Validity of referral hospitals for the toxicovigilance of acute poisoning in Sri Lanka

L Senarathna, NA Buckley, SF Jayamanna, PJ Kelly, MJ Dibleya & AH Dawson

Objective To identify the hospital admission data set that best captures the incidence of acute poisoning in rural Sri Lanka.

Methods Data were collected on all acute poisoning cases admitted to 34 primary and 1 referral hospital in Anuradhapura district from September 2008 to January 2010. Three admission data sets were compared with the “true” incidence of acute poisoning to determine the systematic bias inherent to each data set. “True” incidence was calculated by adding all direct admissions (not transfers) to primary hospitals and to the referral hospital. The three data sets were: (i) all admissions to primary hospitals only; (ii) all admissions to the referral hospital only (direct and referrals), and (iii) all admissions to both primary hospitals and the referral hospital (“all admissions”). The third is the government’s routine statistical method but counts transfers twice, so for the study transferred patients were counted only once through data linkage.

Findings Of 3813 patients admitted for poisoning, 3111 first presented to a primary hospital and 2287 (73.5%) were later transferred to the referral hospital, where most deaths (161/177) occurred. All data sets were representative demographically and in poisoning type, but referral hospital data yielded a more accurate case-fatality rate than primary hospital data or “all admissions” data. Admissions to primary hospitals only or to the referral hospital only underestimated the incidence of acute poisoning by about 20%, and data on ”all admissions” overestimated it by 60%.

Conclusion Admission data from referral hospitals are easily obtainable and accurately reflect the true poisoning incidence.

Introduction

Death from acute poisoning is a major public health issue in many countries. Most deaths are from self-poisoning with highly toxic pesticides, which globally account for the overwhelming majority of poisoning deaths and around one third of all suicides.1 The problem is most widespread in rural areas of developing countries.2,3 This is true of Sri Lanka, where poisoning is among the top five causes of in-hospital deaths in rural areas.4,5 Although acute poisoning can be either intentional or accidental, Sri Lankan hospitals see few accidental poisonings and almost all admissions are due to deliberate self-poisoning.6,2

Continuous surveillance of cases of acute poisoning is important for planning and evaluating public health interventions. However, the methods required for such surveillance are potentially complicated, since the majority of poisoned patients present to small primary hospitals for initial assessment and care and are later transferred to secondary (referral) hospitals.7 To date, most epidemiological studies in Sri Lanka have been performed in these larger referral hospitals,8 as have nearly all hospital studies used to estimate pesticide poisoning rates elsewhere in the world.9 Such studies may be subject to various forms of selection bias. On the other hand, official government statistics are usually a sum of the admission statistics from all hospitals. Since existing surveillance systems rarely allow data linkage to track patients transferred from primary to referral hospitals, transferred patients end up being counted twice. This obviously creates a bias that can result, for example, in an underestimate of the case-fatality rate.9 Hence, it is important, especially in the developing world, to identify a good but uncomplicated strategy for accurately collecting data on acute poisonings and to estimate the magnitude and direction of the systematic bias inherent in various data collection methods. The objective of our study was to explore which of three different data collection methods could deliver the most accurate estimates of the incidence of acute poisoning in a rural district of Sri Lanka.

Methods

For 17 consecutive months we collected data on all admissions of acutely poisoned patients to all hospitals with inpatient beds in Anuradhapura, a large rural district in Sri Lanka’s North Central Province. This included 34 primary hospitals and one referral hospital.

The data were collected as part of a cluster-randomized controlled trial (ISRCTN73983810) that was designed to assess the effect of a brief educational intervention about the management of poisoned patients in primary hospitals. The study established data linkage between the primary and referral hospitals to enable the follow-up of all transferred patients and validate the primary hospital medical record by means of direct interviews with transferred patients.

Anuradhapura district had a total of 820 000 inhabitants, 631 715 of which were above the age of 12 years in mid 2009. The district’s land area represents about 11% of the national territory.10 Demographically and socioeconomically its population is representative of rural Sri Lanka, and so are its health-care services.10,11

All public hospitals with inpatient facilities in the district were included in the study. The 34 primary hospitals are the

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first point of health system contact for the majority of poisoned patients, many of whom are then transferred to the referral hospital, which has an intensive care unit with specialized staff and better stocks of antidotes and medication. The region has four small private hospitals, all of which were excluded from the study because they indicated that they never provided care for poisoned patients.

We collected data on all patients who were 12 years of age or older and who were admitted into study hospitals for acute poisoning from 1 September 2008 to 30 January 2010. During admission, staff examined any traces of the poison ingested or the product label or bottle and obtained a history from the patient or the patient’s family. They also made note of the clinical symptoms to support the diagnosis, and all details concerning exposure, clinical assessment, case management and clinical outcome were recorded for each patient by the treating medical staff. In primary hospitals these records were kept aside for several weeks for later retrospective extraction of data by trained research assistants using a structured data collection form. All data were entered into an Access (Microsoft, Redmond, United States of America) computer database. Admission log books were checked in each hospital to ensure that all cases were identified and traced. Data entry quality was also validated by comparing the data collected for patients transferred to the referral hospital with the data appearing in the records.

At the referral hospital, all patients who were admitted (either directly or as a transfer from a primary hospital) were examined and interviewed by study physicians during admission. Data on the patients’ demographic profile, poison exposure details, history, clinical assessment, management and outcome were prospectively collected and entered into a study database.

The Sri Lankan health system has no unique patient identifier. We identified patients who were transferred from primary hospitals to the referral hospital by using a data-linkage computer algorithm to search the primary and referral hospitals’ study databases, supplemented by occasional manual checking when the algorithm failed to produce a unique match. Only adult patients are treated in medical wards in referral hospitals; patients less than 12 years of age are referred as paediatric admissions. Since we had no access to paediatric wards and records, we could only identify and link adult patients for this study.

Statistical analysis

We obtained data for each unique patient through the labour-intensive process earlier described, as it was considered to reflect the true incidence of acute poisoning in the study district over the study period. The census population above 12 years of age in 2009 was the denominator used to calculate the incidence of acute poisoning and the population rate of death from acute poisoning. We then compared the incidence “observed” using three different possible admission data sets against the patient admission data set considered to be the most accurate, namely, the sum of all admissions to primary hospitals and to the referral hospital, minus all inter-hospital transfers. The three data sets were:

1. all admissions to primary hospitals only;
2. all admissions to the referral hospital only, both direct and referred from a primary hospital;
3. the sum of all recorded admissions to primary hospitals and to the referral hospital (“all admissions”, routine method used for government statistics, which counts referrals twice).

For each data set we calculated the incidence of poisonings and case-fatality rates, both overall and for selected subgroups based on demographics and poison type. We calculated exact 95% confidence intervals (CIs) for estimated proportions. We compared the “true” data with each of the three admission data sets by examining the difference in patient numbers and the ratio of estimated proportions and by determining if the “true” value was included in the CIs. All analyses were conducted in Stata version 11.0 (StataCorp. LP, College Station, United States of America) and graphs were produced using GraphPad Prism version 5.0 software (GraphPad Software, La Jolla, USA).

Ethical clearance

This study protocol was approved by the Human Research Ethics Committee of the University of Sydney, Australia (Ref Number: 12083) and the Ethics Review Committee of the University of Peradeniya, Sri Lanka.

Results

Incidence of poisoning

In total, 3813 poisoned patients (above 12 years of age) were admitted to the hospitals in Anuradhapura district during the 17-month data collection period. The overall annual population incidence among people above 12 years of age was 426 per 100 000, while the annual population incidence in females was slightly higher than in males (450 versus 408 per 100 000, respectively). In-hospital deaths totalled 177, and the annual population mortality rate for acute poisoning was 19.8 per 100 000 for the population above 12 years of age.

Most poisoning admissions (97%) were deliberate self-poisonings; only 3% (119/3813) were accidental poisonings. These occurred mainly while spraying or preparing pesticides, as accidental ingestions, or as a result of medication dosing errors or food poisoning. No deaths were recorded in this group.

Of the 3813 patients admitted for acute poisoning, 3111 (81.6%) were initially admitted to primary hospitals, and 2287 (73.5%) were subsequently transferred to the referral hospital. Direct admissions to the referral hospital totalled 702 (18.4%). Thus, a data set composed of all hospital admissions resulted in the double counting of more than half the patients, whereas each of the two other admission data sets underestimated the incidence by about 20% (Table 1).

Poisoned patients ranged in age from 12 to 86 years (median age: 24 years; inter-quartile range [IQR]: 19–35), and 1952 (51.1%) were female. No age was recorded for 21 patients – 8 females and 13 males. These patients were not included in age-group comparisons.

Observed age, sex and poison

Despite the double-counting or under-counting of admissions, all admission data sets were approximately similar in sex and age distribution (Table 2, available at: http://www.who.int/bulletin/volumes/90/6/11-092114). Minor errors were noted (all less than 20%) in the estimated proportion of different types of poisoning (Table 2).
Variation in mortality and case-fatality

The case-fatality rate among patients admitted to primary hospitals and not transferred was low (1.9%); the case-fatality rate among transferred patients was comparable to the rate observed in patients directly admitted to the referral hospital. This suggests that primary hospitals correctly identify nearly all high-risk patients and transferred them appropriately (Table 3). The best estimate of the actual number of deaths was provided by the “all admissions” data set, but most deaths (161/177) were found in the data set of admissions to the referral hospital exclusively (Table 3). Only two patients died during the transfer to the referral hospital.

Admission data sets for the primary hospital only and the “all admissions” data set substantially underestimated overall case-fatality. The best case-fatality estimate was provided by referral hospital admissions data (Fig. 1 and Table 3). This was also true for the case-fatality rates pertaining to specific types of poisoning (Fig. 1). The “true” case-fatality rate falls within the CI of the case-fatality rate derived from referral hospital data (Table 3).

Discussion

The developing world bears a disproportion-ate share of the global burden of suicide by poisoning. This is largely because the agents commonly ingested in cases of self-poisoning in these countries, such as pesticides, tend to have higher toxicity. However, the types of poisons used in deliberate self-poisoning and their lethality vary substantially in the developing world. Epidemiological data are important because they provide information used to plan and evaluate public health responses. In this paper, we have demonstrated that in a rural district in Sri Lanka the simplest approach is to use data on admissions to the referral hospital, which is not only reasonably representative of poisonings in the entire district but also more accurate than any other hospital admission data set that does not track transferred patients. The public health structure and referral patterns in most of rural Sri Lanka are similar. Thus, we believe that our findings apply to all rural districts in Sri Lanka. The use of referral hospitals for toxicovigilance is more convenient, less expensive and better suited to detailed prospective data collection than other methods. Our findings also help to validate the results of previous studies in rural Sri Lanka based on the use of data for acute poisoning admissions to referral hospitals.

The potential limitations of the suggested method of toxicovigilance need to be considered. In this study primary hospital data were collected retrospectively from patient records by research assistants within 3 weeks of admission using a structured form. We verified the completeness of case-finding by comparing the data thus collected with the data in each hospital’s admissions book. We also validated the quality of data entry by comparing the data collected for the 75% of patients who were
transferred to the referral hospital with the data appearing in the books.

In the referral hospital, data were prospectively collected by junior research physicians who provided 24-hour coverage. This data collection included all data elements collected for referred patients in the primary hospital. Validation confirmed the accuracy of data extraction in primary hospitals. The referral hospital tended to identify the specific poison ingested, whereas primary hospitals tended to list only the chemical class. This is important because agents belonging to the same chemical class vary substantially in their toxicity. Poisoning exposure data that aggregates exposures by chemical groups is seldom useful for developing effective public health response measures, including regulatory restriction of specific compounds.9

In the study district the transfer rate from primary hospitals to the referral hospital was very high. In Sri Lanka, transfers are initiated by physicians in primary hospitals; there are few barriers and no fixed protocol. As previously noted, the resultant double-counting of transferred cases in official statistics leads to large underestimates of the mean case-fatality rates for all poisonings.8

During the study period, deaths from acute poisoning totalled 177 in all hospitals in the study district. Previous studies in the district showed that 96% of deaths from pesticide ingestion occur in public hospitals. This probably reflects easy access to the public health system and the fact that the most toxic pesticides that can cause a rapid death are banned.12,13

Data on “all admissions”, used by the government to derive the population incidence, overestimated the incidence of self-poisoning by about 60%. In 2007, 5118 cases of acute poisoning occurred in Anuradhapura district, for an official incidence of 639 per 100,000.14 In our study, the observed “true” population incidence of acute poisoning in 2008–2010 was 461 per 100,000 (2962 annual cases on average). A casual reader might assume that incidence of acute poisoning has changed dramatically, whereas the difference can be entirely explained by the double counting. In contrast, in our study the estimated average true annual incidence of death from acute poisoning was almost identical to the rate derived from “all admissions”, used for

<table>
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<th>Poisoning type</th>
<th>Directly Transferred</th>
<th>In transfers</th>
<th>All admissions</th>
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<tr>
<td>Organophosphates and carbamate</td>
<td>103</td>
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<td>381</td>
<td>227</td>
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</table>

CI, confidence interval.

a | Sum of all acute poisoning admissions to the district’s primary hospitals and to referral hospitals (i.e. all admissions minus transfers).

b | All admissions to primary hospitals (all are direct admissions, no referrals).

c | All admissions (both direct and transfers) to the referral hospital.

d | Raw total of all admissions to all hospitals in the district (routine method used for government statistics, which double counts patients transferred to referral hospitals).
government statistics: 14.1 per 100,000 (113 deaths per year on average) from government statistics versus 15.2 per 100,000 (125 deaths per year on average) in our study.

Our “gold standard” study, intended to identify the most accurate hospital admission data set required to calculate the incidence of acute poisoning, required a large team of research assistants and auditors and labour-intensive data linkage to avoid undercounting or double counting cases. Such complicated surveillance is unlikely to be practical in a broader, non-research public health setting. This study suggests that referral hospital admissions data can yield incidence and case-fatality estimates very close to the “true” or “gold standard” figures in many respects and are therefore the best hospital data set for this purpose. Collecting data from larger referral hospitals only, has other advantages over collecting it from dozens of small primary hospitals. The large number of patients justifies prospective data collection by a small team, which makes it much easier to ensure good data quality and to collect the data more quickly and efficiently. Data can easily be expanded to include more details on exposure or on the circumstances surrounding the poisoning, the specific chemical used and the clinical management required. Such data can facilitate public health education, research and interventions.

In Sri Lanka, most hospital admissions for acute poisoning are deliberate self-poisonings. Surprisingly, the small, primary hospitals provided little data regarding the less serious occupational and other accidental exposures. Although our study showed minor differences in the type of acute poisoning cases presenting to primary hospitals, referral hospital data captured most of these patients and was generally a better source of data for calculating incidence and case-fatality than primary hospital admissions data. Current government statistics have the additional problem of being based largely on coded data from all hospitals, and as a result they only contain data for the poison’s chemical class (four broad categories) and for patient age and sex. The lack of details on specific types of poison limits the use of government statistics for targeting regulatory responses and assessing interventional studies. In our study relatively few deaths occurred in primary hospitals, and this further confirms that such hospitals correctly identify and transfer nearly all high-risk patients. However, transferred cases rarely died of medication poisoning, which suggests that few such patients need to be transferred for more intensive treatment. Reducing these transfers may save health resources.

Our results may be applicable to rural districts in developing countries at large, particularly if their health systems and referral patterns are comparable to those of Sri Lanka. In this country’s rural provinces, most patients live within 30 minutes (by motorized vehicle transport) of a primary hospital, and primary hospitals are typically at a distance of 1 to 4 hours from the referral hospital by vehicle transport. Public health care is free; the private sector is relatively underdeveloped and poisonings very rarely present to private hospitals. The toxicity of the poisons ingested in Sri Lanka is such that poisoned patients usually reach the hospital alive and seldom die during transfer or have a worse outcome than patients who present directly to referral hospitals. However, poisons with very rapid onset of toxicity and death may be subject to a different sampling bias. For example, in Sri Lanka’s Southern Province we have reported on the high toxicity of a cleaning agent that quickly causes death. When using any sentinel data source, it is important to know the time-course of common poisonings to understand whether the representativeness of the data is threatened by the inclusion of cases of poisoning with certain compounds. Our method of conducting toxicovigilance requires an understanding of both patient transfer patterns and the degree of toxicity of common poisons to know what adjustments should be made in interpreting the data.

**Conclusion**

In Sri Lanka, acute poisoning cases admitted to primary and referral hospitals differ in terms of the poisons ingested, case severity and case-fatality. However, because most patients are subsequently transferred to referral hospitals, admission data from referral hospitals only can be used with reasonable accuracy to represent the true incidence of acute poisoning within an entire province. Studies in other countries should be conducted to try to validate this approach.

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*Fig. 1. “True” case-fatality rate (CFR) in patients admitted to hospital for acute poisoning and CFRs based on three possible hospital admission data sets, Anuradhapura district, Sri Lanka, September 2008 to January 2010*
Referral hospitals for toxicovigilance in Sri Lanka

L Senarathna et al.

Abstract

Objective: To identify the hospitals involved in toxicovigilance monitoring for acute poisoning in Sri Lanka to determine the effectiveness of observing the referral hospitals.

Methods: A questionnaire was sent to all hospitals in the country to determine the number of hospitals involved in the study and the type of data collected. The number of cases of acute poisoning reported to the hospitals was also determined.

Results: A total of 34 hospitals were involved in the study, with 23 of them sending completed questionnaires. The majority of hospitals (21) were general hospitals, and only 3 were specialized hospitals.

Conclusion: The study showed that the referral hospitals are an important source of data for toxicovigilance monitoring in Sri Lanka. However, more efforts are needed to improve the collaboration between hospitals and the relevant authorities to ensure effective monitoring of acute poisoning cases.

Keywords: Toxicovigilance, Referral hospitals, Acute poisoning, Sri Lanka.
The admissions in the hospitals of primary care only, (ii) all admissions to the hospital of reference only (direct and readmissions) and (iii) all admissions in the hospitals of primary care, as well as the hospital of reference ("all admissions"). The third group constitutes the statistical method of governmental usual but can be calculated twice because, in the case of this study, the referrals were not counted as one but only by recollection of data.

Results: Out of 3,813 patients admitted for intoxication, 3,111 were initially presented to the hospital of primary care and 2,287 (73.5%) were subsequently transferred to the hospital of reference, where the majority of cases were treated.

Conclusion: The data on "all admissions" have been overestimated by 60%. The data of the hospital of reference allowed to obtain the incidence of intoxications averted by 20% and the data on "all admissions" were underestimated by 60%.

Resumen

Validéz de los hospitales de derivación para la toxicovigilancia de intoxicaciones agudas en Sri Lanka

Objetivo Identificar el conjunto de datos de ingresos hospitalarios que mejor recoge la incidencia de la intoxicación aguda en la Sri Lanka rural.

Métodos Se recopilaron datos de todos los ingresos por intoxicación aguda en 34 hospitales primarios y un hospital de derivación en el distrito de Anuradhapura, entre septiembre de 2008 y enero de 2010. Se compararon tres conjuntos de datos de ingresos con la incidencia real de intoxicación aguda para determinar el sesgo sistemático inherente a cada conjunto de datos. La incidencia real se calculó sumando todos los ingresos directos (no remisiones) de los hospitales primarios y del hospital de derivación. Los tres conjuntos de datos fueron: (i) únicamente todos los ingresos en hospitales primarios; (ii) únicamente todos los ingresos en el hospital de derivación (directos y remisiones) y (iii) todos los ingresos tanto en hospitales primarios como en el hospital de derivación (todos los ingresos). El tercero es el método estadístico rutinario del gobierno, pero en éste las remisiones se cuentan dos veces, así que para el estudio solo se tuvieron en cuenta una vez los pacientes remitidos a través de la interrelación de datos.

Resultados De los 3,813 pacientes ingresados por intoxicación, 3,111 acudieron en primer lugar a un hospital primario y 2,287 (73.5%) fueron remitidos posteriormente al hospital de derivación, donde se registraron la mayoría de los fallecimientos (161/177). Todos los conjuntos de datos eran representativos demográficamente y por tipo de intoxicación, así que los datos del hospital de derivación confirmaron la alta tasa de mortalidad que se había encontrado en los hospitales primarios, y que los datos del hospital de derivación suprimieron la incidencia de la intoxicación aguda en aproximadamente un 20% y los datos de «todos los ingresos» se sobreestimaron en un 60%.

Conclusión Los datos de ingreso de los hospitales de derivación se pueden obtener fácilmente y reflejan de forma precisa la incidencia de intoxicación real.
References


15. Senarathna DLP. How the level of resources and hospital staff attitude in primary care hospitals in rural Sri Lanka affect poisoning patient outcome. (Minor thesis). Newcastle: University of Newcastle, 2006


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<th>Group</th>
<th>&quot;True&quot; total admissions&lt;sup&gt;a&lt;/sup&gt;</th>
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<th>All admissions to referral hospital only&lt;sup&gt;c&lt;/sup&gt;</th>
<th>All admissions&lt;sup&gt;d&lt;/sup&gt;</th>
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<td>18 (16.7–19.4)</td>
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<td>Oleander</td>
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<td>9.6 (8.6–10.7)</td>
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<td>50.8 (49.0–52.6)</td>
<td>0.99</td>
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CI, confidence interval.

<sup>a</sup> Sum of all direct acute poisoning admissions to the district's primary hospitals and its referral hospital (i.e. all admissions minus transfers).

<sup>b</sup> All admissions to primary hospitals (all are direct admissions, not referrals).

<sup>c</sup> All admissions (both direct and transfers) to the referral hospital.

<sup>d</sup> Raw total of all admissions to all hospitals in the district (routine method used for government statistics, which double counts patients transferred to referral hospitals).

<sup>e</sup> No age was recorded for 21 patients (includes males and females).