Cost benefits of the Drug and Poison Information Centre in preventing unnecessary hospitalisation: the Singapore experience

藥物及中毒諮詢中心在避免不需要住院的成本效益：新加坡的經驗

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Background: The Drug and Poison Information Centre (DPIC) in Singapore was piloted as a new service in April 2004. This study evaluated the cost benefits of its interventions in the first two years of its operation. ***Method:*** A two-year retrospective review of DPIC call records was performed and the following outcome measures were noted: (A) proportion of patients who were managed onsite and hence did not need to attend the emergency department (ED); and (B) proportion of patients who were managed in the ED without the need for admission. Cost savings were calculated based on admission costs for patients with poisoning, including other out-of-hospital costs. This amounted to savings of S$1390 and S$1170 for patients who fulfilled outcome measures A and B respectively. Savings for the hospital was S$1477 per case. The cost of operating the DPIC over the same period was S$507,922. ***Results:*** There were 831 calls on acute toxic exposures over the study period. Of these, 115 and 405 patients fulfilled outcome measure A and B respectively with consequent cost savings of S$159,850 (115 x S$1390 per patient), and S$473,850 (405 x S$1170 per patient). The hospitals saved S$768,040 (520 x S$1477) from prevented admissions. Excluding operating cost, this gave net savings of S$893,818 over the two years from DPIC interventions. ***Conclusion:*** The cost savings from DPIC services is evident from this study. This translates to more effective use of limited healthcare resources. (*Hong Kong j.emerg.med.* 2010;17:45-53)

背境：2004 年 4 月新加坡試行「藥物及中毒諮詢中心」為新的服務。這研究評估在這介入首兩年運作中的成本效益。**方法：**從藥物及中毒諮詢中心兩年的來電記錄，進行回顧性審查，留意以下的結果量度：（甲）在現場處理而因此不需要到急症室求診的病人比例；（乙）在急症室處理而不需要入院的病人比例。基於中毒病人住院的費用，包括其他院外費用，計算所節省的成本。實現結果量度甲及乙的病人各自節省新幣 $1,390 及 $1,170。醫院每個案節省新幣 $1,477。藥物及中毒諮詢中心同期的營運費為新幣 $507,922。**結果：**研究期間共有 831 急性中毒的來電，其中分別有 115 名及 405 名病人實現結果量度甲及乙，結果各自節省成本新幣 $159,850（每病人 $1,390 x 115）及新幣 $473,850（每病人 $1,170 x 450）。由於避免了住院，醫院節省了新幣 $768,040（$1,477 x 520）。扣除經費後，藥物及中毒諮詢中心的介入兩年來節省的淨數為新幣 $893,818。**結論：**從這研究，藥物及中毒諮詢中心服務節省的成本是明顯的，這可解作更有效使用有限的醫療資源。

Keywords: Cost-benefit analysis, health care costs, hospital economics, poison control centers, poisoning

關鍵詞：成本效益分析、醫療費用、醫院經濟學、中毒控制中心、中毒

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Introduction

Injuries, including unintentional poisonings, are a major problem worldwide.[1-9] In 2004, the American Association of Poison Control Centers in the United States recorded more than 2.4 million toxic exposures, averaging 8.3 exposures per thousand population; the total fatalities due to poisonings were 1183.[10] An average of one million poisoning-related emergency department (ED) visits were made in the United States during 1993-1996.[11] In Victoria, Australia, an average of 658 children were admitted to hospital each year because of the ingestion of poisons, mainly pharmaceuticals.[3] Approximately 12% of all acute injury hospital admissions in Ireland were due to acute poisoning.[12]

In Singapore, poisoning is an important cause of significant morbidity and mortality. Together with accidents and violence, poisonings ranked as the 5th most common cause of death (4.9%) and most common cause of hospitalisation (8.6%) in 2005.[13,14] According to official statistics, there have been approximately 9000 cases of poisoning annually managed by hospitals in Singapore for the last three years.[15,16] This places a strong demand on the limited healthcare resources.

A 1998 study noted that poisonings accounted for a significant number of physician consultations in Singapore; the estimated prevalence of poisonings averaged 16.56 cases per thousand population.[17] A study of 50 patients admitted to an intensive care unit in a local hospital in Singapore for poisoning over a two-year period revealed the common toxins involved in such severe poisonings were organophosphates and carbamates followed by benzodiazepines, tricyclic antidepressants and phenothiazines.[18] Victim outcomes included 4 deaths (8%), 17 (34%) requiring ventilatory support, 2 (4%) requiring peritoneal dialysis, and 1 (2%) requiring forced diuresis. Poisoning appeared to be associated with significant morbidity and mortality in the study.

Poisonings are medical problems that need to be recognised and treated early to improve patient outcome. The importance of timely diagnosis and appropriate treatment has made quick access to drug and poison information resources critical.[19]

The first Drug and Poison Information Center was established nearly 50 years ago in Chicago, United States.[20] Since then, more centres have been set up in the United States, Europe, Asia and other countries to provide accurate and reliable information on drugs and toxins in a timely fashion to physicians managing toxicological problems.[12,20-22] These centres are cost-effective and life-saving public health services.[1,8,9,20,23-27] It is estimated that each dollar spent on poison control centre funding prevents four to nine dollars of unnecessary health care expenditures, primarily as a result of treating poisonings at home rather than at a health care facility.[8,9,11,25]

Drug and Poison Information Centre operations in Singapore

The Drug and Poison Information Centre (DPIC) in Singapore was set up in April 2004 as a resource for drug and poison information. It functions round the clock and provides free telephone consultations and advice for both drug information and poison treatment-related advice to healthcare professionals, members of the public and industry. With regards to toxic exposures, the DPIC provides assistance with the diagnosis of poisonings and recommendations for optimal patient management.

The DPIC is staffed by pharmacists (4 full time pharmacists and a pool of 6 part time honorarium-based pharmacists) specialised in drug and poison management who screen the calls and provide initial advice on management of toxic exposures to callers. This is followed up by a more detailed consultation with the supervising toxicologists (4 emergency physicians with specialised training in toxicology who are honorarium-based for phone consultations only) for concurrence with their initial recommendations and for further specific recommendations if needed. The caller thus attains both first aid and basic poisoning advice followed by subsequent specialist advice as needed. Follow-up review calls are made subsequently by the pharmacists to determine the effectiveness of

the advice given, to provide further assistance as required and to enquire about specific outcomes. In particular, the following outcomes are noted: if the advice is followed or if the patients have to seek advice from other healthcare providers or be treated at the ED or be admitted for their condition (Table 1).

All calls to the DPIC are logged into a database, which has been developed in-house to collate information from callers and to document relevant advice and follow up reviews of the patients. The data is maintained by information communications personnel from the Singapore General Hospital (SGH), which is the hospital hosting the DPIC.

This was the first study conducted in Singapore that aimed to evaluate the cost benefits of the interventions provided via the DPIC in its first two years of operation.

Method

A two-year retrospective review of DPIC call records from April 2004 to March 2006 was performed and analysed for the following outcome measures to determine the cost benefits of the DPIC:

1. Outcome measure A: number of patients who were managed onsite and hence did not need to attend the ED for management. For this analysis, the following formula was used:

   Outcome measure A=(C-D), where,

   C=all poisoning calls from the public and community healthcare providers, primarily general practitioners (GP), and

   D=those callers who were advised by the DPIC to go to the ED for further assessment.

   The assumption was that all these patients would have gone to the ED or to their primary care physicians who would have subsequently sent the patient to the ED for further management due to their lack of information resources and expert advice in assisting them with management decisions.

2. Outcome measure B: number of patients who were managed in the ED without the need for in-patient admission. For this analysis, the following formula was used:

   Outcome measure B=(E-F), where,

   E=all calls originating from the ED, F=number of calls from the ED advised for admission.

   The assumption was that these patients who seek treatment for acute toxic exposures at the ED would have been admitted to the in-patient wards if not for the specific advice given by the medical toxicologist for making relevant management decisions.

In order to determine cost benefits, the total cost savings from the prevention of unnecessary attendance at the ED and subsequent prevention of in-patient admission were calculated based on the following component parts:

1. Transportation cost of $165 using emergency ambulance service to the ED.[28]
2. General practitioners' consultation fees of $55 for long consultation of approximately 20 minutes.[29]
3. Average cost of hospitalisation for patients with

Table 1. Advice to caller*

Location of caller	Advice to caller
Caller from the public	Advice to go to hospital Advice to observe at home
Caller from community healthcare providers, primarily general practitioners	Advice to go to hospital Advice to observe at home
Caller from hospital emergency departments	Advice to admit patient Advice to observe at home

*Calls from wards were excluded from the analysis, as the impact on outcomes in warded patients was difficult to evaluate.

poisoning (the fee based on two days of stay in a non-monitored general ward bed was S$570 per patient inclusive of ED consultation fee).
4. Economic cost from spending time away from gainful employment based on a two day length of stay for poisoning multiplied by the average income of Singaporeans ($150/day)[30] i.e. S$300.
5. Caregiver cost from time spent away from family and gainful employment to look after patient and his family ($150/day multiplied by 2 days length of stay of the patient) i.e. S$300, assuming a single caregiver having to take over the duties of the patient in looking after the affected family's needs.
6. Average cost to the hospital for managing these poisoned patients (S$1477 per poisoning case for those admitted two days or less to a non-monitored general ward bed).

For the above calculations, the cost of admission and average length of stay for poisoning were extracted from SGH, the largest public hospital in Singapore. This information, which was captured in the hospital finance database, was data mined to extract information on patients admitted with poisonings as identified by the International Classification of Diseases (ICD) 9th edition, codes for poisoning (960 to 979), based on the primary diagnosis code entered upon discharge of the patients. This information was gathered for patients with poisonings admitted over 2004 and 2005 and then analysed to determine the average length of stay as well as the cost of admission (average bill size per poisoned patient and average cost of poisoning-related admission to the hospital for each poison case that was managed). In order to determine a reasonable average cost involved, patients with a length of stay of two days or less were included in the cost of admission estimation as it was felt that these patients were more likely to have benefited from out-patient management of their condition.

According to hospital statistics, there were a total of 549 admissions for poisoning to the Singapore General Hospital during the years 2004 and 2005. The average length of stay was 7 days (range of 1 to 12 days). Approximately a third of the patients (36.2%) had a length of stay of 2 days or less. The average patient bill for patients with a 2-day length of stay was S$570 (ranging from S$48 to S$6969) per patient and the average total cost to the hospital was S$1477 (ranging from S$194 to S$7101) for each case from subsidies provided to the patient.

It was assumed that patients who were managed in the out-of-hospital setting (outcome measure A) would have saved from all of the above costs (1-5) i.e. S$1390 per patient; while those who were managed in the ED without admission (outcome measure B) would have saved from hospitalisation charges and other economic costs (3-5) i.e. S$1170 per patient. Savings for the hospital is estimated to be S$1477 per case.

This was compared to the cost of operating the DPIC (manpower, training, equipment and licenses for poison databases and reference resources) over the same period i.e. S$507,922.

Results

There were 7926 calls to the DPIC since its operation started in April 04 till March 2006 covering the study period. Of these, 831 (10.5%) calls were on acute toxic exposures involving patients, while the remainder covered various drug information related matters and were excluded from this study. In addition, 113 of the 831 calls were poisoning cases admitted to wards and again were excluded from the analysis.

The majority of calls were from hospital EDs (Table 2) including 3.1% from private hospitals. It was noted that physicians (83.0%) initiated most calls while patients or their caregivers accounted for 13.6% of the calls with the rest from other healthcare providers such as nurses, pharmacists, and paramedics. The main mode of accessing the service was through the telephone (98.9%) with a smaller number through faxes and electronic mail. More than a third of these calls involved young children (Table 3) with the youngest exposure at 1 month and the oldest at 90 years of age. There were similar numbers of males and females victims (48.1% were males).

Most toxic exposures occurred at home (63.5%) with others occurring at the workplace (13.5%) and

Table 2. Outcome of calls

Location	Total number of calls	Number treated on-site
Hospital emergency departments	532 (74.1%)	405 (77.9%)
General practitioner clinics	64 (8.9%)	27 (5.2%)
Public	122 (17%)	88 (16.9%)
Total	**718**	**520**

Table 3. Age of patients affected by poisoning

Age group (years)	Poisoning cases
<5	215 (30.0%)
6 to 20	146 (20.3%)
21 to 50	294 (40.9%)
>50	63 (8.8%)

recreational places such as parks and pubs (7.0%). Most exposures were accidental (65.1%). There were equal numbers of toxic exposures occurring during (49.6%) and after office hours (including weekends and public holidays). The number of agents involved in each exposure ranged from one (82.6%) to a maximum of 6 (<1%) co-ingestants. Most calls were on exposures to analgesics (123 cases, 17.1%), antidepressants and sedatives (103 cases, 14.3%), bites and stings (78 cases, 10.9%), household cleaning products (52 cases, 7.2%), industrial chemicals (61 cases, 8.5%), pesticides (32 cases, 4.5%), alcohol (14 cases, 1.9%), traditional medicines (13 cases, 1.8%) and cosmetics, other household products and nutritional supplements (172 cases, 24.0%).

There were 115 patients (61.8% of all calls from the public and community healthcare providers, primarily GP) who fulfilled outcome measure A with cost savings of S$159,850 (115 x S$1390 per patient) from prevented visits to the hospital as a result of calling the DPIC. Similarly, there were 405 cases (76.1% of calls from the ED), which fulfilled outcome measure B with cost savings of S$473,850 (405 x S$1170 per patient) from prevented admissions, which benefits the patient, the taxpayers and health authorities. In addition, the hospital saved S$768,040 (520 x S$1477) from admissions that were prevented. Hence, the total cost savings from the DPIC interventions amounted to S$1,401,740 compared to the operating cost of the DPIC which was S$507,922 giving a net savings of S$893,818 over the two years.

It was noted in the course of follow up reviews that 13.0% (69 cases) of callers from the ED did not follow DPIC advice and eventually admitted their patients. However, for calls from the public and GP, the majority (96.5%) were compliant with the advice and were managed onsite without seeking treatment at the ED or other physicians. The reason for non-compliance to advice was not captured in the database.

The DPIC was able to provide immediate definitive advice within 15 minutes of the call for most situations (78.1%) and 95.5% of all calls were resolved within one hour. The remaining smaller proportion of cases took up to 8 hours to resolve due to complexities of the cases involved as detailed search for information took up most of the time.

Discussion

The DPIC had a vital role to play in the management of poisonings. This is the first study to determine the cost benefits of such a service in the Singapore context.

The need for drug and poison information services and its usefulness has been studied previously. In countries where drug and poison information centres exist, medical professionals are likely to use this service and are satisfied with the information received in most cases.[31] A study assessing the clinical toxicology resources used by emergency physicians in the United States showed that poison centres were frequently utilised in 66.1% of cases.[32] Other studies have also noted that the DPIC is the most useful source of poison

information.[12] A study that looked at the expectations of emergency physicians regarding DPIC services noted that there was a good fit between emergency physician expectations and services provided by the poison centre in 94% of all services provided.[31]

The lack of timely expert guidance in toxic exposure management results in sub-optimal care delivery including unnecessary interventions and admissions.[9] Studies have shown that most lay people would have the poison victim brought directly to the ED for treatment, irrespective of the nature of the poisoning, if a poison centre was not available.[1,8,33] Although the studies have not looked into the reasons for such behaviour, it can be postulated that ingestion of a potentially toxic agent is a psychologically stressful event to both patient and caregiver, especially so because of the lack of knowledge on the toxic effects. In this regard, the Drug and Poison Information Centre in Singapore was set up to provide a telephone consultation service to healthcare professionals, members of the public and industry, to assist with the diagnosis and management of poisonings.

It has been noted that poisonings between adults and children are different. Adult poisonings are often intentional and lead to serious morbidity and mortality,[9,20] whereas most childhood poisonings are mostly accidental and not associated with serious morbidity and mortality, and can be managed at home with advice.[1,4-7,9,20,34,35] In one study of paediatric patients seen in the ED for acute poisonings, clinical toxicologists judged that 64% did not require a visit to the hospital for medical treatment or assessment.[1] Occasionally, such ingestions can be dangerous or result in death.[6] While many child exposures may not be due to actual poisoning, they still cause anguish to parents and are a legitimate basis for seeking medical assistance.[20]

In our study, most toxic exposures were noted to occur in the younger age groups (pre-school and school-age children, and working adults) and many are accidental and hence potentially preventable. This is very similar to the statistics put out by the American Association of Poison Control Centers, Toxic Exposure Surveillance System (TESS) in the United States where most exposures are recorded in the under 6 years age group. In addition, a proportionally larger distribution of toxic exposure calls occur outside normal working hours during the late evenings and nights as well as public holidays when access to experienced medical professionals are at its lowest compounding the difficulty of managing toxic exposures. Hence, the DPIC services were essential in triaging these cases so that only the cases that needed further assessment in the ED were advised to consult, reducing the burden on ED.

In one study, using TESS data, it was found that public calls to a poison control centre were managed in a non-health-care facility; usually in the patient's home (74%).[10] Similarly, in our study it was noted that most cases (61.8%) were managed in the out-of-hospital setting without the need for ED attendance.

Although it is obvious that reducing visits to the ED and cutting down unnecessary admissions would translate to cost savings, it would be intuitive that the evidence based management advice and guidance from the DPIC for toxic exposures also help to promote effective and efficient use of medical resources by making appropriate referrals to the ED and advising on necessary interventions, appropriate investigations and relevant medical resource utilisation. However, cost savings from this more focussed management planning for poisoning cases that were admitted through DPIC's consultation and advice, and its impact on possible reduction of length of stay was not analysed as it was beyond the scope of this study. In addition, it has been noted that there were better health outcomes for cases that did need to go to the ED as advised by the DPIC.[23] This triaging role of the DPIC and its interfacing with the ED is likely to translate to improved morbidity and mortality outcomes from toxic exposures. However, these intangible benefits are hard to quantify.

The cost benefits of such a service have been demonstrated in several studies.[9,20,23,25-27] Injury, illness and death caused by poisoning can be decreased when poison centres assess patients early and identify patients

who need more aggressive management.[8] Morbidity and mortality associated with poisoning have been on the decrease in Europe due to the efforts of the services provided by such centres.[24] This translates to improved healthcare outcomes in terms of decreased morbidity and mortality and better use of limited healthcare resources, which results in reduced cost to both the individual and to the government.

This first study looking at such a service in Singapore, demonstrates the cost benefits of its interventions in the local medical scene. It is important to note that conservative estimates were made on the cost to the patient and the hospital. Cost estimates were made based on cases identified through the ICD coding system for the primary diagnosis codes only. Hence, more complex cases complicated by other co-morbidities, which would have increased the cost, were not included in the analysis. In addition, the average cost of hospitalisation only took into account stay in a non-monitored general ward bed for a length of stay of two days or less. The costs would have been higher for high dependency and intensive care beds, or if the patients' stay had been prolonged. However, it is fair to assume that those not requiring hospital care were minor poisoning cases only.

As the DPIC has been set up only recently, awareness of its existence was limited. Hence, the net savings would likely be greater if the penetrance of the DPIC services to the general community and medical community is improved through publicity. In addition, the unrealised opportunity cost to the hospital from freeing up a sizeable number of beds for elective work is expected to generate downstream revenue for the hospital.

In evaluating the cost benefits of DPIC interventions, it has been the usual practice to analyse the cost benefits from the purely financial perspective of prevented admissions. However, it would be prudent from the medical standpoint to evaluate the DPIC interventions and its impact on clinical quality of care and improvements in outcomes, particularly reduction in mortality and morbidity for patients who have been overdosed. There are also intangible benefits such as reduced psychological trauma from stress and anxiety for the patient and family, efficient and effective use of limited health resources e.g. better use of ED and emergency ambulance services and reduced impact on worker productivity. Of particular note will be the short turn around times usually within minutes, for DPIC interventions as opposed to the time taken from multiple contact points with the health service. This significantly saves the individual, his family and healthcare providers' precious time.

In addition, the impact of DPIC poisons prevention activities and its effectiveness in reducing toxic exposures to the general population and workforce should also be taken into account when considering the overall cost effectiveness. The extended functions of the DPIC as a sentinel outpost for product and drug safety, and toxic disaster preparedness deserve further mention although it may be difficult to put a dollar value to it.

Limitations

1. Assumptions were made in calculating the component parts of costing. In particular, it was assumed that all poisoning cases arriving at the ED used the emergency ambulance service. No historical data was available on this specific subset of patients in regards to their mode of arrival in the ED and hence this assumption was made.
2. Although it was assumed that patients with a length of stay of two days or less were more likely to benefit from out-patient management of their condition, it is important to note that a short stay of several hours may have been required to monitor for onset of acute effects of intoxication.
3. The actual outcomes from management of toxic exposures at the home, GP clinics and ED without DPIC intervention were largely unknown and hence assumptions were made. However, a study in Singapore, prior to the establishment of the DPIC, had reported that 36.1% of patients presenting with toxic exposures to the ED of three public hospitals in Singapore between 2001 to 2003, were admitted for in-patient care.[36] This should be taken into

account when applying the findings of the study. However, it should be noted that ED admission rates may not be comparable to DPIC advice for admission for one reason being that emergency physicians at EDs are more likely to contact the DPIC for advice on the management of complicated cases which are also the cases more likely to require admission.

4. It is crucial to note that most callers followed the advice given by the DPIC. However, the reasons for non-compliance were not available and were likely multifactorial. A lack of observation facility at the ED of some hospitals might have accounted for some of the admissions. Patients might also have been admitted for social reasons, which were beyond the control of the physician-in-charge even with inputs from the DPIC and hence might be unpreventable although medically unwarranted. The extent of these were not analysed in this study.
5. The DPIC is hosted within the premises of Singapore General Hospital and hence the overheads (for facilities, physical space and utilities) as borne by the hospital were not reflected as part of the operating costs.
6. The impact from cost savings to the employer and business opportunity costs were not included in this study due to the complexity of analysing its component costs.

Conclusion

The Singapore experience confirms the cost benefits of the DPIC. It appears that for every dollar spent on the DPIC, its interventions saved approximately S$2.76 in other healthcare related costs. Benefits from the other extended functions of the DPIC such as poison prevention activities, product safety and adverse drug reaction reporting, toxicovigilance and hazardous materials disaster preparedness should also be taken into account. Hence, in the broader perspective, DPIC activities contribute to socio-economic and psychological preparedness of the community at large in dealing with hazardous chemicals in our environment.

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