Medical inpatient mortality at Groote Schuur Hospital, Cape Town, 2002 - 2009

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Background. Despite the challenges facing healthcare in South Africa, empirical insights into the performance of healthcare services over time are scarce.
Methods. We analysed first admissions of adult medical inpatients to Groote Schuur Hospital, Cape Town, from January 2002 to July 2009. Data included age, sex, medical specialty, and date of admission and discharge. We used population group and hospital billing codes as proxy measures for socio-economic status (SES). We calculated the duration of stay in days from the date of admission to discharge, and inpatient mortality rates per 1 000 patient days. Poisson regression was used to estimate mortality rate ratios (MRR) in unadjusted analysis and after adjusting for potential confounders.
Results. There were 42 582 first admissions. Patient demographics shifted towards a lower SES. Median age decreased from 52 years in 2002 to 49 years in 2009, while patients aged 20 - 39 years increased in proportion from 26% to 31%. The unadjusted proportion of admissions which resulted in in-hospital deaths increased from 12% in 2002 to 17% in 2009. Corresponding mortality rates per 1 000 patient days were 17.0 (95% confidence interval (CI) 15.9 - 18.3) and 23.4 (95% CI 21.6 - 25.4), respectively (unadjusted MRR 1.37; 95% CI 1.23 - 1.53). Annual increases in mortality rates were highest during the first 2 days following admission (increasing from 30.1 to 50.3 deaths per 1 000), and were associated with increasing age, non-paying patient status, black population group and male sex, and were greatest in the emergency ward (adjusted MRR 1.73, comparing 2009 with 2002; 95% CI 1.49 - 2.01).
Discussion. Increasing medical inpatient mortality rates at a large South African academic hospital were most marked during the first 2 days after admission and appeared greatest among emergency medical inpatients.

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Over the past decade, the public health system in South Africa (SA) has struggled to develop and extend its services in the face of a complex burden of disease.[1] Today this public health system provides care to more than 80% of the population. With *per capita* public health expenditure markedly less than that of the private healthcare system, expanding access to services to marginalised populations remains a challenge nationwide.[2] During the same period the HIV/AIDS epidemic has spurred morbidity and mortality, particularly among young adults, with reductions in lifespan that are only partially reversed with the availability of antiretroviral therapy.[3] In parallel, there is a growing burden of chronic lifestyle-related diseases (in particular cardiovascular conditions and unprecedented levels of obesity), the full health effects of which are only beginning to manifest at a population level.[4,5]

This unique burden of disease has placed stress on a public healthcare system that seeks to increase access to services, and limits the country's ability to achieve Millennium Development Goals.[6] Yet, despite the challenges facing our public sector healthcare, there are few empirical insights into the performance of SA healthcare services over time. We investigated temporal trends in hospital mortality using routinely collected data on medical inpatient admissions from a large tertiary hospital in Cape Town.

Methods

Our analysis focused on adult medical inpatients at Groote Schuur Hospital (GSH) – a tertiary academic hospital in Cape Town. An historic centre of excellence in SA,[7] GSH has 174 medical inpatient beds and serves a catchment population of approximately 1.5 million people as part of a network of primary healthcare (PHC) clinics and secondary hospitals. Ward facilities include general medical wards (with a short-stay medical ward and long-term medical inpatient beds) as well as sub-specialist services, including intensive care, dialysis and acute coronary care wards.

Facility management and the Research Ethics Committee of the University of Cape Town granted permission to use anonymous patient information from the hospital admissions database. Data available included basic demographic information (such as age and sex) and hospital information (medical specialty, dates of admission and discharge). Given the significant inequalities in socioeconomic status (SES) across SA,[8] we used population group (a racially based marker of historical discrimination) and hospital billing codes (distinguishing patients deemed able to pay healthcare costs from those deemed unable to pay for care) as proxy measures for SES.

We included only individuals' first admissions in the analysis to account for repeated admissions of chronic cases (e.g. for renal

dialysis). We excluded repeat admissions, individuals aged <15 years, and records pre-dating 1 January 2002, when the hospital database was not used regularly. We calculated the duration of stay in days from the date of admission to discharge, and inpatient mortality rates per 1 000 patient days.

Poisson regression was used to estimate mortality rate ratios (MRR) in unadjusted (crude) analysis and after adjusting for potential confounders. Estimates of mortality rates and MRR are accompanied by 95% confidence intervals (CIs).

Results

From January 2002 to July 2009, there were 63 172 admissions to the medical wards identified in the hospital database, representing 42 582 patients. Overall, 9 958 (23%) had more than one admission during this period, accounting for an additional 19 802 admissions. Hereafter, analysis is restricted to the 42 582 first admissions.

Table 1 describes the medical inpatient admissions by calendar year. The number of admissions per month and the duration of stay across all medical wards remained constant over time.

The overall distribution of patients across specialties changed minimally, with a reduction in emergency medicine/short-stay ward inpatients mirrored by an increase in general medical inpatients. Patient demographics shifted towards an increasing proportion of patients of low SES, with an increase in the proportions of patients classified as black and patients deemed unable to pay hospital fees. The median age of patients decreased from 52 years in 2002 to 49 years in 2009, with an increased proportion of patients aged 20 - 39 years (26 - 31%).

Overall, the crude proportion of adult medical admissions which resulted in in-hospital death increased from 12% in 2002 to 17% in 2009. The corresponding mortality rates were 17.0/1 000 patient days (95% CI 15.9 - 18.3) and 23.4/1 000 patient days (95% CI 21.6 - 25.4), respectively (crude MRR 1.37; 95% CI 1.23 - 1.53) (Fig. 1a). The annual increases in mortality rates were highest during the first 2 days following admission (increasing from 30.1 to 50.3 deaths per 1 000), with mortality rates beyond 2 days of admission appearing relatively constant over consecutive calendar years (Fig. 1b).

Mortality rates were highest in the short-stay medical ward (62.0/1 000 patient days; 95% CI 59.9 - 64.2) and respiratory

Table 1. Description of medical inpatient admissions at GSH, January 2002 - July 2009

	2002	2003	2004	2005	2006	2007	2008	2009
Total admissions, *N*	6 489	5 507	5 833	5 270	5 389	5 087	5 542	3 465
Mean admissions per month, *n*	541	459	486	439	449	424	462	538
Medical specialty, *n* (%)								
Emergency medicine/ short stay	2 995 (46)	2 296 (42)	2 517 (43)	1 952 (37)	1 932 (36)	1 680 (33)	2 118 (38)	1 258 (36)
General internal medicine	1 221 (19)	1 123 (20)	1 087 (19)	1 237 (23)	1 229 (23)	1 255 (25)	1 273 (23)	939 (27)
Cardiology	766 (12)	699 (13)	748 (13)	660 (13)	752 (14)	744 (15)	752 (14)	452 (13)
Neurology	393 (6)	339 (6)	339 (6)	308 (6)	305 (6)	341 (7)	316 (6)	169 (5)
Dermatology	208 (3)	198 (4)	226 (4)	241 (5)	221 (4)	229 (5)	248 (4)	147 (4)
Respiratory medicine	263 (4)	205 (4)	176 (3)	141 (3)	182 (4)	134 (3)	163 (3)	93 (3)
Nephrology	177 (3)	164 (3)	170 (3)	192 (4)	163 (3)	163 (3)	172 (3)	118 (3)
Other	476 (7)	483 (9)	570 (10)	539 (10)	605 (11)	541 (11)	500 (9)	289 (8)
Age, median (IQR)	52 (36 - 65)	52 (37 - 65)	50 (35 - 65)	51 (35 - 65)	51 (35 - 65)	50 (35 - 65)	50 (35 - 65)	49 (34 - 64)
Female, *n* (%)	3 399 (52)	2 849 (52)	3 077 (53)	8 202 (53)	2 792 (52)	2 651 (52)	2 956 (53)	1 818 (52)
Population group, *n* (%)								
Black	1 220 (21)	1 041 (20)	1 225 (23)	1 082 (22)	1 148 (23)	1 201 (26)	1 368 (27)	843 (28)
Coloured	3 905 (66)	3 336 (66)	3 422 (64)	3 185 (66)	3 220 (65)	2 972 (63)	3 152 (63)	1 937 (63)
White	737 (12)	631 (12)	630 (12)	539 (11)	556 (11)	4 74 (10)	465 (9)	241 (8)
Asian/Indian	84 (1)	75 (1)	63 (1)	53 (1)	55 (1)	43 (1)	54 (1)	37 (1)
Billing method, *n* (%)								
Non-paying patient	5 533 (85)	4 499 (82)	4 870 (83)	4 513 (86)	4 603 (85)	4 297 (85)	4 780 (86)	3 047 (88)
Paying patient	956 (15)	1 006 (18)	963 (17)	757 (14)	786 (15)	790 (15)	762 (14)	418 (12)
Duration of stay (days), median (IQR)	4 (2 - 8)	4 (2 - 8)	3 (2 - 8)	4 (2 - 9)	4 (2 - 8)	4 (2 - 9)	4 (2 - 9)	4 (3 - 8)
Died during admission, *n* (%)	780 (12)	682 (12)	651 (11)	736 (14)	693 (13)	665 (13)	825 (15)	573 (17)

IQR = interquartile range.

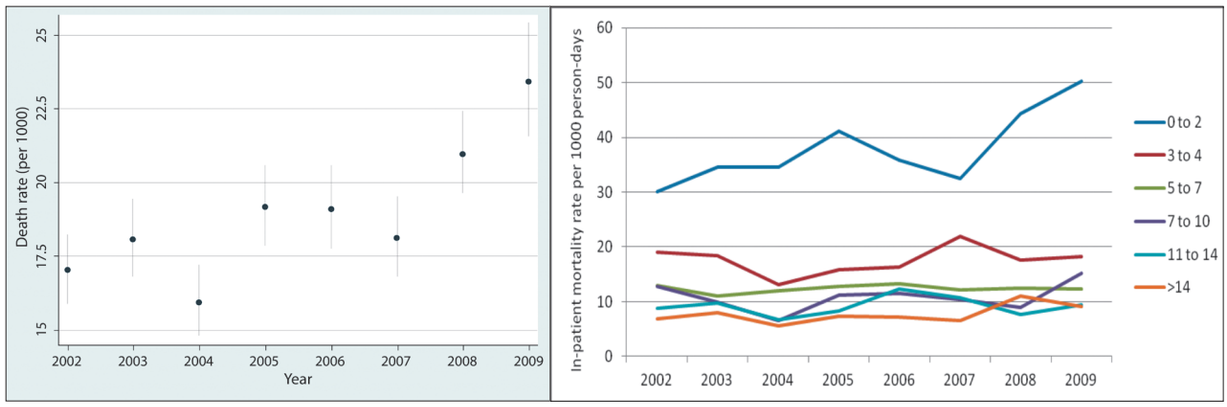

Fig. 1. Mortality rates among medical inpatients at Groote Schuur Hospital, Cape Town, South Africa, (A) by calendar year, and (B) by duration of inpatient stay across calendar years.

Table 2. Poisson regression showing MRRs among medical inpatients at GSH, January 2002 - July 2009

	Panel A: unadjusted estimates		Panel B: adjusted estimates*	
	MRR	**95% CI**	**MRR**	**95% CI**
Year of admission				
2002	1.00	(reference)	1.00	(reference)
2003	1.06	0.95 - 1.17	1.20	1.08 - 1.34
2004	0.97	0.87 - 1.08	1.15	1.03 - 1.29
2005	1.11	1.00 - 1.23	1.45	1.30 - 1.62
2006	1.05	0.94 - 1.16	1.38	1.23 - 1.53
2007	1.01	0.91 - 1.12	1.38	1.23 - 1.54
2008	1.14	1.03 - 1.26	1.36	1.32 - 1.51
2009	1.27	1.14 - 1.42	1.49	1.32 - 1.67
Age (years)	1.02	1.02 - 1.02	1.01	1.01 - 1.12
Female	0.88	0.84 - 0.93	0.87	0.81 - 0.92
Population group				
White	1.00	(reference)	1.00	(reference)
Coloured	1.04	0.94 - 1.14	0.89	0.81 - 0.98
Asian/Indian	0.98	0.73 - 1.34	0.77	0.56 - 1.04
Black	0.89	0.80 - 0.96	1.15	1.03 - 1.28
Billing method				
Non-paying patient	1.00	(reference)	1.00	(reference)
Paying patient	0.59	0.54 - 0.65	0.75	0.68 - 0.83

MMR = mortality rate ratio; GSH = Groote Schuur Hospital; CI = confidence interval.

*Adjusted estimates are from a Poisson model including all covariates shown and medical specialty.

medicine ward (including the respiratory ICU) (34.4/1 000 patient days; 95% CI 31.4 - 37.6). Mortality was lowest among dermatology inpatients (1.0/1 000 patient days; 95% CI 0.7 - 1.4). Increasing inpatient mortality rates were also associated with increasing age, non-paying patient status, black population group and male sex (Table 2). The annual increases in mortality persisted after adjusting for medical specialty and these individual patient characteristics (adjusted MRR comparing 2009 with 2002, 1.49; 95% CI 1.32 - 1.67). In analyses restricted by medical specialty, the annual increases in inpatient mortality were greatest in the emergency medicine/short-stay ward (adjusted MRR 1.73, comparing 2009 with 2002; 95% CI 1.49 - 2.01).

Discussion

These data suggest that medical inpatient mortality rates at a large SA academic hospital have increased over the past decade. Furthermore, the overall hospital mortality rate of 12 - 17% is comparable to rates observed in North America during the mid-19th century and is substantially higher than the 2.1% mortality rate documented in contemporary Massachusetts.[9,10]

These increases in mortality rate are most marked during the first 2 days after admission and appear greatest among emergency medicine/short-stay medical inpatients. These death rate trends appear independent of shifts in the demographic characteristics of medical inpatients. They also reverse a trend of improving inpatient mortality rates for medical patients at GSH, from 21% the 1940s to 10% in the 1980s.[11,12]

Several explanations may help us understand these increases in hospital mortality. First, it is plausible that increasing mortality rates reflect greater morbidity in the populations served by GSH.[13] The increase in mortality between 2002 and 2009 is most notable in the first few days following admission, in keeping with the notion that pre-hospital morbidity is a principal factor in the increase in hospital mortality. In turn, SA's shifting burden of disease presents a significant challenge to healthcare services, with a parallel increase in morbidity related to HIV, tuberculosis (TB) and chronic diseases of lifestyle.[14] At GSH, the decreasing age of medical inpatients over time likely reflects the growing burden of HIV and TB on healthcare services.

Second, increased access to healthcare services may enable individuals with more advanced morbidity to access tertiary care. Since 1994 there has been a movement across SA to increase access to public health services through an expanded PHC platform.[15] This shift to increase accessibility of PHC has also increased access to higher levels of healthcare. Now, patients who were previously too marginalised to access a hospital (and may have died before arriving at GSH) could have greater access to tertiary services.[16] The increase over time in patients of low SES (measured by hospital billing status and population group) is consistent with this idea that requires further investigation.

Finally, increasing inpatient mortality may reflect changes in the quality of medical care. Over the past decade public healthcare resource allocation has shifted to PHC services at the expense of tertiary hospital budgets.[15] While there is no evidence that services at GSH have deteriorated during this period, and hospital mortality rates can be problematic as measures of quality of care,[17] these data cannot rule out this possibility.

This analysis of hospital-wide mortality is unique in sub-Saharan Africa; few public health facilities of the size of our centre have high-quality electronic medical records systems. However, these data remain subject to significant limitations. Measures to understand the reasons for inpatient death, such as the underlying diagnosis and the degree of morbidity upon arrival at hospital, are not available. This analysis also focuses on a single tertiary institution during a 7-year period, and the results should be generalised with caution, particularly given the context-specific nature of health systems.

In summary, mortality among medical inpatients is increasing in this SA tertiary hospital, a trend most marked by increasing deaths soon after admission. This phenomenon likely reflects increasing morbidity of the local population and the increasing accessibility of tertiary healthcare services with the expansion of PHC. These findings point to the challenges facing tertiary hospitals, and healthcare services more generally, in SA.

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