An investigation into the dramatic increase in deaths from gastroenteritis during the summer of 2007/08 at National District Hospital, Bloemfontein, Free State

[a] **Brits H,** MBChB, MFamMed [b] **Joubert G,** BA, MSc
[a] Department of Family Medicine, University of the Free State
[b] Department of Biostatistics, University of the Free State
Correspondence to: Prof Hanneke Brits, e-mail: britsh.md@ufs.ac.za, P O Box 339, Bloemfontein, 9300. Tel: +27-51-401-2939
Keywords: child; death; gastro-enteritis

Abstract

SA Fam Pract 2009;51(5):418-422

Introduction and background: Despite national guidelines and agreed upon admission and referral criteria for children in National District Hospital (NDH), Bloemfontein, the number of children admitted with gastroenteritis (GE) has increased dramatically since December 2007. From the previous year's Child Healthcare Problem Identification Programme (Child PIP) data the increase in GE admissions was evident in NDH. During the preceding year, 123 children were admitted for GE and during the audit period 267. The number of deaths in NDH also increased from an average of 2.25 a month over the past 3 years to 10 a month during January and February 2008.

Aim: The aims of the study were: to determine the causes of death of children in NDH; to determine the relationship between nutritional status, HIV disease, laboratory results, demographic data, time of admission, duration of admission and other diseases or conditions and GE child deaths in NDH; to determine whether doctors adhered to prescribed GE treatment protocols; to determine whether nursing personnel carried out doctors' orders as prescribed; and to identify other factors that contributed to GE deaths.

Methodology: A cross-sectional study design was used. All child deaths, as well as all children admitted with GE to Ward 3 in NDH from May 2007 to April 2008 were included in the study. The first author collected the information on a cause of death form, a data form and an audit tool. As part of the quality-improvement project, 10 items were assessed to determine whether doctors adhered to treatment protocols, and 10 items were assessed to determine whether nurses adhered to nursing orders and basic nursing care. Any other factors that contributed to poor care were also noted.

Results: 1. Cause of death: During this period, 49 children died, 33 (67%) due to GE, 6 (12%) due to tuberculosis (TB), 5 (10%) due to septicaemia, 4 (8%) due to pneumonia and 1 (2%) due to congenital abnormalities. Only 4.1% of the children who died were considered as normal weight for age according to their Road to Health Chart (RTHC). Regarding HIV status, 82.5% of the children who died tested HIV positive. In total, 19.4% of all GE admissions died during this one-year period. 2. GE deaths: Demographic data such as gender and age did not influence the outcome of GE. As expected, severe malnutrition, HIV-positive status and severe dehydration all contributed statistically significantly to high mortality in GE. Severe abnormalities occurred in the laboratory results of most of the children who died and indicated the severity of their disease(s). No specific organisms were cultured from stool specimens and the quality of drinking water in Bloemfontein was declared safe for human consumption. 3. Other factors that contributed to GE deaths: Medical and nursing care were of a high standard and treatment protocols were followed. Pre-admission factors such as transport, non-availability of 24-hour medical services, non-initiation of emergency treatment before referral, and caregivers not realising the severity of the disease need urgent attention to prevent further deaths.

Conclusion: GE contributed to 67% of deaths in the paediatric ward of NDH. Underlying poor nutritional status and/or HIV disease were present in 96% of the GE deaths. In more than nine out of ten cases the doctors and nurses in the hospital rendered medical care in accordance with standard guidelines. Pre-admission factors need to be addressed in order to prevent more deaths.

Ⓟ **Peer reviewed. (Submitted:2008-11-13, Accepted:2009-02-06).**

Introduction

Despite national guidelines[1] and agreed upon admission and referral criteria for children in National District Hospital, (NDH), Bloemfontein, the number of children admitted with gastroenteritis (GE) has increased dramatically since December 2007. This was noticed while collecting Child Healthcare Problem Identification Programme (Child PIP) data. This increase in the number of children presenting with GE and the severity of the disease overburden both Pelonomi (secondary hospital) and NDH in Bloemfontein. The effect was that children who qualified for referral to Pelonomi Hospital could not be transferred because of the shortage of beds in Pelonomi and had to be treated at NDH. The number of deaths in NDH increased dramatically from an average of 2.25 a month over the previous 3 years to 10 per month during January and February 2008 (Child PIP data). During the previous year only four children died in NDH due to acute GE (Child PIP data). This increase urged urgent investigation.

NDH's paediatric ward (Ward 3) uses the Hospital Essential Drug List and Standard Treatment Guidelines[2] for the treatment of children with GE. These guidelines were updated in 2006.

Aim

1. To determine the causes of death of children in NDH.
2. To determine the relationship between nutritional status, HIV disease, laboratory results, demographic data, time of admission, duration of admission and other diseases or conditions and GE child deaths in NDH.
3. To determine whether doctors adhered to prescribed GE treatment protocols.[2]
4. To determine whether nursing personnel carried out doctors' orders as prescribed.
5. To identify other factors that contributed to GE deaths.

Methodology

A cross-sectional study design was used. All child deaths, as well as all children admitted with GE to Ward 3, NDH, from May 2007 to April 2008 were included in the study.

Information was obtained from the clinical records of the patients. The first author collected the information on a cause of death form, a data form and an audit tool. As part of the quality-improvement project, 10 items were assessed to determine whether doctors adhered to treatment protocols, and 10 items were assessed to determine whether nurses adhered to nursing orders and basic nursing care. Any other factors that contributed to poor care were also noted.

All files were traced and could be used for data collection. Routine laboratory results were used in the study and no extra blood was taken for study purposes. Laboratory results were not available for data collection due to the following reasons: it was not indicated in all patients according to standard treatment guidelines, some patients died before the blood could be taken, or blood samples clotted or could not be obtained. As the hospital is an HIV-treatment site, all children are routinely tested for HIV after consent to enable the initiation of antiretroviral treatment as soon as possible.

A standard Road to Health Chart (RTHC) was used to classify children's nutritional status. Weight for age between the 3rd and 97th percentile was regarded as normal, between the 3rd and 60% of the 50th percentile as underweight for age and a weight of less than 60% of the 50th percentile as severe malnutrition.

Some dehydration was regarded as children with no signs of dehydration other than drinking eagerly, *moderate dehydration* was regarded as at least two of the following signs present: (a) restless or irritable, (b) sunken eyes, (c) drinking eagerly, or (d) moderate decrease in skin turgor (< 2 seconds). Children with at least two of the following signs were regarded as having *severe dehydration:* (a) lethargic or unconscious, (b) sunken eyes, (c) drinks poorly or unable to drink, (d) severe decrease in skin turgor (> 2 seconds), or (e) capillary refill time of > 3 seconds.

A pilot study was done on the files of five GE cases of April 2007 to determine whether the data-collection form is appropriate. No changes were required.

The Department of Biostatistics at the University of the Free State analysed the data obtained during the study. Numerical variables were summarised by means and standard deviations or percentiles. Categorical variables were summarised by frequencies and percentages. Risk factors were assessed by relative risks with 95% confidence intervals. Mann-Whitney tests and chi-squared tests were used to determine the statistical significance of findings.

Approval to use patient records was obtained from the Chief Executive Officer of NDH. The Ethics Committee of the Faculty of Health Sciences, University of the Free State, also approved the study.

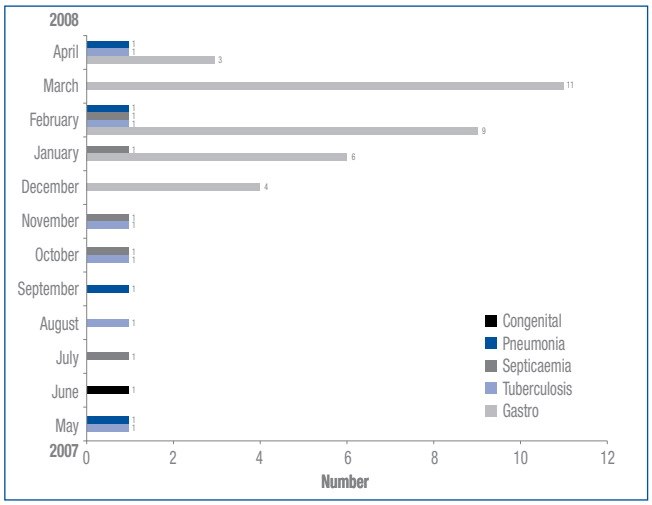
Results

A total of 983 children were admitted to Ward 3, NDH, during the period of study, of which 359 (36.5%) were premature babies admitted for weight gain, 170 (17.3%) were admitted with GE and 141 (14.3%) with pneumonia.

Part 1: Causes of death

During this period, 49 children died, 33 (67%) due to GE (all during the summer season), 6 (12%) due to tuberculosis (TB), 5 (10%) due to septicaemia, 4 (8%) due to pneumonia and 1 (2%) due to congenital abnormalities. Only 4.1% of the children who died were considered as 'normal weight for age' according to their RTHC. Regarding HIV status, 82.5% of the children who died tested HIV positive. In total, 19.4% of all GE admissions died during this one-year period. Figure 1 demonstrates the causes of death per month.

Figure 1: Causes of death per month



Part 2: GE: Admissions and deaths

Demographic data of the children with GE

Males contributed to 57% of the GE admissions. The median age of children admitted was 14 months and varied between 3 months and 97 months. Gender and age did not influence the mortality of GE patients. Table I indicates the town of origin, the hospital(s) that they are supposed to be referred to and the percentage of children who died in NDH from that specific town.

From the previous year's Child PIP data the increase in GE admissions was evident. This is displayed in Figure 2. During the preceding year, 123 children were admitted for GE and during the audit period 267.

Nutritional status

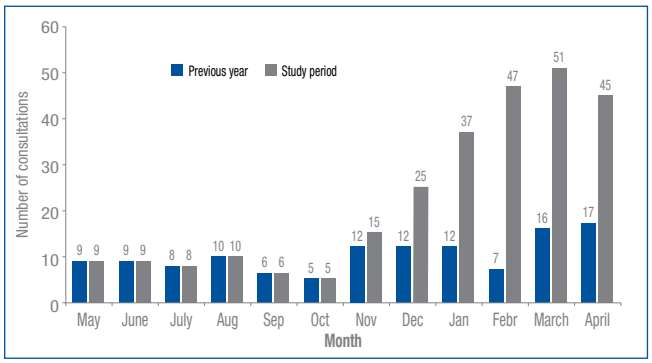
In total, 63.3% of all the GE admissions were considered malnourished according to their RTHC. Table II indicates the nutritional status per category, the incidence of malnutrition per category and the percentage of children per category who died. Children with malnutrition had significantly higher mortality than children with normal nutrition

Table I: Town of referral, appropriate referral hospital and percentage who died due to GE

Town of origin	Appropriate referral hospital	Died (%)
Bloemfontein (n = 126)	National/Pelonomi	15.9%
Dealesville (n = 4)	Hoopstad/Soft border*	0%
Reddersburg (n = 3)	National/Pelonomi	0%
Bultfontein (n = 1)	Hoopstad/Bongani	0%
Welkom (n = 2)	Bongani	0%
Dewetsdorp (n = 1)	National/Pelonomi	0%
Boshoff (n = 8)	Hoopstad/Bongani	12.5%
Botshabelo (n = 4)	Botshabelo/Pelonomi	50%
Thaba Nchu (n = 3)	JS Moroka/Pelonomi	66.7%
Petrusburg (n = 4)	Diamond/Pelonomi	25%
Brandfort (n = 11)	Winburg/Soft border*	36.4%
Soutpan (n = 3)	Winburg	100%

*A soft border town may also refer to another hospital, due to a better transport network.

Figure 2: Comparison with previous year of admissions for GE



($p < 0.0001$); relative risk for underweight for age compared to normal weight for age 2.8 (95% CI 0.8; 9.9); and relative risk for severe malnutrition compared to normal weight for age 10.6 (95% CI 3.4; 33.2).

Table II: Nutritional status of children admitted with GE and deaths per category

Nutritional status	Incidence	Number who died	Percentage who died
Normal (n = 62)	36.7%	3	4.8%
Underweight for age (n = 66)	39%	9	13.6%
Severe malnutrition (n = 41)	24.3%	21	51.2%

Classification of dehydration

From Table III it is evident that the greater the degree of dehydration, the higher the mortality ($p = 0.0103$); relative risk for moderate dehydration versus some dehydration 6.0 (95% CI 0.8; 43.1); and relative risk for severe dehydration versus some dehydration 9.8 (95% CI 1.4; 71.2).

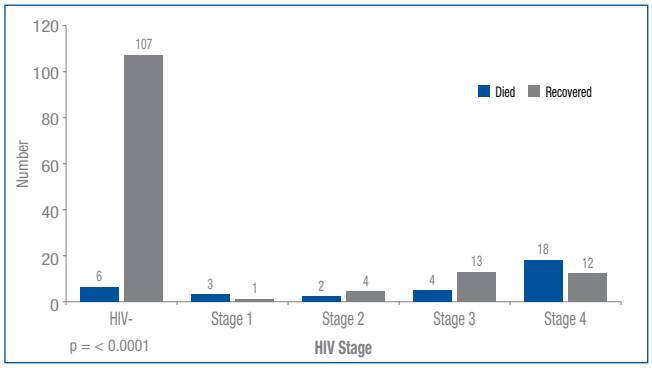
Table III: Classification of dehydration and outcome per category

	Died (%)	Recovered (%)
Some dehydration (n = 31)	3.2%	96.8%
Moderate dehydration (n = 98)	19.4%	80.6%
Severe dehydration (n = 41)	31.7%	68.3%

HIV status and clinical HIV staging

In total, 66% of the children admitted for GE were HIV negative. Only four (15.4 %) of the children who died were HIV negative, of which one was severely malnourished with miliary TB and another one a severely mentally retarded child with bedsores. Figure 3 indicates the mortality of children according to HIV staging.

Figure 3: Comparison of HIV clinical staging and outcome of GE



Dehydration, HIV and malnutrition

In the group of children who died, a combination of two or three of the following were present in 96% of the cases: HIV-positive status, moderate to severe dehydration and malnutrition. Two or three of these factors were present in only 53.4% of the children who did not die.

Laboratory results

Laboratory investigations were performed in accordance with treatment protocols. Stool specimens for MC&S (microscopy, culture and sensitivity) were negative in the majority of cases and no pattern could be detected from the few positive cultures. The water quality in Bloemfontein and surrounding areas was tested and environmental officials declared the water safe for human consumption. Table IV indicates the laboratory results of the children who died and those who recovered.

Time of and duration of admission

The average time children spent in hospital before they were discharged or died was four days, but ranged from hours to 21 days. There was no difference in duration of admission between the children who died and those who recovered. Just more than 50% of admissions occurred after hours, with no statistical difference between the outcome of children admitted during office hours and those admitted after hours.

Other diseases

A co-morbidity of TB, anaemia, kwashiorkor, failure to thrive and HIV encephalopathy contributed statistically significantly to mortality. Table V indicates the prevalence of some co-morbid conditions and the percentage of children who died with both GE and the co-morbid factor present.

Underlying factors such as premature birth, twin pregnancies, cerebral palsy and birth defects were very few and did not contribute statistically significantly to deaths in GE.

Table IV: Laboratory results and outcome of GE

		Median	Range	Reference value	p-value	95% for difference
Na+	Died (n = 33) Recovered (n = 136)	126 mmol/l 134 mmol/l	110–148 114–161	135–47	< 0.0001	-11; -5
K+	Died (n = 33) Recovered (n = 136)	2.2 mmol/l 3.1 mmol/l	1.4–8.2 1.1–6.4	4.1–5.3	0.0125	-1.0; -0.1
Albumin*	Died (n = 22) Recovered (n = 67)	20 g/l 28 g/l	12–39 9–55	33–48	0.0002	-12; -4
Haemoglobin	Died (n = 33) Recovered (n = 132)	10 g/dl 11.3 g/dl	6.8–16.2 4.5–14.6	10.5–13.7	0.0041	-1.8; -0.3
White blood cell	Died (n = 33) Recovered (n = 132)	12.6 x 10^9/l 12.7 x 10^9/l	3.8–29.1 1.5–58.7	6–18	0.7383	-1.9; 2.9
Platelets	Died (n = 33) Recovered (n = 132)	400 x 10^9/l 450 x 10^9/l	28–999 7–999	140–350	0.2574	-142; 38
pH ^	Died (n = 11) Recovered (n = 33)	7.14 7.23	6.82–7.38 6.80–7.39	7.37–7.43	0.0332	-0.23; -0.01

* Only done in children with oedema or severe malnutrition
^ Only done in children with severe dehydration or shock

Table V: Percentage of children with GE and a co-morbid factor present and percentage who died if both factors were present

Condition	Percentage of children with co-morbidity	Percentage of children who died with co-condition	Percentage of children without co-condition who died	p-value
Tuberculosis (n = 24)	14.1	37.5	16.4	0.0244
Anaemia (n = 34)	20	35.29	15.4	0.0088
Kwashiorkor (n = 17)	10	41.18	17.0	0.0253
Failure to thrive (n = 25)	14.7	64	11.7	< 0.0001
HIV encephalopathy (n = 8)	4.7	50	17.9	0.0468
Pneumonia (n = 37)	21.8	27.03	17.3	0.1855
Upper respiratory tract infection (n = 13)	7.6	0	21.0	0.0751

Part 3: Quality-improvement project

Adherence of doctors to protocols

Table VI indicates the 10 criteria evaluated for adherence to the treatment protocol for GE compared between the children who died and those who recovered. Admission criteria were only met in 21% of the children who died and 58% of the children who recovered from GE.

Table VI: Adherence of doctors to protocol items

	Died (n = 33)	Recovered (n = 137)
Admission criteria in NDH met	21%	58%
Correct classification of dehydration	100%	96%
Appropriate special investigations and reaction	100%	98%
Classification of nutritional status	82%	87%
Appropriate antibiotics for co-conditions	73% *	91%
Rehydration fluid 20 ml/kg/h x 4 hours prescribed	97%	99%
Replacement of losses – 10 ml/kg/loss prescribed	97%	100%
Maintenance fluid according to age prescribed	97%	96%
Appropriate introduction of milk/food prescribed	100%	96%
Appropriate follow-up plan in file	100%	100%
Median number of items adhered to	9	9

* Intravenous (IV) access could not be established in three patients in need of IV antibiotics. Antibiotics should only be prescribed for a specific indication and not routinely. An oral antibiotic was used in bloody diarrhoea and IV antibiotics were indicated in children with septicaemia, severe malnutrition or HIV infection.

Adherence of nursing staff to nursing orders and protocols

Table VII indicates the 10 criteria used to evaluate nursing staff and compare the children who died and those who recovered.

Table VII: Nursing adherence to prescriptions

	Died (n = 33)	Recovered (n = 137)
Vital signs recorded in file	100%	99%
Reactions to vital signs recorded	97%	91%
Rehydration fluids given – recorded	97%	98%
Replacement of losses – recorded	70%	88%
Maintenance fluid given – recorded	88%	96%
Food given as prescribed – recorded	94%	91%
Correct administration of antibiotics – recorded	97%	100%
Correct administration of other treatment – recorded	97%	93%
Report on abnormalities – recorded	100%	96%
Input and output chart up to date	100%	99%
Median number of items adhered to	9	10

Other factors that contributed to GE deaths

Factors identified from the audit that contributed to mortality in GE include:

1. Non-availability of 24-hour medical services in 24% of children who died, especially in surrounding towns both inside and outside the referral area of NDH.
2. Referral from general practitioners and clinics without initiation of rehydration fluids before referral in 30% of cases.
3. Time for transport from one medical service to another within Bloemfontein taking an average of six hours.
4. Parents or caregivers did not realise the severity of the GE or delayed in seeking medical care.

Discussion

GE, as the main cause of death, contributed to 67% of all deaths in Ward 3, NDH, that occurred from May 2007 to April 2008. The factors contributing to these deaths were investigated.

Demographic data such as gender and age did not influence the outcome of GE. As expected, severe malnutrition, HIV-positive status and severe dehydration all contributed statistically significantly to high mortality in GE.

Severe abnormalities were indicated in the laboratory results of most of the children who died and also indicated the severity of their disease(s). Low-presenting levels of sodium contributed to poorer outcome and were mainly due to diarrhoea or HIV disease. GE causes potassium loss through the gut and it is therefore expected that the majority of children with GE would have low potassium levels. Although potassium was substituted in all children with low potassium levels, an initial low potassium level predicted a poorer outcome in GE. An albumin level test was done only in children with oedema or severe malnutrition. Lower albumin levels are indicative of poor nutrition and contributed to poorer outcome. Inadequate iron intake and chronic diseases such as TB and HIV influence haemoglobin levels. The haemoglobin levels of the children who died were statistically significantly lower than those of the children who recovered. White blood cells indicate the body's response to infections. In both groups the median white blood cells were within normal limits, which can be explained by the fact that white blood cell counts are low in severe HIV disease and high in severe infections that could counterbalance each other. Platelet count did not contribute to GE outcomes, as it is also influenced by HIV disease as well as infections.[3]

No specific organism could be identified from the children's stool specimens and the quality of drinking water in Bloemfontein was declared safe for human consumption.

Doctors and nurses adhered well to the prescribed standard treatment protocols and prescriptions. Doctors can improve on their prescription of antibiotics for co-morbidities and nurses on fluid replacement for losses. Admission criteria were not met mainly because children were from outside the referral area or in need of secondary care (26% of admissions and 36% of GE deaths were from outside Bloemfontein). Transport time and non-availability of 24-hour medical services contributed to these deaths.

Conclusion

A marked increase in GE admissions and deaths occurred during the summer of 2007/08. Despite this, no specific organism or poor water quality could be identified as being the cause. Underlying poor nutritional status and/or HIV disease were present in 96% of the GE deaths. Medical care rendered in the hospital by doctors and nurses was of high quality and in accordance with standard guidelines in more than nine out of ten cases. Recording of replacement of losses was the only area identified that could be improved.

Pre-admission factors such as transport, non-availability of 24-hour medical services, non-initiation of emergency treatment before referral and caregivers not realising the severity of the disease were identified as major causes contributing to GE deaths. These factors need urgent attention to prevent further deaths.

Recommendations and implementation of results

Regular in-service training programmes are necessary to update and refresh everyone involved in the management of patients, as well as to improve understanding and teamwork in the clinical setting. In-service training was done for nursing personnel in the paediatric ward in NDH as soon as the increase in GE occurred. An Interactive Communication and Management (ICAM) lecture was presented for doctors in the Free State, as well as in-service training for doctors working in NDH.

As soon as bad practices are noted, trainers and supervisors of clinical staff should get involved to rectify them immediately. The provincial and regional IMCI (Integrated Management of Childhood Illness) co-ordinators were therefore contacted to attend to clinics that had poor referrals and to the non-initiation of emergency treatment before referral.

Management on all levels should be alerted of disease outbreaks, so that they can implement policies and procedures to contain the conditions. The results of this study were made available to the management of NDH in the form of a report. A report on the increase in GE cases as well as a comprehensive report on the outcome of the study was sent to regional and provincial Department of Health authorities early in the outbreak of the epidemic.

References

1. The Primary Health Care Package for South Africa – A set of norms and standards. Part 3: Norms and standards for district hospitals. Department of Health, Pretoria; March 2001.
2. Standard Treatment Guidelines and Essential Drug List. Hospital Level Paediatrics. Department of Health. Republic of South Africa; 2006.
3. Zeichner SL, Read JS. Handbook of Pediatric HIV Care. 2nd edition. Cambridge University Press; 2006.