (MED)

New Address:
Department of Tropical Public Health
Institute of Hygiene and Tropical Medicine
Universidade Nova de Lisboa
96 Rua Da Junqueira
1300 Lisboa, Portugal

Buch E
MBBCh, DTM&H, DOH, MSc (MED), MMED (Com Health)
Department of Community Health,
Faculty of Medicine,
University of the Witwatersrand

Curriculum vitae

Paulo Ferrinho had his school education in Mocambique and then went on to the University of Cape Town to obtain the MBChB in 1980. He did his internship at the Groote Schuur hospital in Cape Town and then worked at the Gelukspan Community Hospital from 1982 to 1986. After that he became a registrar in Community Health at the University of the Witwatersrand. He then became the Clinic Manager and Director for Research of the Alexandra Health Centre and University Clinic/Institute for Urban Primary Health Care until 1991. Currently he is at the Institute of Tropical Medicine and Hygiene in Lisbon. Although specialising in Community Health, his professional interest remains in support to primary health care.

Summary

In South Africa (SA) there is a commitment to and indications that resources are being allocated for the eradication of measles. Still there has been no comprehensive review of the epidemiology of the disease in SA. This understanding is important to identify factors and trends to guide public health practice. This series of articles tries to cover this gap.

Part I reviews briefly the international literature on the epidemiology of the disease and describes the methodology followed, the sources of data and analysis strategy. The other articles review South African reports on morbidity-mortality and relationships to age, population group, sex and geographical distribution (part II); part III reviews other factors influencing measles morbidity and mortality in SA (protein-energy-malnutrition, age at infection, urbanisation, socio-economic status and health care) and part IV contains appropriate conclusions and recommendations.

S Afr Fam Pract 1992; 13: 208-18

KEYWORDS:
Measles; Data Collection; Age Factors; Sex Factors; Epidemiology; Demography; Disease Outbreaks.

Introduction

In South Africa (SA) measles has a long recorded history of devastating effects.[1,2] Because of renewed opportunities for measles control related to new developments in vaccine technology[3] and to the state's commitment to measles control in SA[4] we analyse the patterns of occurrence of the disease in SA and we study morbidity and mortality data in relation to age, sex, population group and geographical distribution.

Endemicity and Seasonal Distribution

In SA measles is a perennial disease with national peaks of notification in late winter and early spring. Rates are highest in the dry season, ie in September followed by October and then August.[5] The lowest rates occur in February, followed by January and December.[5] Similar patterns are reported for Soweto[6] and Alexandra (unpublished observations). Other areas report different seasonal prevalences.[7,8]

In periurban Western Cape shifting peaks probably represent major population movements related to the relaxation of influx control legislation, in the summers of 1984 to 1987, with the population again stabilizing towards the end of the decade.[9]

The national seasonality hides, therefore, regional patterns which vary according to a number of factors not always entirely clear. We speculate that climate and population mobility probably explain some of the variation in seasonal pattern.

... Measles in South Africa: II

What is apparent is that the current patterns fit with the notion of measles being endemic in SA with patterns and levels of endemicity varying from region to region.

Measles Morbidity and Mortality in South Africa

The review of measles morbidity-mortality is based on data from notifications, active surveillance systems, hospital reports, death certificates and infant mortality studies.

Notified data

After measles notification was introduced,[10] the absolute number of notifications remained low for 1979 because of low reporting, but increased sharply in 1980 and have since remained high. It is the second most commonly notified disease in SA and is the most common in children under five years of age.[5]

Data shows there are clear areas of high incidence

The number of notifications varied from 300 to 2 000 per month (excluding TBVC countries) and averaged 14 292 per year and 1 190 per month between 1980 and 1989.[5,11,12] The incidence of notifications per 100 000 population varied between a high of 78,9 in 1987 and a low of 27,4 in 1989 for the period 1980 to 1989. The notified incidence has shown an overall downward trend, but this does not reach statistical significance.

The average of all annual incidence rates for the past decade (1980 to 1989) is 52,46 per 100 000 population.

Between 1980 and 1989 the absolute numbers of notified deaths varied between a low of 171 cases in 1981 and a high of 494 in 1983, averaging 303 deaths per annum.[5] For the same period, case fatality rates (CFR) based on notifications varied between a low of 1,3% in 1981 and a high of 3,8% in 1989 with an overall rate of 2,2%[5,11,12] The slope of the regression line shows an overall upward trend (not statistically significant). This upward trend is in contradistinction to the notified mortality rate per 100 000 population, which has shown a stable trend over time. The average of the yearly notified mortality for the past decade is 1,10 per 100 000[5,11,12] For 1990 measles was the 4th commonest cause of notified deaths.[13]

Notified measles shows a strong racial differential, the highest rates being for Blacks, and then Coloureds.[5] Most of the notified cases are of the Black population group.

The regions of the Republic of SA (excluding all the homelands) have on average 2,4 times (excluding tuberculosis) more notifications of diseases targeted by the Expanded Programme on Immunization each year than all 10 homelands (including TBVC countries) combined. In view of the roughly equal total populations it was previously concluded that there is a higher notified incidence in the Republic of SA and undernotification in the homelands.[14] This profile is not true for measles. In the 1985 census 43% of the SA population was based in the homelands, while in 1986 60%,[5] in 1989 77%[11] and in 1990 72%[15] of measles notifications came from the same homelands. Data from the National Directorate for Epidemiology suggest that in relation to their share of the population, there is a consistent excess of notifications from the Eastern Cape, KwaZulu and

Measles still account for a heavy workload in hospitals

Table I. Incidence rate for and, case fatality rate (CFR) of measles for Lebowa.

Year	Incidence/100 000		CFR (%)
	Praktiseer	Lebowa	Praktiseer
1984	97	-	1,03
1985	103	127	2,91
1986	60	49	1,43
1987	109	93	1,94
1988	88	77	1,21
1989	-	-	-

... Measles in South Africa: II

Lebowa. We have no reason to believe that case ascertainment and notification are better in these areas than in the rest of the country.

Data from Lebowa, Kangwane, Kwandebele, Gazankulu, Northern Transvaal, Orange Free State and Eastern Cape is presented elsewhere.[16] Table I also reflects some previously unpublished data from Lebowa (MAR Selahle, personal communication, 1990). It is again apparent that blacks in the Eastern Cape and Lebowa are again singled out as at high risk.

The population distribution (1970) of the 4 independent homelands, Bophuthatswana, Ciskei, Transkei and Venda, was respectively 26%, 15%, 51% and 8%, while their share of measles notifications was 0,5% 1,6%, 73% and 23% for 1989 and 0,1%, 2,9%, 95,2% and 1,8% in 1990, showing a clear excess of cases for Transkei (1989 and 1990) and Venda (1989). Personal knowledge of some of the areas and contact with professionals working in the others allow speculation that notification in either Venda or Transkei is not better than in the other homelands. To what extent the figures reflect true geographical differentials rather than different phases in the epidemic cycle is not clear. Still the consistently low notification rate for Bophuthatswana is in keeping with the high vaccination uptake reported by independent researchers for different regions of the homeland.[17-27]

For the past 3 years the Ciskei reported significant success in promoting universal vaccination to reduce measles morbidity.[28] This is reflected in a reduction of notifications since 1986. The extent to which this is just a cyclical

Table II. Reported measles cases and case fatality rates (CFR) in Transkei Hospitals, 1987.

Hospital	Cases	Deaths	CFR (%)
All Saints	916	118	12,88
Bambisana	334	9	2,69
Butterworth	119	1	0,84
Cala	147	10	6,80
Canzibe	294	25	8,50
Cofimvaba	173	9	5,20
Empilisweni	181	2	1,10
Glen Grey	442	25	5,66
Greenville	90	1	1,11
Holy Cross	539	36	6,68
Madwaleni	433	15	3,46
Mary Terese	325	2	0,62
Nessie Knight	174	24	13,79
Sipeto	132	3	1,74
St Barnabas	115	10	8,70
St Elizabeth	620	28	4,52
St Lucy's	322	2	0,62
St Patric's	159	4	2,52
Tayler Bequest	373	10	2,68
Umlami	474	1	0,21
Umtata	325	83	25,54
Zitulele	342	21	6,14
TOTAL	7 029	439	6,25

Note: The following hospitals are excluded as no deaths are reported: Isilimela, Mt Ayliff, Rietvlei, St Margaret's, Tafalofefe.

... Measles in South Africa: II

variation of the epidemic cycle or a real success in controlling the illness is again not clear.

Data for Transkei in 1987 is presented in Table II,[29] reflecting the magnitude of the problem in this region, where vaccination services have reportedly not been functioning well.[30]

Regional notified mortality data, reported elsewhere[16] reflects a high CFR for Blacks in the Northern Transvaal and the Eastern Cape and a dropping CFR in Gazankulu and the Eastern Cape.

Active surveillance data

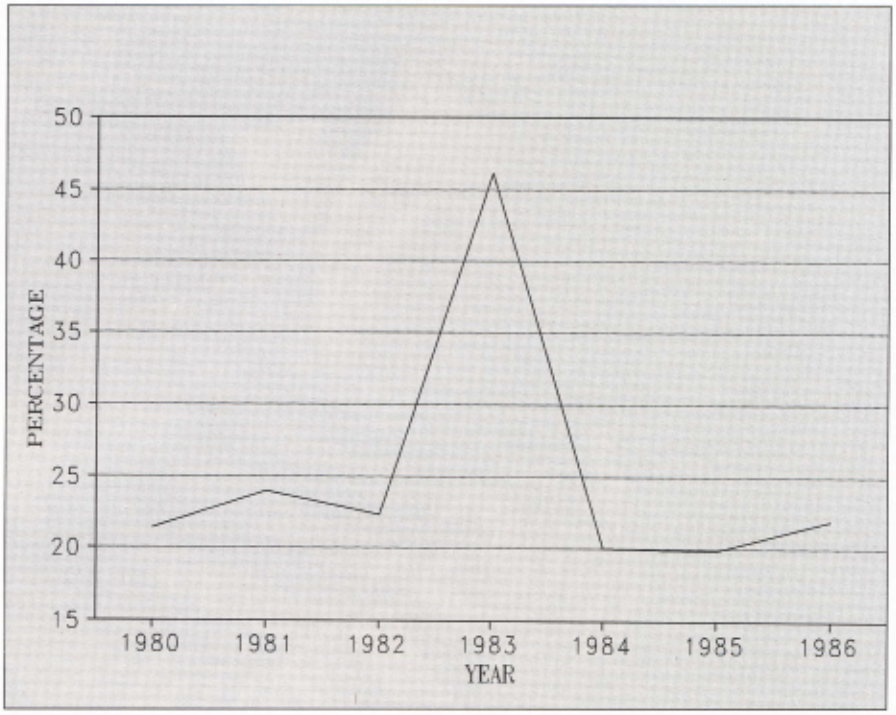
The use of an active surveillance system in Benoni and Johannesburg revealed a rate of measles notification for Benoni 15 times in excess of the Johannesburg rate.[31] The reason for this differential is not entirely clear but it could be related to the fact that Benoni included squatter populations in their surveillance, while in Johannesburg this was usually excluded.[31]

The overall CFR for the cases studied in the Johannesburg-Benoni surveillance system was 3%, a figure comparable to the CFR for notifications, but much lower than that reported from hospitals.[31]

Hospital reports

Some hospitals report a decreasing workload due to measles admissions while others report the reverse. The reasons for this will be explored. In many areas hospitals are the only sources of notification. This applies to the data presented in Tables I and II.

Figure 1. Notified deaths as percentage of certified deaths



Review of admissions to the City Hospital for Infectious Diseases in Cape Town revealed an enormous increase in the number of measles admissions between 1950[32] and 1986.[33] The 1973 CFR was 8%, 9% for Coloureds, 6% for Blacks and 0% for Whites. The overall rate was 8%.[32] For 1985 to 1986 the CFR was 4%.[33]

At Baragwanath in Soweto, between 1986 and 1989 measles was the third or fourth reason for paediatric admissions.[34] In 1986 it accounted for 11,8% of all inpatient deaths, 15,0% in 1987, 10,6% in 1988 and again 10,6% in 1989.[35]

At Ga-Rankuwa Hospital measles accounted for 4,8% of all paediatric admissions in 1986, 9,6% in 1987, 4,5% in 1988 and 1,2% in 1989.[36] From 1986 to 1989 measles was amongst the 5 major causes of death every year; during 1986 measles accounted for 16,9% of paediatric deaths with a CFR of 8,1%; during 1987 for 17,9% of paediatric deaths with a CFR of 7,1%; during 1988 for 10,8% of paediatric deaths and a CFR of 6,6% and for 1989 the equivalent figures were 15,1% and 10,2%.[36]

At Elim Hospital, in Gazankulu, the proportion of admissions to the children's wards attributable to measles dropped from approximately 10% of the total paediatric admissions in 1976-1981 to 1% in 1986.[37,38] During 1976-1981 measles accounted for 13% of all paediatric

... Measles in South Africa: II

inpatient deaths (CFR=8%).[37] In 1985-1986 there were no deaths attributable to measles, apparently as a result of improved vaccination coverage.[39]

In 1987, the CFR for 22 Transkeian hospitals varied between 0,2% and 25,5% (overall 6,3%). The high rate observed for Umtata Hospital, could be attributed to its status as both a referral and general hospital for an overcrowded urban area.[29]

At the Gelukspan Community Hospital, in Bophuthatswana, several reviews of hospital mortality fail to identify measles as a cause of childhood mortality.[18 20,39]

At Moroka Community Hospital, also in Bophuthatswana, the 1982 hospital report describes the number of measles admissions between 1978 and 1982 (597 for 1978, 183 for 1979, 460 for 1980, 128 for 1981 and 117 for 1982). More than half of the cases were admitted from contiguous farm areas, not legally part of Bophuthatswana and without health services for the black population.[40] A published review of mortality, from Moroka Hospital in Bophuthatswana, 1983, reports one death due to measles out of 237 deaths in the age group 0 to 2 years.[40]

Certified mortality

In this section death certificate data on measles mortality was analyzed by calendar year and racial group for 1970 to 1986. Data for Blacks is available only from 1979.

Figure 1 shows that notified measles deaths are consistently less than half of the certified deaths although the overlap between the two data sets was never studied.

Measles is the 2nd most commonly notified disease in South Africa

The certified mortality rate per 100 000 population (all population groups) shows an upward trend from 1981 (fig 2).

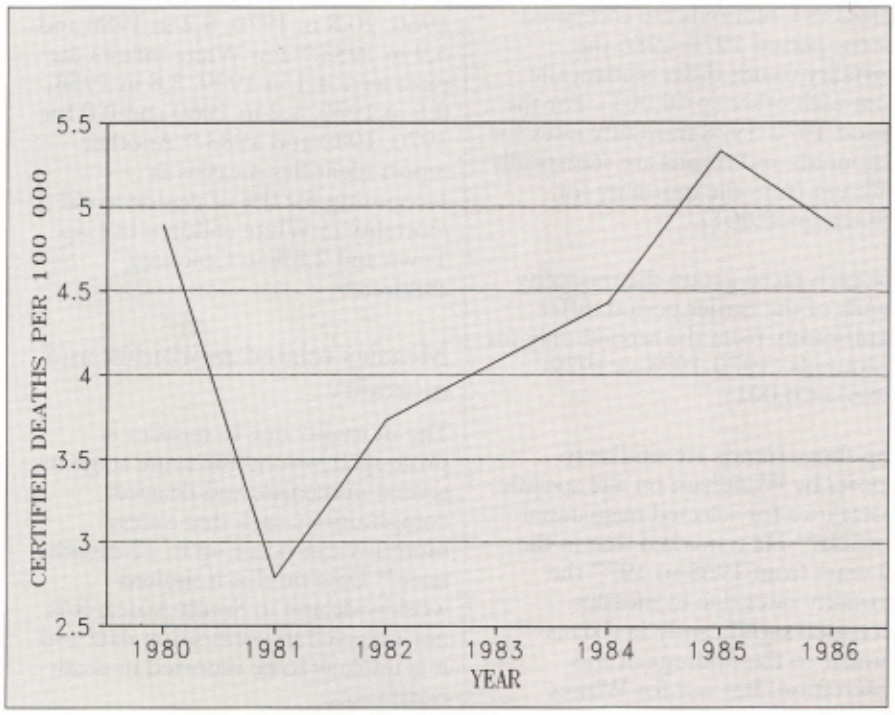
For certified deaths there is a racial differential. Most of measles deaths certified since 1979 are for Blacks (fig 3).

Measles mortality rates for Blacks are higher than for all other racial groups, despite the fact that the cause of death in Blacks is more likely to remain undefined.[41-43] The mortality rates are intermediary for Coloureds and equally low for Asians and Whites, although in the early 1970s the Asian mortality rate was much higher than for Whites.

With exclusion of the Blacks all the population groups show statistically significant decreases in their measles mortality for the period 1970-1986. For Blacks, although there is a positive regression slope, the change is not statistically significant.

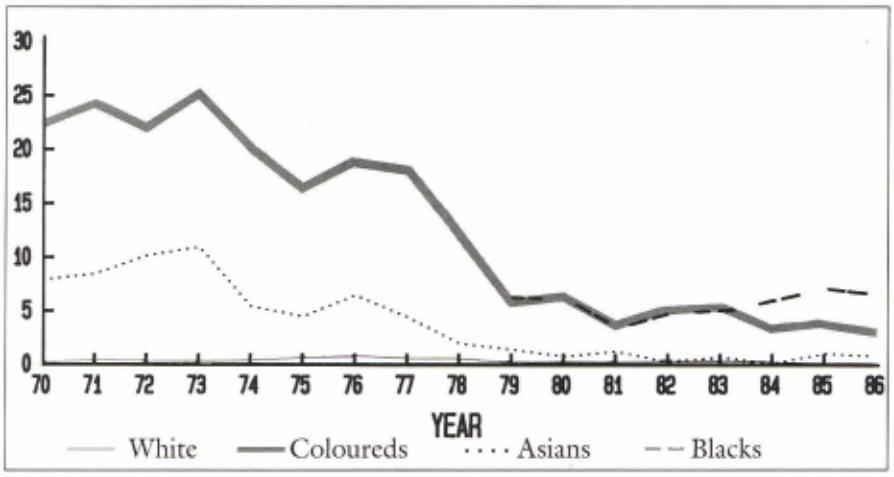
The data is further analysed for the periods 1970-1978 and 1979-1986 *or* 1970-1979 and 1980-1986.

Figure 2. Certified mortality rate per 100 000 population



... Measles in South Africa: II

Figure 3. Measles mortality rate (per 100 000 Population) in the RSA 1970-1986



1970-1978 there is no data for Blacks.

TBVC countries are excluded.

During the seventies statistically significant trends are observed for: Whites (positive regression line slope, 1970-1978, r=0,696, p=0,035); Asians (1970-1978 and 1970-1979; goodness of fit is better for the second period (r=-0,835, p=0,001) than for the first (r=-0,773, p=0,012)); and Coloureds (1970-1978 and 1970-1979; goodness of fit is better for the second period (r=-0,859, p=0,001) than for the first (r=-0,832, p=0,003).

For the eighties all the trends are negative, with the exception of the Black mortality which is positive. The only regression slope reflecting statistically significant trends is the one for Coloured mortality rates for the period 1979-1986 (r=-0,727, p=0,039).

When mortality rates for Coloureds vs Whites, Asians vs Whites and Asians vs Coloureds are compared for the period 1970-1986 the mortality trends differ statistically from each other (p<0,001). For the period 1970-1978 mortality rates for Coloureds and Asians are statistically different from the mortality for Whites (p<0,001).

For each racial group the mortality trends of the earlier period differ significantly from the second only for Coloureds (1970-1978 vs 1979-1986) (<0,001).

The above trends are similar to reports by Wyndham on age specific mortalities for selected magisterial districts.[44] He remarked that in the 10 years from 1968 to 1977 the mortality rates due to measles decreased significantly in Asians (similar to the findings of this dissertation) but not for Whites (again similar to the findings reported in this article) or Coloureds (in contrast to our results), and he suggests that the campaign to reduce mortality was largely unsuccessful.[45] Moodie reports an improvement of the Coloured rate to 6,3 per 100 000 for the period 1978 to 1982[46] (similar to our findings).

Infant mortality reports

Infant mortality has received a lot of attention as an indicator of health in general and child health in particular.[47-53] Three of the recent infant mortality studies analyse causes of infant deaths.[47,50,52]

A report ranks measles as the second commonest cause of mortality of Coloured infants in 1983. The report also shows that the IMR for measles in Coloured children has varied since 1938, when it was 16,9 per 1 000 live births, to 9,6 in 1950, 12,6 in 1960, 20,8 in 1970, 8,2 in 1980 and 6,9 in 1983.[50] For White infants the rates were 4,1 in 1929, 3,8 in 1938, 0,5 in 1950, 1,2 in 1960 and 0,0 for 1970, 1980 and 1983.[50] Another report identifies measles as accounting for 0% of postneonatal mortality in White children in Cape Town and 2,8% in Coloured children.[52]

Measles related morbidity and mortality

The mortality due to measles is prolonged beyond the acute stage by several immediate and delayed complications such that excess mortality can occur up to 12 months later.[54] Data on this is limited worldwide and in South Africa. It is not reflected in notification data and it is unlikely to be reported in death certificates.

... Measles in South Africa: II

In SA, hospital reports of post-measles morbidity and mortality are associated to protein-energy-malnutrition,[55-63] diarrhoea[55,59,60] and respiratory infections.[32,33,55-65]

It has actually been argued that measles vaccination is such an important measure to control diarrhoea in developing countries that a significant proportion of cases could be prevented by effective vaccination against measles.[66] If we assume that in 1984 only 30% measles cases were notified, then the expected true incidence for SA was 50 000. Again if we assume that 40% had diarrhoea and that 15% of these died,[67] then 20 000 episodes and 3 000 diarrhoeal deaths were associated with measles. Using diarrhoea prevalence and mortality predictions for diarrhoeal diseases for SA[67] we can calculate that prevention of measles would prevent 20%-25% of all diarrhoeal deaths and less than 5% of all diarrhoeal episodes.[9]

In many areas, hospitals are the only sources of notification

Post-measles complications are related to the prevalence of vitamin A in the community. It seems that in South Africa vitamin A deficiency is common in several areas.[59,60,68-74] In these areas measles may have serious consequence for children in terms of high mortality and blindness. Blindness present in children seen in the Elim Health ward was in 41% of the cases associated with measles and malnutrition.[72-74]

Finally a rare complication of measles that, for no obvious reason, is relatively common in the Cape, is subacute sclerosing panencephalitis.[75-82]

Conclusions

The measles morbidity data suggests that there are clear areas of high incidence. This is reflected when both smaller, contiguous, geographical areas (Johannesburg and Benoni) and the work-load of hospitals are considered.

High notification areas are likely to represent areas where notifications are also a fraction of the truth and, as discussed later, where vaccine coverage is poor. We have no reason to believe that notifications are better in these than in other areas.

Notification data for measles should, therefore, not be lumped together but reported for health districts. If this is done timeously it will allow for energetic and prompt action to be directed at areas of high notification. A possible mechanism for this would be the deployment of a Health Information Officer in each health district to assist management of these districts with information of relevance for the operation of primary health care services. One of the duties of this officer could be to analyse notification data as reported and to identify a threshold number over which the full strength of public health interventions should be mobilised.

While the notified incidence of measles has shown a consistent drop, although not statistically significant, since 1980, the mortality data has not been so encouraging.

Measles carries a high CFR in South Africa. National data based on notifications shows an upward trend in the CFR (not statistically significant), although some regional data do show clear and consistent downward trends.

The notified mortality remains around 1 per 100 000 with occasional peaks. This is very similar to the pattern of certified death rates, with rates starting to come down in the 1970s and then stabilizing in the 1980s, indicating the 70s as a decade of substantial gains for all population groups except Whites (no data for Blacks) in terms of measles mortality, although each group started with different baselines (high for Coloureds and Asians and low for Whites). The 1980s represented a period of further gains for Coloureds, of stabilization for Blacks and Asians and of reduced mortality for Whites.

Measles deaths as a share of IMR seem to be on the decrease.

Hospital data is not easy to interpret. They are dependent on the nature of the hospital (academic, infectious diseases, particular interest of the staff, etc), on the number of hospitals serving one community, on measles admission policies and on the lack of health care in some rural communities that results in admissions to hospitals in contiguous health wards. What the data tell us is that measles still accounts for a

Data from the Transkei shows that vaccination services have not been functioning well

signficant workload in those hospitals for which data are available. Assuming that the hospital data on trends over time are generalisable, it is apparent that downward shifts are associated with successful vaccination efforts in the community served by the hospital (Ga-Rankuwa and Elim Hospitals) and upward shifts seem to be associated with communities with a large and growing urban poor sector (City Hospital in Cape Town). Common to most reports are CFRs in excess of 5%. Some report CFRs that are decreasing over time in the presence of increasing admissions for measles (City Hospital in Cape Town). This could reflect more liberal admission policies or changes in treatment protocols. Others report an increasing or stable CFR in the presence of dwindling numbers of admissions (Ga-Rankuwa Hospital), possibly reflecting more stringent admission criteria. Decreases in both admissions and mortality are likely to reflect a successful immunization strategy in the community served by the hospital, with little influx of non-vaccinated residents.

Very little is known about measles in farm workers. This data is likely to be hidden amongst the figures reported by hospitals not always directly serving the farm worker population but sometimes admitting them because of absence of health services for these workers. This has been the experience of the author in the Gelukspan Health Ward of Bophuthatswana and it is also reflected in the reports of Moroka hospital.

Measles related morbidity is common both in the acute stage and after the acute episode. In SA there are scanty data particularly on post-measles morbidity. Mortality related to acute stage measles complications and to post-measles morbidity is equally underestimated and no data are available. The available data from SA and elsewhere suggest that mortality is actually associated with deficiency of vitamin A.

In summary, measles is a less frequent disease than in the past. Still it remains unjustifiably high in the Coloured and Black population groups, carrying a severe prognosis, particularly for the Blacks. In Lebowa and the Eastern Cape measles remains a common disease with an unacceptably high CFR.

Although the data is limited it seems that amongst the urban poor, measles does carry a particularly severe prognosis.

In present day developing countries measles has been particularly severe in Africa with CFR often exceeding 10%. In the 1960s hospital CFR in West Africa averaged 12% and the equivalent figure for East Africa was 6%.[83,84] The SA mortality pattern reported here is similar to the high CFRs reported from East Africa in the 1960s.[84]

References

1. Burrows EH. A History of Medicine in South Africa. 1st edition. Cape Town: AA Balkema, 1958;143.
2. Brincher JAH. Pro Roy Soc Med 1938; 31: 807.
3. World Health Organisation. Expanded programme on Immunisation, Global Advisory Group: Part 1. Measles control. Wkly Epidemiol Rec 1990; 65 (2): 5-12.
4. The National Health Policy Council, Republic of South Africa. Resolutions 8/89 and 9/89, 20th February 1989.
5. Anonymous. Eighty years of measles notifications. Department of National Health and Population Development,

... Measles in South Africa: II

Pretoria. Epidemiological Comments 1988; 18(6): 2-31.

6. Hukins G. A Preliminary Evaluation of the Effects of the Measles Immunisation Programme on the Incidence of Notified Measles Cases Among Blacks Less Than 15 Years of Age in the Johannesburg Area from 1984 to 1986. A Short Report Submitted to the Faculty of Medicine, University of the Witwatersrand in Partial Fulfilment of the Requirements for the Degree of Master of Medicine in the Discipline of Community Health. Johannesburg 1990.
7. Mutanda-Musoke RW. Causes of Infant Morbidity and Mortality among admitted infants - Glen Grey Hospital between 01.07.85 and 30.06.86. A Short Report Submitted to the Department of Community Health, Faculty of Medicine, University of the Witwatersrand in Partial Fulfilment of the Requirements for the Diploma of Public Health, Johannesburg.
8. Crisp N. Letaba Hospital Primary Health Care Survey. Unpublished report, 1987.
9. Ferrinho P. The Epidemiology of Measles in South Africa. A Comprehensive Health Interpretation of the Data. Dissertation submitted to the Faculty of Medicine of the University of the Witwatersrand, in fulfilment of the requirements for M Med (Community Health), Johannesburg, 1991.
10. Anonymous. Department of Health: Measles Immunization. S Afr Med J 1979; 65: 856-7.
11. Anonymous. Notified medical conditions. Department of National Health and Population Development, Pretoria. Epidemiological Comments 1989; 16(1): 20-3.
12. Anonymous. Notified medical conditions. Department of National Health and Population Development, Pretoria. Epidemiological Comments 1990; 17(1): 16-19.
13. Anonymous. Notifiable medical conditions (January to December 1990) Epidemiological Comments 1991; 18 ((1): 29.
14. Ijsselmuiden CB, Küstner HGV, Barron PM, Steinberg WJ. Notification of five of the EPI target diseases in South Africa. An assessment of disease and vaccination reporting. S Afr Med J 1987; 72: 311-16.
15. Anonymous. Notified medical conditions. Department of National Health and Population Development, Pretoria. Epidemiological Comments 1990; 17(7): 17-19.
16. Anonymous. Measles in South Africa. Department of National Health and Population Development, Pretoria. Epidemiological Comments 1987; 17(4): 2-15.
17. Sutton C. Vaccination coverage of children aged 12-35 months in the Gelukspan Health Ward. Conference paper, Fourth Conference on Priorities in Paediatrics in South Africa, Rustenburg, 7-9 September 1988.
18. Bekkers M, Van der Knaap M. A nutrition survey in Bophuthatswana, February - June 1980. Rotterdam: Institute of Epidemiology, Erasmus University 1980.
19. Oosthoek CHA, Van Hooft IMS. Analysis of the health intervention programme for the under six population of the Gelukspan District July 1980 - June 1982. Rotterdam: Institute of Epidemiology, Erasmus University 1982.
20. Gimbel HL, de Ruiter IPE. GOBI and pre-school child health survey in Bophuthatswana, March - June 1984. Rotterdam: Institute of Epidemiology, Erasmus University 1984.
21. Anonymous. Evaluation of immunization coverage in Molopo District (Bophuthatswana). Department of Health and Social Welfare, Republic of Bophuthatswana, Undated.
22. Strydom SM. Survey of health indicators. Jubilee Community Hospital Bophuthatswana. Unpublished report.
23. Michael K. Report on the health information survey conducted in the Moretele II Region of Bophuthatswana in November 1984. Unpublished report.
24. Kimbowa JW. Evaluation of immunisation coverage in rural areas. A comparative study in two rural districts (Taung and Gelukspan). S Afr J Epidemiol Infect 1986; 1: 48-51.
25. Ferrinho P, Gear JSS, Reinach SG. Some aspects of vaccination coverage in the Gelukspan Health Ward. S Afr Med J 1987; 72: 341-2.
26. Sutton CJ, Edginton ME. Vaccination coverage of children aged 12-35 months in the Gelukspan Health Ward. S Afr J Epidemiol Infect 1990; 5: 52-4.
27. Sebati LM. Vaccination coverage of children aged 12-36 months in the Odi Health Ward - Bophuthatswana. A Short Report Submitted to the Department of Community Health, Faculty of Medicine, University of the Witwatersrand in Partial Fulfilment of the Requirements for the Diploma of Public Health, Johannesburg 1989.
28. Thomas T, Kibel MA. Measles vaccination campaign - 1990. S Afr Med J 1990; 77: 1-2.
29. Department of Health, Transkei. Annual Report 1987. Umtata.
30. Tshibangu NN. Immunisation and viral disease in Transkei. S Afr Med J 1987: 71: 90-2.
31. Padayachee N, Schoub B, Hurwitz, Evans A, De Beer M, Wagstaff L, Ijsselmuiden C, Martin D, Johnson S, Gruntner I, Naidoo S. A descriptive study of measles in Johannesburg and Benoni. S Afr J Epidemiol Infect 1990; 5: 24-6.
32. Dick B. The provision of measles vaccine for an urban population. S Afr Med J 1975; 48: 1507-13.
33. Hussey G, Reynolds LG, Kettles AN. Measles in Cape Town. Conference paper, 6th Conference of the Epidemiological Society of Southern Africa, Cape Town, 14-15 May 1987.
34. Stein H, Rosen EU. Changing trends in child health in Soweto. The Baragwanath Hospital picture. S Afr Med J 1980; 58: 1030-2.
35. Harrisberg J, Radcliffe M, Kala U, Hartman E, Bolton K. Measles outbreak at Baragwanath Hospital - a plea for action. S Afr Med J 1988; 73: 62
36. Wensing RTM, Wekke JVD. Goldfields Nutrition Unit Follow-up Study, 1989-1990. MEDUNSA 1990.
37. Ijsselmuiden CB. Beliefs and practices concerning measles in Gazankulu. S Afr Med J 1983; 63: 360-3.
38. Crisp NG, Ijsselmuiden CB, De Swardt R, Steyn MM, Gibbs DM, Tshabalala ET. Provision of Immunisation - the Gazankulu experience. S Afr Med J 1987; 72: 345-8.

39. Ferrinho P. Paediatric Inpatient Statistics in a Rural Hospital. S Afr Med J 1988; 73: 681-2.
40. Medical Superintendent. Moroka Community Hospital Health Ward Annual Report, 1982. Department of Health and Welfare, Republic of Bophuthatswana, February 1983.
41. Bradshaw D, Botha H, Joubert G, Pretorius JP, van Wyk R, Yach D. Review of South African Mortality (1984). Medical Research Council, Technical Report no. 1, Parow, May 1987.
42. Botha JL, Bradshaw D. African vital statistics - a black hole? S Afr Med J 1985; 67: 977-81.
43. Kielkowski D, Steinberg M, Barron PM. Life after death - mortality statistics and the public health. S Afr Med J 1987; 76: 672-5.
44. Wyndham CH. Leading causes of death among children under 5 years of age in the various population groups of the RSA in 1970. S Afr Med J 1984; 66: 717-18.
45. Wyndham CH. Trends in the mortality rates for the ten leading causes of death among White, Coloured and Asian children under 5 years of age in the RSA, 1968-1977. S Afr Med J 1984; 66: 719-25.
46. Moodie JW. Measles in the RSA. Supplement to the S Afr Med J 1986/10/11;57-60.
47. Kearney M. Infant and child mortality and morbidity: Cape Divisional Council. Conference paper, Third Annual Conference on Priorities in Paediatrics Care in South Africa, Wigwam Hotel, Rustenburg, September 9-11, 1987.
48. Rip MR, Bourne DE. The spatial distribution of infant mortality rates in South Africa, 1982. S Afr Med J 1988; 73: 224-6.
49. Rip R, Bourne DE, Woods DL. Characteristics of infant mortality in the RSA 1929-1983. Part I Components of the white and coloured infant mortality rate. S Afr Med J 1988; 73: 227-9.
50. Rip R, Bourne DE, Woods DL. Characteristics of infant mortality in the RSA 1929-1983. Part II. Causes of death among white and coloured infants. S Afr Med J 1988; 73: 230-2.

... Measles in South Africa: II

51. Yach D. Infant mortality rates in urban areas of South Africa, 1981-1985. S Afr Med J 1988; 73: 232-4.
52. Molteno CD, Ress E, Kibel MA. Early childhood mortality in Cape Town. S Afr Med J 1989; 75: 570-4.
53. Molteno CD, Kibel MA. Postneonatal mortality in the Mastroosberg Divisional Council area of the Cape Western Health Region. S Afr Med J 1989; 75: 575-8.
54. Clemens JD, Stanton BF, Chakraborty J, et al. Measles vaccination and childhood mortality in rural Bangladesh. American Journal of Epidemiology 1988; 1289: 1330-9.
55. Wittenberg DF. Measles associated diarrhoea. Conference paper, Fourth Annual Conference on Priorities in Paediatric Care in South Africa, Wigwam Hotel, Rustenburg, September 7-9, 1988.
56. Wesley AG, Sutton JB, Widrich AJ. The aetiology of pneumonia associated with measles in Bantu children. S Afr Med J 1971; 45: 1402-4.
57. Orren A, Kipps A, Dowdle EB, Shearing S, Falls E. Serum complement concentrations, nutritional status and the outcome of measles and measles pneumonia. S Afr Med J 1979; 55: 538-43.
58. Beckford AP, Kaschula ROC, Stephen C. Factors associated with fatal cases of measles. A retrospective autopsy study. S Afr Med J 1985; 68: 858-63.
59. Hussey GD, Klein MA. A randomised controlled trial of vitamin A in children with severe measles. N Engl J Med 1990; 323: 160-4.
60. Klein MA, Hussey GD. Vitamin A reduces morbidity and mortality in measles. S Afr Med J 1990; 78: 56-7.
61. Wesley A Coovadia HM, Watson AR. Immunization against measles in children at risk for severe disease. Transactions of the Royal Society of Tropical Medicine and Hygiene 1979; 73: 710-15.
62. Scragg JN, Rubridge CJ. Patterns of disease in Black and Indian children in Natal. S Afr Med J 1978; 54: 265-70.
63. Kipps A, Kaschula ROC. Virus pneumonia following measles. S Afr Med J 1976; 50: 1083-8.
64. Kaschula ROC, Druker J, Kipps A. Later morphologic consequences of measles: a lethal and debilitating lung disease among the poor. Reviews of infectious diseases 1983; 5: 395-404.
65. Schonland M. Strong ML Wesley A. Fatal adenovirus pneumonia. Clinical and pathological features. S Afr Med J 1976; 50: 1748-51.
66. Feachem RG, Koblinsky MA. Interventions for the control of diarrhoeal diseases among young children: measles immunization. Bull WHO 1983; 61: 641-52.
67. Yach D, Strebel PM, Joubert G. The impact of diarrhoeal disease on childhood deaths in the RSA, 1968-1985. S Afr Med J 1989; 76: 472-5.
68. Fairney A, Sloan MA, Patel KV, Coumbe A. Vitamin A and D status of Black South African women and their babies. Human Nutrition: Clinical Nutrition 1987; 41C: 81-7.
69. Kuming BS, Politzer WM. Xerophthalmia, protein-calorie malnutrition and infections in children. Br J Ophthamol 1967; 51: 649-66.
70. Hill JC, Maske R, van der Walt S, Coetzer P. Corneal disease in rural Transkei. S Afr Med J 1989; 75: 469-72.
71. Argent AC, Rothberg AD, Kuyl J. Vitamin A and zinc status of mother-infant pairs at three South African hospitals. Pediatric Rev Commun 1989; 3: 343-50.
72. Bucher PJM, Ijsselmuiden CB, Hadley A. Legal blindness in the northern Transvaal. Infama 1988; 28: 9-11.
73. Ijsselmuiden CB, Bucher PJM. Prevalence and causes of blindness in the northern Transvaal. (Abstract). S Afr J Epidemiol Infect 1988; 3 suppl: S4.
74. Bucher PJM, Ijsselmuiden CB. Prevalence and causes of blindness in the northern Transvaal. Br J Ophthalmol 1988; 72: 721-6.
75. Mackenzie DJM, Kipps A, McDonald R. SSPE in Southern Africa. S Afr Med J 1975; 49: 2083-6.
76. McDonald R, Kipps A, Leary PM. SSPE in the Cape Province. S Afr Med J 1974; 48: 7-9.
77. Kipps A, Naude WT, Smith T, Mackenzie DJM, McDonald R. Measles antibodies in the serum and cerebrospinal fluid in subacute sclerosing panencephalitis. S Afr Med J 1974; 48: 10-12.
78. Bhettay E, Kipps A, McDonald R. Early onset of SSPE. J Pediatr 1976; 89: 271-2.
79. Moodie JW, Philcox D, Naude WT, Lipper S, Kipps A. Atypical presentation of subacute sclerosing panencephalitis in 3 patients. S Afr Med J 1980; 58; 968-71.
80. Moodie JW, Mackenzie DJM, Kipps A. Subacute sclerosing panencephalitis (SSPE) in southern Africa: recent additions to the SSPE register. S Afr Med J 1980; 58; 964-7.
81. Naude WT, Moodie JW, Kipps A, Stannard LM. Virological investigation of a brain biopsy from a case of SSPE. S Afr Med J 1977; 51: 939.
82. Kipps A, Dick G, Moodie JW. Measles and the central nervous system. Lancet 1983; ii: 1406-10.
83. Morley DC, Martin WJ, Allen I. Measles in West Africa. W Afr J Med 1967; 16: 24-31.
84. Morley DC, Martin WJ, Allen I. Measles in East and Central Africa. East Afr Med J 1967; 44: 497-508.