THE SOUTH AFRICAN NATIONAL NON-NATURAL MORTALITY SURVEILLANCE SYSTEM — RATIONALE, PILOT RESULTS AND EVALUATION

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Background. While individual mortuaries have recorded data for non-natural deaths in time-limited studies, there have been no systematic efforts to draw forensic-medical services and state mortuaries into a nationwide fatal injury surveillance system. Beginning in June 1998, the National Non-Natural Mortality Surveillance System (NMSS) commenced pilot operation.

Objective. To evaluate the NMSS and illustrate its utility from sample findings.

Design. Data entered into the system by mortuary staff were checked against a random sample of cases for which separate forms were completed by an independent researcher. Process observations and follow-up with data users were used to assess the system's acceptability, timeliness and data usefulness.

Setting. Eighteen mortuaries in six provinces representing approximately 35 000 cases per year, or around 50% of all non-natural deaths.

Participants. The National Departments of Health; Safety and Security; and Arts, Culture, Science and Technology; national and provincial forensic medico-legal services; the South African Police Services; universities and science research councils.

Main outcome measures. Surveillance system simplicity, flexibility, acceptability, sensitivity, positive predictive value, representativeness, timeliness, data usefulness and resources.

Results. The NMSS was established at 10 target sites. Lack of equipment, personnel resistance, and closure of some mortuaries prevented implementation in the remaining eight mortuaries. Sensitivity was internally assessed and ranged from 65% to 95% for manner of death. Positive predictive value was also internally measured, and ranged from 74% to 80% for manner of death and from 71% to 82% for mechanism of death. Timeliness was good, and basic reports covering most items were available 6 weeks after a case had been examined. While staff found the system simple, acceptability depended on the individuals involved at different mortuaries, and the system was compromised to some extent by bureaucratic barriers. End users found the data to be of great value. NMSS set-up costs totalled approximately R26 000 per mortuary, and it is estimated that maintenance costs will be R8.00 per case registered.

Conclusions. With minimal resources, the NMSS uses existing investigative procedures to describe and report the epidemiology of fatal injuries. The pilot study demonstrates the feasibility of the system, and identifies the need to remove organisational constraints and individual barriers if it is to be sustained and expanded beyond the pilot sites.

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Injuries resulting from violence, traffic collisions and other accidents are among the leading causes of death in South Africa,[1-3] yet are poorly understood due to a dearth of epidemiological information.[4,5] Action to remedy this was prioritised by the National Department of Health, and in 1998 the Department of Arts, Culture, Science and Technology's Innovation Fund for Crime Prevention approved a grant to develop a National Non-Natural Mortality Surveillance System (NMSS).

After describing the rationale and method, the NMSS experience over a 12-month period from June 1998 to June 1999 is reviewed. We present sample findings to illustrate the system's capacity, and evaluate the exercise to identify strengths and weaknesses as a basis for future improvements.

RATIONALE, OBJECTIVES AND METHOD

The NMSS collates and disseminates 23 items of information produced during the medico-legal investigation of known and suspected deaths due to non-natural causes.

RATIONALE AND OBJECTIVES

The NMSS rationale is similar to that for public health surveillance generally, and the procedure consists of four activities.[6] These are: (*i*) the ongoing and systematic collection of data; (*ii*) the consolidation and analysis of collected data; (*iii*) the dissemination of information through narrative epidemiological reports to public health practitioners and others who need to know; and (*iv*) follow-up to see that the data have been applied to prevention and control. These activities form an information loop, which is only completed when information entered into the system is finally applied.[7]

Injury surveillance itself is one component in the more encompassing public health approach to injury and violence prevention.[8] The approach (Fig. 1) recognises that injuries show clear patterns with regard to the relationships between causes and high-risk groups, times, places, products and circumstances.[9,10] Within this framework injury surveillance is the main problem definition mechanism, identifying the how, when, where and what of injuries. Risk factor identification looks at why, and involves investigations such as cohort and case-control studies. The third step uses surveillance and risk factor information to design and implement interventions, and the final step involves the implementation and ongoing evaluation of interventions that have been proven or are highly likely to prove effective.

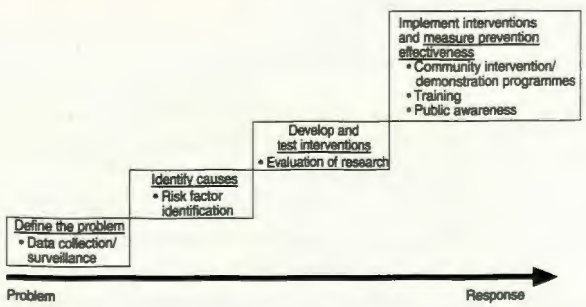


Fig. 1. Public health model of a scientific approach to violence and injury prevention.

The NMSS has six objectives: (*i*) to provide ongoing and systematic information on the incidence, causes and consequences of non-natural deaths at local, regional and national levels; (*ii*) to enable the early identification of new fatal injury trends and emerging problem areas so that appropriate interventions can be established in time; (*iii*) to determine priorities for injury and violence prevention action, both for high-risk groups and socio-environmental risk factors; (*iv*) to help evaluate direct (e.g. gun law enforcement) and indirect (e.g. socio-economic upgrading) violence and injury prevention measures; (*v*) to monitor seasonal and longitudinal changes in the non-natural mortality profile; and (*vi*) to examine medico-legal resource allocation.

METHOD

The NMSS collates 23 information items from a number of otherwise separate points in the medico-legal examination procedure that by law must be followed for deaths known or suspected to have arisen from non-natural causes.[11,12] Mortuary administrative personnel and participating forensic pathologists enter most data items into the system within days or weeks after a case is examined. Specialist scientists in Johannesburg, Cape Town and Pretoria do the system evaluation, data cleaning, analysis and dissemination.

Case report form

The NMSS case report form reflects local conditions while accommodating the International Classification of Diseases, 9th revision (ICD 9)[13] and the draft International Classification of the External Causes of Injury (ICECI).[14] Prototypes were applied in earlier studies of fatal injuries[2,15] that confirmed the feasibility of implementing it on a wider basis. The form has 23 items divided into five clusters (Fig. 2). Except for the geographical information and the 'context of attack' fields, all items are pre-coded.

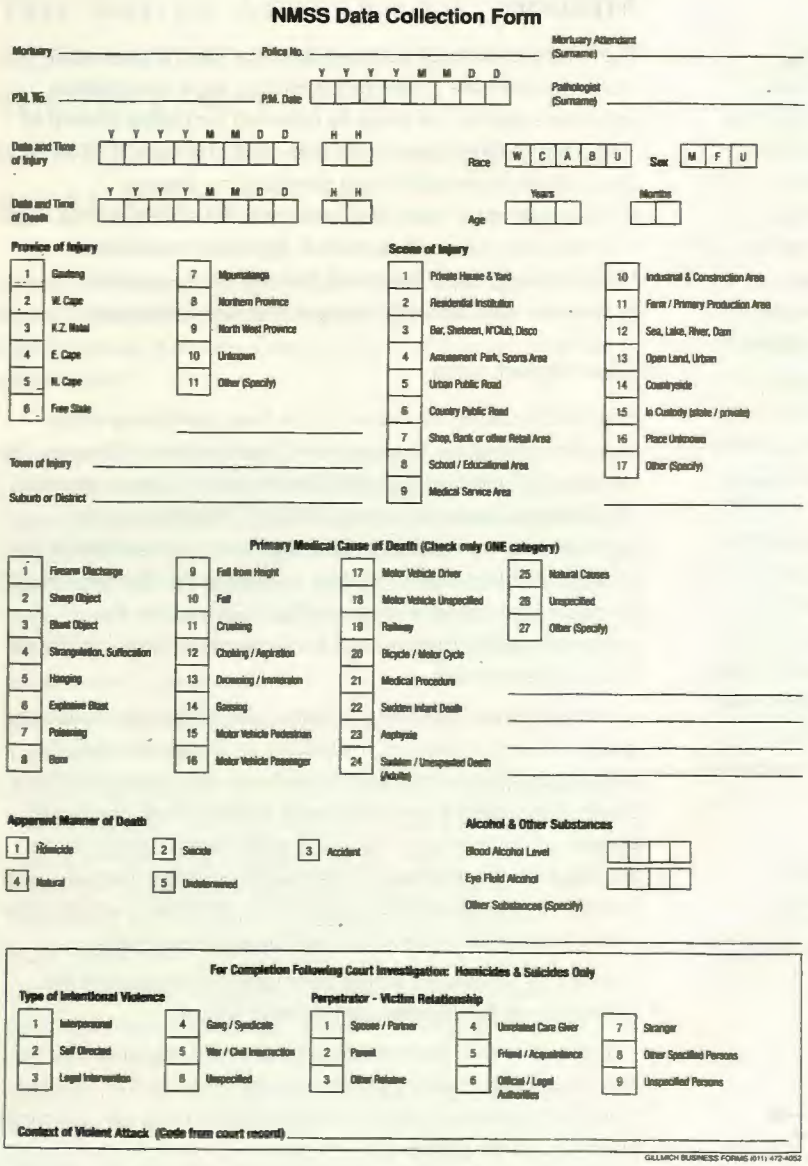
Items 1 - 6 are case and personnel identifiers. The police and postmortem numbers are for linking and cross checking the data against police information systems, and against Statistics South Africa data from the recently revised death certificate. Names of the mortuary attendant and examining doctor are recorded for the mortuary's own administrative purposes, and to improve the investigative process by indicating where extra training in observation and recording may be needed.

Items 7 - 15 concern victim demographic details and the time, geographic location and scene of injury.

Items 16 and 17 concern the primary medical cause and/or the circumstance and apparent manner of death (i.e. accident, homicide, suicide, natural or undetermined) and are completed by the examining doctor.

Items 18 - 20 concern the presence of alcohol, drugs or other toxins in the deceased; the information is produced at the state chemical laboratories. Analysis for blood alcohol level is largely routine for adult fatalities, while analysis for other drugs is less routine.

Items 21 - 23 pertain to deaths due to intentional violence only, and are adapted from the 1998 ICECI draft module for the classification of injuries due to intentional violence.[14] Item 21 classifies the type of violence, item 22 records the victim-perpetrator relationship, and item 23 the precipitating circumstances of the violent attack. Information for these items is produced during court investigations into deaths due to homicide, suicide or cause unspecified. For cases heard in the criminal courts, the dockets are sent after sentencing to one of the criminal records centres in Pretoria or Johannesburg, or to local criminal records centres in some of the larger cities and



NMSS Data Collection Form

Mortuary _____ Police No. _____ Mortuary Attendant (Surname) _____

P.M. No. _____ P.M. Date Y Y Y Y M M D D Pathologist (Surname) _____

Date and Time of Injury Y Y Y Y M M D D H H Race W C A B U Sex M F U

Date and Time of Death Y Y Y Y M M D D H H Age Years Months

Province of Injury

1 Gauteng
2 W. Cape
3 K.Z. Natal
4 E. Cape
5 N. Cape
6 Free State
7 Mpumalanga
8 Northern Province
9 North West Province
10 Unknown
11 Other (Specify) _____

Town of Injury _____

Suburb or District _____

Scene of Injury

1 Private House & Yard
2 Residential Institution
3 Bar, Shebeen, N'Club, Disco
4 Amusement Park, Sports Area
5 Urban Public Road
6 Country Public Road
7 Shop, Bank or other Retail Area
8 School / Educational Area
9 Medical Service Area
10 Industrial & Construction Area
11 Farm / Primary Production Area
12 Sea, Lake, River, Dam
13 Open Land, Urban
14 Countryside
15 In Custody (state / private)
16 Place Unknown
17 Other (Specify) _____

Primary Medical Cause of Death (Check only ONE category)

1 Firearm Discharge
2 Sharp Object
3 Blunt Object
4 Strangulation, Suffocation
5 Hanging
6 Explosive Blast
7 Poisoning
8 Burn
9 Fall from Height
10 Fall
11 Crushing
12 Choking / Aspiration
13 Drowning / Immersion
14 Gassing
15 Motor Vehicle Pedestrian
16 Motor Vehicle Passenger
17 Motor Vehicle Driver
18 Motor Vehicle Unspecified
19 Railway
20 Bicycle / Motor Cycle
21 Medical Procedure _____
22 Sudden Infant Death _____
23 Asphyxia _____
24 Sudden / Unexpected Death (Adults) _____
25 Natural Causes
26 Unspecified
27 Other (Specify) _____

Apparent Manner of Death

1 Homicide 2 Suicide 3 Accident 4 Natural 5 Undetermined

Alcohol & Other Substances

Blood Alcohol Level
Eye Fluid Alcohol
Other Substances (Specify) _____

For Completion Following Court Investigation: Homicides & Suicides Only

Type of Intentional Violence

1 Interpersonal
2 Self Directed
3 Legal Intervention
4 Gang / Syndicate
5 War / Civil Insurrection
6 Unspecified

Perpetrator - Victim Relationship

1 Spouse / Partner
2 Parent
3 Other Relative
4 Unrelated Care Giver
5 Friend / Acquaintance
6 Official / Legal Authorities
7 Stranger
8 Other Specified Persons
9 Unspecified Persons

Context of Violent Attack (Code from court record) _____

GILLMOH BUSINESS FORMS (011) 472-4052

Fig. 2. The NMSS case report form.

towns. Dockets investigated at the inquest courts are archived at each court.

Data capture, analysis and reporting

Input data for the NMSS are generated by existing medico-legal investigation procedures, and while not all aspects of the system are passive, its methods are simple.

Completion of case report form

The NMSS case report form is non-electronic, requiring completion by hand before manual entry of the data into the computer. To protect against data loss, the form is self-carbonating so that two copies are produced. Scene of death and autopsy items are completed by the mortuary personnel responsible for attending at the scene, collecting bodies and/or admitting cases. Once these items have been completed, the top copy of the form is stored with others for entry on a weekly, monthly or fortnightly basis into an NMSS computer. The bottom copy of the form is included with the official docket that goes to the court.

Data produced through laboratory investigations are obtained directly from the state chemical laboratories by specialist researchers. Using the mortuary number to link the case report form with the laboratory results, the researchers update the relevant items in batches on a 3-monthly basis.

Because it is dispersed between the different criminal record centres and inquest courts, specialist researchers must actively retrieve court information concerning the type of violence, victim-perpetrator relationship and context of attack. They access the archived dockets and retrieve the bottom copy of the surveillance form, which is completed following scrutiny of the court findings as recorded in the docket. The information is then entered into the computer database at the collation points in Cape Town and Johannesburg.

Computer equipment

Within each mortuary the NMSS uses the software programme EpiInfo 6,[16] operating on a personal computer. EpiInfo 6 is designed for epidemiological applications and a specially prepared data capture file, identical to the hard copy of the case report form, is supplied to enter each case. Staff at each participating mortuary received instruction in managing the database; using the built-in analysis programme they can conduct their own descriptive and statistical analyses of the data.

Data cleaning and integration

Data from the mortuaries, laboratories and criminal record centres are cleaned and integrated by specialist researchers at the Johannesburg and Cape Town centres responsible for maintaining the NMSS. The data are retrieved from each mortuary and the state chemical laboratories on a 3-monthly basis. Integration involves linking the files for different periods in the case of single mortuaries, and linking the datasets between mortuaries to enable regional and national analyses. Data cleaning involves the identification and correction of obvious typographical errors that would otherwise disrupt computerised analysis.

Data analysis and reporting

Analysis of the NMSS data is conducted at the Johannesburg and Cape Town co-ordinating centres, while geographical items are analysed by the Council for Scientific and Industrial Research in Pretoria. In addition to regular reports in a standard format, customised reports are prepared in response to appropriately motivated special requests from individual agencies. All reports exclude any individual case identifiers and indicate the limitations of the data. The maps prepared show the spatial and temporal variance of fatal injuries at town or suburb level (to preserve confidentiality by not identifying individual cases) using a variation of crime clocks,[17] as well as the spatial distribution of other variables.

Pilot implementation and evaluation

NMSS pilot implementation started in June 1998 at 18 mortuaries spread across eight cities and covering approximately 38 000 cases a year. In selecting these sites it was assumed that they would be the most likely to have the necessary equipment and staff resources. The system evaluation procedure was informed by the USA Centers for Disease Control (CDC) guidelines[18] for evaluating surveillance systems, namely: simplicity, flexibility, acceptability, sensitivity, positive predictive value (the proportion of persons identified by the system as cases that actually meet the case definition), as well as quality, timeliness, and usefulness of the data.

Illustrative surveillance findings

The distribution of the 6 202 non-natural mortality cases by reporting mortuary for 1 January to 31 June 1999 is shown in Table I. The data were obtained from 10 of the 18 mortuaries targeted for pilot implementation.

In Gauteng, 2 of the proposed pilot mortuaries were closed in the early stages of the attempted implementation. Data collection was maintained at Diepkloof for 7 months until labour disputes over broader issues led to the suspension of data collection. Pretoria, Bloemfontein and New Brighton mortuaries lack the requisite computer facilities to run the NMSS data capture software. Chatsworth and Phoenix mortuaries did not have suitable infrastructures.

Representativeness

Before reviewing the NMSS pilot findings, it is emphasised that they are intended only to illustrate the system's potential and to evaluate the quality of the data obtained. Outside of each mortuary's own catchment area, the data are of limited and uneven representativeness. Regional representativeness is highest for the Cape Town metropole and Kimberley, with all mortuaries serving these catchment areas included. It is lowest for Johannesburg and Durban. In Johannesburg, only 2 mortuaries out of 7 participated, and in Durban only 1 out of 3. Of the 2 mortuaries serving East London, 1 participated in the NMSS, in Port Elizabeth 2 out of 3 mortuaries participated, and 1 out of 3 in Pretoria. Nationally, the 6 202 cases reported in the pilot findings described below represent around 20% of the estimated 30 000 new non-natural deaths that occur every 6 months, and the 10 participating mortuaries represent 4% of all 246 sites at which medico-legal examinations are conducted.[19]

Apparent manner of death, by province

For all five provinces included in the pilot period, homicide was the leading manner of death (45.7%) followed by traffic collisions and other unintentional injuries such as falls, burns and drowning (35.2%). Suicide accounted for 7.8% of all non-natural deaths and in a further 11.2% the specific manner of death was undetermined (Fig. 3).

While the proportion of homicide deaths exceeds 40% in all provinces, it is highest in KwaZulu-Natal and the Western Cape, whereas the Northern Cape has the highest incidence of suicides. Fatal motor vehicle collisions are lowest in the Eastern Cape and highest in the Western Cape and Gauteng.

Table I. Mortuaries included in NMSS and number of cases seen in 6 months

Province	Mortuaries (*N*)						
Gauteng	Germiston	Roodepoort	MEDUNSA	Hillbrow	Springs	Diepkloof	Pretoria
	1 109	653	257	Closed	Closed	NCD	NCD
Western Cape	Salt River	Tygerberg					
	1 179	994					
KwaZulu-Natal	Gale St	Chatsworth	Phoenix				
	1 237	NCD	NCD				
Northern Cape	Kimberley						
	122						
Eastern Cape	Gelvandale	L. le Grange	East London	New Brighton			
	89	166	396	NCD			
Free State	Bloemfontein						
	NCD						

NCD = not presently collecting data.

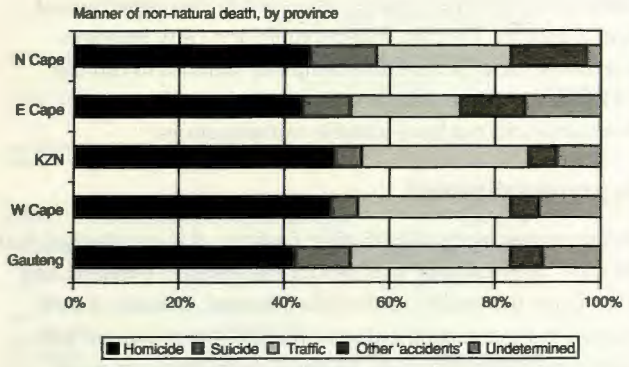


Fig. 3. Manner of non-natural death (NMSS, 1999, 6-month provisional data).

Homicide

More than 45% of all cases registered in the NMSS were the result of homicide. The victims were predominantly male (86.3%) and the average age was 32 (± 11.6) years. However, males were significantly younger than females (31.6 versus 34.1 years, $t = 3.65$, $P < 0.001$).

In more than half of all homicide cases the weapon used was a firearm. Table II shows that these firearm homicides predominated in three of the five provinces sampled, with the highest levels recorded in Gauteng and KwaZulu-Natal and the lowest levels in the Eastern and Northern Cape. In the latter region, two-thirds of homicides were committed with a sharp instrument such as a knife.

Blood alcohol concentration (BAC) was assessed in 43.7% of all homicide cases, and found to be positive in 56.8%. Those who were positive had very high blood alcohol levels (0.17 ± 0.08 g/100 ml). The proportion of BAC-positive cases was highest for homicides involving sharp instruments (69.1%) and lowest for firearm deaths (39.1%).

Data on victim-perpetrator relationship, type of violence and context of attack have not yet been included in the database pending the completion of court investigations.

Suicide

Suicide accounted for 8% of all the non-natural deaths included in the NMSS database. Victims were predominantly male (78.7%) and the average age was 36 (± 14.7) years, although 10% were younger than 20 (the youngest age was 11 years). A further 13% of cases were older than 54 years.

There were distinct differences in mechanism of suicide according to gender (Table III). Men were more likely to commit suicide by means of a firearm (odds ratio (OR) 1.69, 95% confidence interval (CI) 1.00 - 2.87) or hanging (OR 2.66, 95% CI 1.52 - 4.59), while women were more likely to use poison (OR 3.31, 95% CI 1.80 - 6.10) or to set themselves alight (OR 7.8, 95% CI 2.81 - 22.35). Self-immolation was most common in the KwaZulu-Natal region.

Blood alcohol levels were assessed in 43.1% of the suicide cases. Just over one-third of the cases were found to be alcohol-positive, and these cases had an average alcohol level of 0.16 ± 0.1 g/100 ml. There were no significant BAC differences with regard to gender or mechanism of suicide.

Table II. Mechanism of homicide, by province

Mechanism of homicide	Gauteng (%)	Western Cape (%)	KwaZulu-Natal (%)	Northern Cape (%)	Eastern Cape (%)	Total (%)
Firearm	60.8	44.3	59.4	16.4	32.5	50.7
Sharp instrument	22.0	41.9	22.2	65.5	49.3	33.0
Blunt object	11.3	7.4	14.6	10.9	11.4	10.6
Other	5.9	6.4	3.8	7.2	6.8	5.7

Table III. Mechanism of suicide, by gender*

Mechanism of suicide	Total ($N = 484$)	Males ($N = 381$)	Females ($N = 102$)	Odds ratio† (95% CI)
Firearm (%)	33.2	35.4	24.5	1.69 (1.00 - 2.87)
Hanging (%)	35.1	39.4	19.6	2.66 (1.52 - 4.59)
Poisoning (%)	12.2	8.9	24.5	3.31 (1.80 - 6.10)
Burn (%)	4.1	1.8	12.8	7.8 (2.81 - 22.35)
Gassing (%)	6.0	6.6	3.9	1.72 (0.55 - 5.98)
Other (%)	9.4	7.9	14.7	0.50 (0.24 - 1.01)

* Gender not known in one case.
† The odds ratio was statistically significant if the confidence interval (CI) did not include 1.

Fatal traffic collisions

Traffic collisions accounted for 27.8% of all non-natural deaths registered in the NMSS and 81.4% of all the accidental deaths. Fig. 4 shows that more than 40% of traffic victims were pedestrians, 15% were passengers, and 13% drivers. Unfortunately in almost one-third of cases the traffic-user category could not be ascertained from the medico-legal documentation.

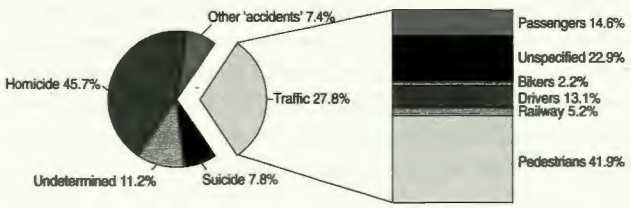


Fig. 4. Fatal traffic collisions (NMSS, 1999, 6-month provisional data).

From Table IV it can be seen that traffic victims tended to be male (74.3%) and an average of 33.8 (± 16.1) years, although a disturbing proportion of pedestrian and passenger fatalities were children.

The alcohol-relatedness of fatal vehicle collisions in South Africa has been well documented. The NMSS data yielded similar results, with more than half of all fatally injured traffic victims having positive BACs. The alcohol-positive cases also had particularly high BACs (mean BAC 0.18 ± 0.1 g/100 ml). Furthermore, proportionally more pedestrians than other fatally injured traffic victims were drunk at the time of their collision ($P < 0.0001$). These pedestrians had higher alcohol levels than drivers or passengers ($P < 0.001$).

Other fatal accidents

Other fatal accidents accounted for less than 8% of all cases and were predominantly caused by burns (30.7%), drowning (24.5%) and falls (15.1%). These deaths involved significant numbers of children. Nearly half of all drownings occurred among children under the age of 15 years, and more that 20% of this age group were also victims of burns (Fig. 5). As

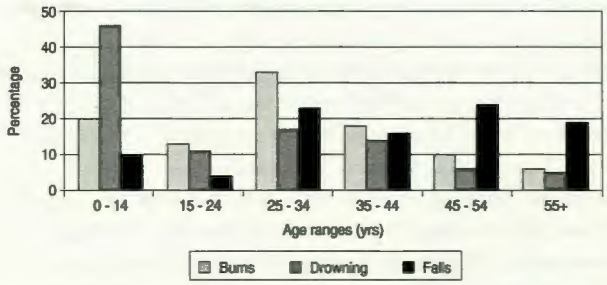


Fig. 5. Fatal accidents, by age (NMSS, 1999, 6-month provisional data).

expected, more than 40% of fatal falls occurred in persons aged 45 years and over.

EVALUATION RESULTS

Simplicity

Efforts to maximise the simplicity of the NMSS included extensive consultations with personnel at all levels of the process during the design phase. Staff training requirements were minimal, and case reporting was simplified by the use of a one-page, easy-to-understand form with check boxes for most data items, and minimal need for additional coding before analysis. In all mortuaries the staff responsible for capturing the data into EpiInfo 6[16] found the programme simple to operate and minimally demanding in terms of the time needed to enter each case. Except for the spatial mapping of cases using geographical information systems (GIS), all analyses were completed using a simple spreadsheet, and could be readily automated. Problems encountered in relation to GIS analysis involved lack of consistency between formally defined suburb boundaries and the boundaries perceived and defined by the police and mortuary attendants.

Acceptability and organisational constraints

At the level of individual mortuaries, system acceptability varied according to whether the primary contact was a police officer or a forensic pathologist with an academic appointment. Where the primary contact was a police officer, the system

Table IV. Characteristics of victims fatally injured in traffic collisions

Variable	Pedestrians ($N = 723$)	Drivers ($N = 226$)	Passengers ($N = 252$)	All traffic victims ($N = 1\,724$)
< 20 years (%)	20.1	2.9	18.0	15.8
Male (%)	72.5	86.7	63.9	74.3
BAC-positive (%)	69.8*	54.9	33.3	56.7
Mean BAC level (g/100 ml)	0.21 ± 0.09†	0.13 ± 0.07	0.11 ± 0.06	0.18 ± 0.10

*20.98, $P < 0.0001$.
BAC = blood alcohol concentration.

tended to be viewed with considerable suspicion as something that could potentially derail the investigative process by disclosing sensitive information before the completion of court investigations. In addition, organisational rules dictated that no decisions could be made without being referred to a higher level of command. At many such mortuaries this resulted in extended delays of many months, and in one or two instances where organisational dynamics coincided with individual resistance, in the indefinite postponement of implementation. Acceptability was higher and organisational constraints fewer where the primary contact was a forensic pathologist, although this was not without exception.

The government departments involved in the NMSS are the Department of Health and the Department of Safety and Security, which are jointly responsible for the administration and funding of different components of the forensic-medical examination process. While the NMSS is strongly supported by top management within both departments, the organisational constraints imposed by this dual control seriously undermine effective implementation and maintenance of the NMSS.

This was clearly illustrated by the difficulties involved in finalising contracts with the participant mortuaries and establishing channels by which they could be financially reimbursed. While the Department of Health funds the medical and laboratory staff involved in obtaining much of the NMSS information, the Department of Safety and Security funds the police officers who collect the bodies, administer the mortuaries and prepare the case reports. Police regulations forbid police officers from receiving any reward for additional work done, and prevent the Department of Health from paying over the financial reimbursement budgeted for the completion of case report forms and data capture. This has led to a suspension of data collection at several mortuaries. The status quo is expected to remain unless a top-down police directive resolves the impasse, or until a way of proceeding with a more creative method of payment for participation is agreed on.

Flexibility

Some difficulties were experienced in introducing the NMSS case report form at most of the mortuaries. This may, in part, be due to extremely rigid organisational structures and daily routines. It is therefore unlikely that the NMSS case report form can easily be modified to provide additional injury-related information. However, this rigidity is balanced by the flexibility of the data capture and analysis programme, which allows for the rapid execution of customised analyses using continuous data for age, and reasonably fine-grained information for place of injury.

Sensitivity

The sensitivity of a surveillance system is the ability of the system to identify correctly all of the true cases in a target population. In South Africa, at both local and national level, no alternative methods are available for identifying all non-natural deaths, so the system's sensitivity cannot be externally evaluated. The only available alternative information sources are police crime statistics. However, these cover homicides only. An unrelated study showed that Cape Town mortuaries identified approximately 20% more firearm-related deaths in children and adolescents than were included in official police crime statistics.[20]

NMSS sensitivity relative to the total number of cases seen in each mortuary was defined as the total number of cases logged in the mortuary death register divided by the total number of cases entered into the NMSS database by mortuary staff. This ranged from 75% (in one mortuary where confusion arose with regard to the inclusion of 'natural' cases) to 95%.

Positive predictive value

The positive predictive value is the likelihood that an event identified by the surveillance system actually occurred. In relation to the manner of death (i.e. whether it was homicide, suicide or accident), formal assessment is possible only against the outcome of court investigations, and therefore only available when these are complete. It was, however, internally assessed by comparing the manner and mechanism of death recorded in the system with the manner and mechanism of death as registered by an independent coder for a 10% random sample of cases seen at 4 Gauteng mortuaries.

For manner of death the percentage agreement was 80%, 76%, 76% and 74%, and for mechanism of death 82%, 74%, 68% and 71%. Scrutiny of the records showed that inconsistencies for the manner of death were mainly due to assumptions made by mortuary staff on the basis of the cause of death. For example, if the cause of death was burn, then it was frequently assumed that the manner of death was 'accident', while it could equally well have been 'homicide' or 'suicide'. Inconsistencies in the mechanism of death arose because of incorrect classifications when assigning a case to one of the precoded categories on the case report form. For example, assault and electrocution were classified as 'other', while they should be classified as 'blunt object' and 'burn', respectively. Feedback and training are given to mortuary staff with regard to these issues. By January 2000, validations had been performed on 9 of the 10 mortuaries included in the system.

Data quality

Data quality was assessed for a 10% random sample of cases at the 4 Gauteng mortuaries. For each case, an independent expert examined all available documentation before completing a new report form. Correct items were defined as those where there was agreement between the values initially recorded and those recorded by the independent rater. Table V shows the percentage agreement by item and mortuary for the 4

Table V. Items correctly recorded by four NMSS mortuaries

Item	Diepkloof (%)	Roodepoort (%)	Germiston (%)	MEDUNSA (%)
Police number	21.6	81.8	59.7	76.0
Investigating officer	86.3	87.9	98.4	40.0
PM number	100.0	100.0	100.0	100.0
PM date	90.2	97.0	93.5	92.0
Pathologist	96.1	100.0	98.4	100.0
Date of injury	37.3	57.6	32.3	36.0
Time of injury	43.1	40.9	51.6	100.0
Date of death	90.2	89.4	98.4	96.0
Time of death	68.6	78.8	48.4	28.0
Race	98.0	97.0	98.4	100.0
Sex	100.0	97.0	96.8	96.0
Age	37.3	76.3	64.5	84.0
Province	82.4	81.8	80.6	76.0
Town	72.5	59.1	45.2	76.0
Suburb	70.6	43.9	46.8	76.0
Scene	41.2	31.8	17.7	60.0

PM = postmortem.

mortuaries where this evaluation was conducted.

Data accuracy varied across the different mortuaries and the different items. High levels of agreement were obtained for the postmortem number, postmortem date, pathologist's name, date of death, race and sex. Examination of the data suggests that accuracy was low for some of the items because the information required for the completion of that item was unavailable. Some items were left blank, even if the information later became available. Elsewhere, mortuary staff attempting to complete the case report form seem to have made assumptions about the data. For example, because the date and time of injury is not usually recorded in the mortuary dockets, the mortuary staff assumed that the date and time of injury was the same as the date and time of death, although in many instances death would not have been immediate. Since the location and scene of the injury were also infrequently recorded in the mortuary dockets, it was assumed that the injury occurred at the residential address of the deceased or where the body was collected. This was often the scene of death as opposed to the scene of injury. For example, many 'injuries' were recorded as occurring in medical service areas because this was where police officers collected the body.

Similar findings resulted from validation procedures at the other mortuaries included in the study. Feedback pointing out these errors was given to mortuary staff following these evaluations and its effectiveness in improving accuracy was tested by a repeat of this evaluation procedure.

Timeliness

For 17 of the 23 items, the average time between the occurrence of death and entry into the NMSS computer at the level of the individual mortuary was 4 - 5 weeks. These items concerned the basic data on the cause, mechanism, time and place of death. The lag period was determined by the preference at most mortuaries for entering the data in monthly batches. The quarterly reports summarising these data for each mortuary were completed approximately 6 weeks after the date of the last case in the batch, with this period representing the time required to obtain the data from participating facilities, clean it and prepare summary analyses using a uniform template.

For the items requiring laboratory analysis, the average time between occurrence of death and item completion ranges between 4 weeks and 4 months, depending on where the specimen was taken and where it was processed. In mortuaries in smaller cities, blood specimens are sent to one of three state chemical laboratories in Pretoria, Johannesburg or Cape Town. There are lengthy delays during this process and some specimens were even lost. All non-natural deaths over the age of 16 years, where death was not due to late-effects, should have a specimen analysed for alcohol. However, some facilities do not take samples on all cases because of the unavailability of legal containers.

It is estimated that at least 18 months from the date of death is required to complete the court investigation. Consequently the items concerning type of violence, victim-perpetrator relationship and precipitating circumstances could not be assessed.

Data usefulness

A number of reports prepared in response to special requests from national and local government departments have been produced, and the findings used to argue for policy changes

and prevention activities in relation to firearm-related deaths, violence among adolescents, and child pedestrian safety. These applications, alongside the many requests for routine and customised reports that are received, suggest that the usefulness of the data justify the resources required to establish and maintain the NMSS.

Resources

The major costs of the NMSS may be divided into set-up and maintenance costs. Set-up costs include the purchase of computers for the mortuaries, printing of case report forms, and salaries for the professional time involved in developing and evaluating the system. Maintenance costs include the case and participation fee per mortuary, and the costs of periodic data cleaning, analysis and reporting.

NMSS set-up costs for the 10 mortuaries successfully included in the pilot implementation amount to R3 000 per mortuary as a participation fee, R80 000 for computers, R6 000 for the printing of case report forms and R150 000 for the professional time involved in system development and evaluation. This is a total of R266 000, or approximately R26 000 per mortuary.

Annual NMSS maintenance costs for the 10 mortuaries amount to R1.00 for each case registered, R6 000 for NMSS data capture forms, R75 000 for professional time for data cleaning, validation, analysis and reporting, and R5 000 for postage and communication. This means that once up and running each case included in the fatal injury surveillance system would cost approximately R8.00, and therefore that total coverage of all non-natural deaths in South Africa would cost R490 000 per year.

Conclusion

NMSS pilot implementation has provided valuable insights into the personnel, resource and organisational realities underlying the injury surveillance crisis in South Africa. The costs of providing computers for these and other sites are small compared with the overall forensic medical services budget, suggesting the low value placed on information and information management in these contexts. It is against this background that the proposed transfer of the mortuaries and their staff from the South African Police Services (SAPS) to the Department of Health[2] is to be welcomed as a way of creating at least the organisational potential for them to adopt a more scientific approach alongside their traditional role as part of the criminal justice system.

These organisational issues raise a number of questions around integration of the NMSS with other health and crime information systems. With the criminal justice and policing sector, two links must be built. First, if the NMSS requirement for court information on violent deaths is to be met, then this information must be electronically recorded so that it can be automatically retrieved and merged with the mortuary data. Further NMSS developments must therefore occur in collaboration with agencies developing court and criminal justice information systems. Second, NMSS data should be linked to the SAPS crime information systems, both to add value to their crime statistics by showing possible clustering of intentional and unintentional injuries, and as an ongoing way of checking the completeness of police homicide statistics.

From a health perspective, the proposed comprehensive National Health Information System is perhaps the most important link to consider. The NMSS has already been identified to provide some data for indicators to monitor adolescent health and substance abuse in the compilation of Year 2000 Goals, Objectives and Indicators. It will be essential to ensure that the required data for these indicators are incorporated in the NMSS. In addition, it will be important to ensure coherence between the NMSS and other disease surveillance systems being developed and to adhere to the standards in data definitions and coding that are being compiled by the South African National Health Information System.

Flowing from these concerns are issues around the usefulness of the system to those using it. The NMSS has been designed to meet the information requirements of three main stakeholder groups, namely forensic medical services, the national crime prevention strategy, and violence and injury prevention agencies at local, provincial and national level. For forensic medical services the NMSS provides information for the allocation of resources, auditing of costs and rationalisation of services. The majority of the country's mortuaries and provincial medico-legal departments lack the capacity to collate and analyse their case and services profiles and are therefore unable to perform proper costing, service evaluation and planning. For the national crime prevention strategy the NMSS provides crucial baseline data for all deaths due to intentional violence, including information on particularly sensitive indicators such as gunshots, alcohol and other substance involvement, the covariance between violent and unintentional injury deaths, and geographical variations in the magnitude and patterning of homicides and suicides. The third stakeholder group consists of injury prevention agencies including national and local government, the SAPS, non-governmental organisations, businesses, and parastatals such as Metro Rail. The NMSS will provide this group with the descriptive information needed for the design and implementation of preventive interventions at municipal, metropolitan, provincial and national levels.

The improvement of surveillance methodologies is a national priority. The provision of timely and accurate information on the causes of non-natural mortality is vital in informing public policy. It is hoped that this initiative will facilitate understanding

of the utility of routinely available data sources in providing much-needed information on the epidemiology of injury causes and deaths.

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AN OUTBREAK OF FOOD POISONING AMONG CHILDREN ATTENDING AN INTERNATIONAL SPORTS EVENT IN JOHANNESBURG

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Objectives. To describe an outbreak of food poisoning at a major international sports event in Johannesburg and to determine the likely cause and source of the outbreak.

Design. A descriptive, case-control study.

Setting. An international sports event in Johannesburg.

Methods. A questionnaire survey of involved children was used to conduct a case-control study. Microbiological and chemical analysis of the implicated food was undertaken. Site visits to the premises involved in food preparation were conducted.

Results. A total of 578 children were involved. Of the 361 children who returned questionnaires, 134 were affected by an acute-onset emetic-type illness, while 53 children developed diarrhoea. Consumption of fruit juice was associated with acute illness, while diarrhoea was associated with the consumption of maize-meal porridge (pap) and chicken stew. Microbiological analysis revealed high bacterial loads in samples of the fruit juice and the presence of *Shigella flexneri* in the maize-meal porridge. Visits to the suppliers of the implicated foods revealed several deficiencies in terms of food hygiene precautions.

Conclusion. The likely vehicles and causes of this outbreak are elucidated. Guidelines for monitoring the supply and distribution of food to future similar events should be established. Furthermore, hospitals should have protocols in place to deal with such outbreaks in a manner that facilitates epidemiological investigation.

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