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Data Requirements for Information Management System Development for Poisoning with Acidic and Alkaline Substances

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ABSTRACT

Introduction: Ingestion of acidic or alkaline substances and its long-term effects on digestive system indicates is a common health problem worldwide. To identify the root causes of injuries, standard data collection is required. **Aim**: The present study was conducted to determine the data requirements for the establishment of information management system for poisoning with acidic and alkaline substances in Iran. **Methods:** This is a descriptive and cross-sectional study conducted in 2017. First, we attended at the hospitals affiliated to Iran, Tehran and Shahid Beheshti universities of medical sciences, which had poisoning wards; we studied all forms, reports and medical records of people who had been poisoned by acidic or alkaline substances. In the next step, a comprehensive literature review was carried out to retrieve related resources. Data were collected using data extraction form and Delphi method was used to survey them. Validity of the questionnaire was evaluated through content validity and its reliability checked by the test-retest method and Cronbach's alpha. **Results:** A minimum data set (MDS) of alkaline and acid poisoning divided into two categories: administrative with three classes including 35 data elements, and clinical with 6 classes including 145 data elements. **Conclusion:** Comprehensive and uniform data elements about alkaline and acid poisoning was not available in Iran. Development of a MDS resulted in standardization and effective management of the data through providing uniform and comprehensive data elements for alkaline and acid poisoning and comparability of information in various levels and made effective decision-making and policy-making possible.

Keywords: Information system, Dataset, Poisoning, Acids, Alkalies.

1. INTRODUCTION

Ingestion of caustic substances (strong acid or alkaline substances) and its long-term effects on the digestive system is a public health problem worldwide (1, 2). Random ingestion of these substances is common in infants and children under the age of five, especially between 1 and 4 years old. They are also consumed for suicide commitment especially by adolescents and adults (3). In the United States, the prevalence of poisoning with caustic substances is estimated to be between 5000 and 15,000 cases per year (4, 5). Substances with a pH of less than 2 (strong acid) or higher than 12 (strong alkaline) are called caustic substances (4). In fact, a caustic substance is a chemical substance that can damage any tissue that comes in contact with it (6).

During the acute phase of poisoning with caustic substances, there is a risk of bleeding, perforation of esophagus, and airway shock and edema (7). The prevalence of esophagus burn caused by caustic substances is 15.8% in 1000 cases (8). Lack of monitoring system, inadequate education of health care professionals regarding the management of such poisonings and lack of access to the proper information system might be the major reasons for the high prevalence of this poisoning (9). In the age of information technology, the use of information systems may improve make decisions. Having real information about events and accidents leading to injuries and illnesses and the measures used to help the medical staff is extremely important to save the lives of patients. Therefore, the first step in controlling injuries is to analyze them and identify their root causes. The Minimum Data Set (MDS) devel-

opment for collecting information in an integrated and standardized manner at the national level is the most important step (10).

MDS is a standard tool for data collection (11) and provides access to accurate and unambiguous data of diseases (12). Using these data is necessary to compare and analyze activities and access new and reliable information about the number of patients, diseases, new therapies and their outcomes (13). However, there is still no standard tool for collecting information on poisoning with acidic and alkaline substances in Iran.

2. AIM

The present study was conducted to determine a standard data set for implementation of an information management system for poisoning with acidic and alkaline substances in Iran and provides a basis for conducting other clinical research in the field of information systems.

3. METHODS

This is a descriptive and cross-sectional study conducted in 2017. First, we attended the Firouzgar, Baharloo and Loghman Hakim hospitals affiliated to Iran, Tehran and Shahid Beheshti universities of medical sciences, which had poisoning wards and then we studied all forms, reports and medical records of people who had been poisoned by acidic or alkaline substances. In the next step, a comprehensive literature review was carried out to retrieve related resources, including articles, reports, forms that were accessible by the Internet, books and thesis. Data were collected using data extraction form and to find resources related to the topic, databases including ISI Web of Sciences, Google Scholar, PubMed, Cochrane, MagIran, and SID using keywords such as; caustic injury data, MDS, minimum data set, caustic registry form, caustic injury form, caustic registry, poisoning registry form, and poisoning registry from 1990 to 2017. Sampling was not performed at this stage, and the retrieved resources were assessed according to the entry criteria (valid resources in English and Persian from 1990 to 2017 in full text). Data were extracted using the data extraction form. The checklist used for data collection was divided into two administrative and clinical sections according to information management standards and reference books. The final checklist was then created based on the elements retrieved from the first and second steps. Using the data elements of the checklist, a questionnaire was constructed in five-option Likert scale; so that, the score of 5 reflected the most important case and score of 1 reflected the least important case.

To determine the validity of the content quality was used of experts panel (2experts in the field of health information management and 3 experts in the field of clinical toxicologists and the poisonings). They provided their suggestions for more adaptation of the questionnaire with the aim of study and their corrective comments were received and applied in the questionnaire. To evaluate the reliability of the instrument of the test-retest method and Cronbach's alpha was used. Hence, 7 individuals (3 experts in the field of health information management and 4 experts in the field of clinical toxicologists and the poisonings) were selected from a matched group outside the research community and were asked to complete the questionnaire, which was done twice within 10 day interval. The value of correlation coefficient using Pearson test (according to the normality of the data) 0.87 was calculated. The value of Cronbach's alpha for the entire questionnaire was obtained to be 0.76 and the reliability of the questionnaire was confirmed.

Research population for determination of data requirements for information management system development for poisoning with acidic and alkaline substances were experts of health information management departments of Tehran, Iran and Shahid Beheshti Universities of Medical Sciences (10 individuals), as well as clinical toxicology and poisoning specialists working in Loghman Hakim, Baharloo and Firouzgar Hospitals (9 individuals). In the present study, due to limitation in the number of experts, the census method was used. To determine the minimum data set, the questionnaire was given to the experts. The administrative section of the questionnaire was completed by the health information management specialists and clinical section of the questionnaire was completed by clinical toxicology and poisoning specialists. Finally, data elements of the information management system for poisoning with acidic and alkaline substances were selected using the Delphi technique. Table 1 shows the demographic characteristics of the specialists.

Participants	Quantity	Gender	Frequency for each Age group	Average work experience (year)
Health information management or medical records	10	Female: 7 Male: 3	30-39: 1 40-49: 4 50-59: 5	17.4
Clinical toxicology and poisoning	9	Female: 2 Male: 7	30-39: 1 40-49: 4 50-59: 4	10.66

Table 1. Participants' characteristics in Delphi technique

Data analysis was performed using Likert's 5-option scale and the decision criterion for accepting data elements was the level of agreement of the experts. Thus, the data elements that were agreed upon less than 50% (scores below 2.5 from 5) were removed from the proposed MDS. The data elements where the collective agreement for them was more than 75% (scores of 3.75 to 5), were considered in the final MDS. Since no data elements obtained the agreement scores of between 50 and 75 (scores 2.5 to 3.75) for re-survey, the Delphi technique was implemented only in one round. Finally, the proposed MDS for the information management system for poisoning with acidic and alkaline substances was determined. Data analysis was done using descriptive statistics and SPSS software version 21.

4. RESULTS

The MDS for information management system development for poisoning with acidic and alkaline substances was divided into two parts: administrative with three categories, and clinical with 6 categories (Tables 2 and 3).

Group	No	Minimum data set	Average	Group	No	Minimum data set	Average
Demographic information of patients	1	First name	4.9	data of the care center	17	Hospital name	4.7
	2	Family name	4.9		18	Hospital code	4.8
	3	Father's name	4.9		19	Hospital address	4.1
	4	Sex					
	5	Date of birth	4.2	Attendance and follow up information	20	Transportation to hospital	4.5
	6	Marital status	4.1		21	Full name of referring physician	4.7
	7	Height	3.8		22	medical council number of referring physician	4.5
	8	Weight	3.9		23	Specialty of referring physician	4.6
	9	National code	4.6		24	Full name of treating physician	4.7
	10	Education level	3.8		25	medical council number of treating physician	4.5
	11	Type of insurance	4.2		26	Specialty of treating physician	4.6
	12	Occupation	3.9		27	Work address of treating physician	3.9
	13	Landline number of patient	4		28	Phone number of treating physician	3.9
	14	Mobile number of patient	4.3		29	Admission date	4.8
	15	Patient's address	4.2		30	Admission time	4.7
	16	Patient's email address	3.8		31	Dealing with toxin	4.6
					32	Place and duration of hospitalization	4.8
					33	Discharge status	4.9
					34	Date of future follow ups	4.6
					35	Death	4.8

Table 2. administrative minimum data set for poisoning with acidic and alkaline substances

Out of the 192 data elements that were surveyed, 180 elements obtained a collective agreement of more than 75% and 12 elements were removed as they obtained agreement of less than 50%. Since no data elements obtained the agreement of between 50 and 75 (scores of 2.5 to 3.75), the Delphi technique was implemented only in one round. Out of the 180 elements accepted in the proposed MDS for the information management system for poisoning with acidic and alkaline substances, 35 elements were related to the administrative part and 145 elements were related to the clinical part.

In the proposed information requirement set in Table 2, in the demographic information section, the highest mean was related to the first name, family name and father's name (4.9) and the lowest mean was related to the height, education level and patient's email address (3.8) according to the viewpoint of the health information management experts. In the health center information section, the hospital code had the highest mean (4.8) and the hospital address had the lowest mean (4.1), and in the referral and follow-up information section, the discharge status had the highest mean (4.9) and the work address and the telephone number of the treating physician had the lowest mean (3.9).

In the proposed information requirement set presented in Table 3, in the medical history section, gastrointestinal diseases had the highest mean (mean=5), and smoking cigarette and medication use had the lowest mean (mean=3.88). In the type of poisoning section, from the viewpoint of the research community, the highest mean was related to the name of the ingested alkali substance, time to ingestion of acidic substance until reaching the hospital, the measures taken until the transportation to the treatment center (mean=4.88), and the lowest mean was related to the characteristics and amount of acid, amount and concentration of alkaline substance and time of ingestion until reaching the hospital (mean=4.66). In the clinical finding section, throat and laryngeal swelling, mouthwatering, dysphagia, abdominal rigidity, rebound, and gastrointestinal bleeding had the highest score (5) and body tremor had the lowest score (3.77). In the complications section, the highest score (5) was related to gastrointestinal bleeding, perforation, fistula, esophageal stricture, mediastinitis and peritonitis, and the lowest score (4.55) was related to liver dysfunction. In the diagnostic section, endoscopy had the highest mean (4.77) and sodium and ammonia tests had the lowest mean (3.77). In the therapeutic interventions, shock treatment had the highest mean (4.77) and gastric emptying had the lowest mean (3.88).

5. DISCUSSION

According to the survey and various studies, the data elements of the information management system for poisoning with acidic and alkaline substances are divided into two parts: administrative part and clinical part. The administrative part consists of three categories (demographic information, information of care delivery center, and information of referral and follow-up). The clinical part has 6 main categories (medical history, type of poisoning, clinical findings, complications, diagnostic interventions and therapeutic interventions) and 19 subcategories, which need to be considered in the design of such system.

The quality of information in health information system plays an essential role in decision making and planning (14). Data and information should have a desirable quality to meet the needs of users, including the patient, physician, other healthcare professionals, health care providers, and authorities (15). To collect quality data and achieve integrated health information system, we need a minimum data set (16), because MDS is consid-

ered to be a primary step in the national information system (17). Hawes et al. showed that, using a minimum set of data increases the accuracy and comprehensiveness of the medical information and ultimately leads to the provision of high quality health care (18).

The initial results of the present study showed that, data related to the poisoning with acidic and alkaline substances in Iran are not collected in a standard way. Organized and unorganized data are clearly available in every organizational structure. Thus, it seemed necessary to design a minimum set of data for poisoning with acidic and alkaline substances. The MDS increases the data interoperability and sharing (19). Therefore, the development of MDS for poisoning with acidic and alkaline substances can enhance the interoperability of poisoning data through the standardization of data elements.

Some of the data elements that were verified by experts in the present study have also been approved by the experts of other fields. For example, patient personal information, pre-treatment evaluations, drug therapies and therapeutic interventions were among the factors that had been considered as the minimum data required in cystic fibrosis information systems, athletic health records, orthopedic injuries, breast cancer, nursing and burns (18). This similarity suggests the need for these data sets in many care systems.

Sadoughi emphasized on the need to record demographic information of patient, including the national ID number, first name, gender, date of birth, occupation, ethnicity, and postcode (20). The results of this study are consistent with the findings of present study in terms of the need for recording patient's national ID, full name, gender, date of birth and occupation. However, in the present study, the elements of the ethnicity and post code obtained the agreement of less than 50%, so they were removed from the proposed MDS.

A study by Robinson et al., entitled "The Performance Standards for Australian Poisons Information Centers," indicated that, all exposure to poisons should be recorded in a robust database, taking into account sufficient measures to maintain data integrity. They also emphasized on the necessity to use a set of data that has been agreed upon to allow coordination of centers at the national level and provide data in the same format for annual reports. In this study, the minimum data set considered for each exposure to a toxic substance included; the

Main category	Subcategory	No	Minimum data set	Average
Medical history	Use of substance and medication	1	Use of medication	4.22
		2	Smoking cigarette	3.88
		3	Alcohol consumption	4.22
	Diseases	4	CNS diseases	4.55
		5	Cardiac diseases	4.33
		6	Pulmonary diseases	4.66
		7	Gastrointestinal diseases	5
		8	Hepatic diseases	4.66
		9	Renal diseases	4.77
		10	Skin diseases	4.77
		11	skeleton diseases	4
		12	Hemorrhagic diseases	4.66
		13	Endocrine/ hormone disorders	4
		14	Psychological diseases	4.44
	Poisoning with toxic substances	15	Name of substance	4.66
		16	Number of exposures	4.66
		17	Cause of exposure	4.66
	Family history	18	Medication use	3.88
		19	Psychological problems	4
Type of poisoning	Acidic	20	Name of ingested substance	4.77
		21	Characteristics of substance	4.66
		22	Amount of substance	4.66
		23	Concentration of substance	4.77
		24	Time of ingestion until hospital arrival	4.88
		25	Interventions implemented until transportation to health center	4.88
	Alkaline	26	Name of ingested substance	4.88
		27	Characteristics of substance	4.77
		28	Amount of substance	4.66
		29	Concentration of substance	4.66
		30	Time of ingestion until hospital arrival	4.66
		31	Interventions implemented until transportation to health center	4.88
Clinical findings	Vital signs	32	Blood pressure	4.66
		33	Heart rate	4.55
		34	Temperature	4.22
		35	Respiratory rate	4.55
		36	Level of consciousness	4.55
	CNS	37	Headache	4
		38	Dizziness	4.22
		39	Seizure	4.11
		40	Drowsiness	4.55
		41	Coma	4.33
		42	Delirium	4.33
		43	Confusion	4.33
		44	Delusion	4.33
		45	Motor impairment	4
		46	Body tremor	3.77
		47	Myoclonus	4.11
	Cardiovascular	48	Arrhythmia problem	4.55
		49	Long QRS	4.44
		50	QTC long term	4.33
		51	PSVT	3.88
	Digestive-hepatic	52	Burn of the lips	4.77
		53	Burn of the oral mucosa	4.77
		54	Swelling of the tongue	4.88
		55	Swelling of the throat and larynx	5
		56	Erythema and redness of mucus	4.88
		57	Mouth ulcers	4.66
		58	Mouth watering	5
		59	Dysphagia	5
		60	Nausea	4.33
		61	Blood vomiting	4.77
		62	Diarrhea	3.88
		63	Abdominal pain	4.66
		64	bloody stool	4.55
		65	Abdominal rigidity	5
		66	Rebound	5
		67	Tenderness	4.77
		68	Reflux or gastritis	4
		69	Gastrointestinal bleeding	5
		70	Hepatic problems	4.33
	Pulmonary	71	Cough	4.33
		72	Vowel breathing	4.44
		73	Shortness of breath	4.55
		74	Cyanosis	4.66
		75	Acute lung injury	4.77
		76	chemical pneumonitis	4.66
		77	Wheezing	4.33
		78	ARDS	4.33
		79	Hemoptysis	4.77

Table 3. Clinical minimum data set for poisoning with acidic and alkaline substances

patient's demographic information (name, age, sex, pregnancy status, weight, medical record number), information regarding the exposure factors (such as the name of the product, the substance ingredients, exposure time, dose, and root), symptoms and conditions of the patient, related medical history, and current treatment or intervention and counseling provided to the patient. All these data elements are consistent with the findings of present study (21).

The American College of Toxicology keeps the information of patients undergoing medical toxicology care in a Toxicology Investigators Consortium (ToxIC) registry form. The minimum data set stored in this registry includes demographic information, exposure, agent, syndrome, signs and symptoms, and treatment. This largely confirms the findings of present study. It should be noted that in the above registry, the demographic information only includes the name of the institution, age, gender, and patient code, and other identifying options, including the patient's name, medical record number, or date of birth are not clear (22). However, in the proposed minimum data set for Iran, the patient identifying information is clearly recorded and highly important. In another study by William et al, it was indicated that the American Toxic Exposure Surveillance System (TESS) contains a uniform data set to be used in US poisoning centers. In this system, information related to each exposure to toxic substances is included in several main categories, including information of the case, patient information, exposure information/substance, clinical impacts (toxic effects), treatment and medical results (23), which is consistent with the minimum data set of the present study.

This study showed that comprehensive and uniform data elements about poisoning with acidic and alkaline substances do not exist in Iran. Therefore, the present study determined the data requirements for the creation of an information management system for poisoning with acidic and alkaline substances. Developing a MDS is a starting point to help overcome data variations between poisoning care centers. It will result in standardization and effective management of the data through providing uniform data elements. In addition, establishment of policies and prevention and control of poisoning with acidic and alkaline substances will be possible, which results in the improvement of the quality of care and containment of costs.

The present study has two strengths: First, collection of initial data set for survey of experts was appropriate and detailed that making the final conclusion easier and more coherent in reporting. Second strength point was

Main category	Subcategory	No	Minimum data set	Average
Clinical findings	Skin and eyes	80	Burn of facial skin	4.77
		81	Pain at the contact point	4.11
		82	Burn at the contact point	4.44
		83	Eczema or rash	4.11
		84	Angioedema	3.88
		85	Blisters	4
		86	Necrosis	4.11
		87	Abnormal bleeding and bruising	4.33
		88	Erythema	4.11
	Metabolic status	89	Hypoglycemia	3.88
		90	Metabolic acidosis	4.44
		91	Metabolic alkalosis	4.44
		92	Increase anion gap	4.11
		93	Increase osmolal gap	4
Complications		94	Gastrointestinal bleeding	5
		95	Perforation	5
		96	Fistula	5
		97	Esophageal stricture	5
		98	Mediastinitis	5
		99	Peritonitis	5
		100	Kidney failure	4.77
		101	Liver dysfunction	4.55
		102	Hemolysis	4.66
Diagnostic interventions	Laboratory tests	103	ABG	4.55
		104	WBC	4.22
		105	Hb	4.55
		106	HCT	4.55
		107	Platelet count	4.33
		108	Retic	3.88
		109	Lactate	4.33
		110	B.S	3.88
		111	BUN	4.33
		112	Creatinine	4.44
		113	Sodium	3.77
		114	Potassium	3.88
		115	Mg	3.88
		116	Anion Gap	4.22
		117	Troponin	3.88
		118	Ammonia	3.77
		119	CK	3.88
		120	CPK	3.88
		121	PT ,PTT	4.22
		122	INR	4.22
		123	ALT	4
		124	AST	4
	Para-clinical measures	125	Endoscopy	4.77
		126	X Ray	4.44
		127	CT Scan	4.44
Therapeutic interventions	Supportive treatment	128	Blood injection	4
		129	Intravenous fluids	4.55
		130	Stomach emptying	3.88
		131	Ventilation and intubation management	4.44
		132	Shock treatment	4.77
		133	Oxygen therapy	4
		134	Esophageal stent	4.44
	Medications	135	Steroids	4.22
		136	Antibiotics	4.44
		137	Antioxidants	4.11
		138	Anti-pain	4
	Surgeries	139	Jejunostomy feeding	4.33
		140	Laparotomy	4.44
		141	Gastrotomy	4.33
		142	Esophagectomy	4.44
		143	Colon Interposition	4.22
		144	Gastric pull-up	4.44
		145	Buginage	4.44

Table 4. Clinical minimum data set for poisoning with acidic and alkaline substances (CONT)

use of acceptable number comments of health information management experts that, in addition to standardizing and organizing how to receive information, greatly increased the reliability of results from a managerial perspective.

6. CONCLUSIONS

Considering the ever-increasing advances in medical science and technology, the most important discussion of the current time is the provision of integrated health care and availability of the comprehensive, valid, and accurate information. Therefore, in order to improve the quality of information, the existence of a rational, expandable and flexible structure of data elements is considered as a necessity. In Iran like in many other coun-

tries, there are problems such as lack of accurate and principled information, the existence of repetitive data elements in health forms, and lack of timely access to medical records of patients with acid and alkaline poisoning, and this a major obstacle to quick and rational treatment of such poisonings. Therefore, there is a need for a coherent and integrated data set for proper and correct decision-making. Development of MDS for acid and alkaline poisoning can contribute to the provision of high quality care and improved record-keeping and enhanced efficiency in hospitals and clinical centers

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