Designing and Evaluating a Child Maltreatment Surveillance System: Towards Improving the Management of Child Abuse Incidents

Zahra Karbasi [1], Reza Safdari[2], *Maliheh Kadivar [3,4], Leila Shahmoradi [2], Somayyeh Zakerabasali [5], Parisa Eslami[2], Azadeh Sayarifard[3]

[1] Department of Health Information Sciences, Faculty of Management and Medical Information Sciences, Kerman University of Medical Sciences, Kerman, Iran.

[2] Department of Health Information Management, School of Allied Medical Sciences, Tehran University of Medical Sciences, Tehran, Iran.

[3] Community Based Participatory Research Center, Iranian Institute for Reduction of High-Risk Behaviors, Tehran University of Medical Sciences, Tehran, Iran.

[4] Department of Pediatrics, Division of Neonatology, Children's Medical Center, Tehran University of Medical Sciences, Tehran, Iran.

[5] Department of Health Information Management, Health Human Resources Research Center, School of Management & Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.

Abstract

Background: Child abuse is a significant global concern, with short-term and long-term consequences for the lives of children who are victims of violence. For effective action by decision-makers, the information and analysis obtained from surveillance systems must be used to determine the problem, the magnitude of maltreatment, its relationship with other issues, and the likelihood of preventing maltreatment.

Objectives: Due to the importance of child abuse and the management and control of this event, this study was conducted to design and evaluate a child abuse surveillance system.

Methods: The system was designed in Visual Studio version 2017 using the C# programming language and ASP.NET framework. SQL Server was used to store the data. The design of the child abuse surveillance system was evaluated according to the usability evaluation.

Results: The minimum data set was indexed to collect and store data on abused children by the standard format. Web-based child abuse surveillance system (CASS) has 3 types of users. The system evaluation results showed that the highest number of problems were related to the principle of "help and documentation".

Conclusion: Designing a CASS is a practical step in managing and controlling the data of abused children. This system and registration of information will help professionals, managers, and decision-makers make the right decisions to take care of injured children with up-to-date information.

Key Words: Child abuse, Child maltreatment, Surveillance, Surveillance system.

＊Corresponding Author:

Maliheh Kadivar, Department of Pediatrics, Division of Neonatology, Children's Medical Center, Tehran University of Medical Sciences, Tehran, Iran. Email: kadivarm@tums.ac.ir

1- INTRODUCTION

Child abuse is a significant concern globally (1), with short-term and long-term consequences on the lives of children victims of violence (2). Child abuse includes four types of physical, sexual, emotional abuse, and neglect (3). Based on the results of a meta-analysis, the global prevalence of child abuse is estimated at 22.6 (4). In high-income countries, the annual rate of physical violence against children is estimated at 4% to 16%, and emotional abuse at about 10% (5). According to the World Health Organization (WHO), child abuse has a high social and economic cost (6). The results of numerous studies show that the economic burden of child abuse is significant (7-9). Reducing child abuse requires decision-making and action at various levels (10). The WHO emphasizes the need to increase the capacity of data collection in order to design monitoring programs for reducing violence. It is essential to collect complete and quality data at all levels and according to the standards. Accordingly, the lack of consistent information makes it difficult to determine the magnitude of violence. This information gap is the result of data loss and differences in data collection methods. To monitor and control the trend of violence, the development of data systems is one of the basic actions (1). Accurate data can help achieving appropriate understanding and responses to child abuse. To this end, this challenge must be addressed through effective surveillance (11).

The purpose of surveillance is to continuously collect, analyze, interpret and publish specific data for planning, evaluation, and necessary actions (12). Accordingly, the data collected can identify and control health concerns or promote health programs. Surveillance is one of the key components of health which can help tracking the health status of a particular population, assessing the prevalence, evaluating the interventions, and determining research priorities (13). Surveillance systems collect routine data based on new cases and population-based surveys to assess the prevalence and link between past events of maltreatment, high-risk behaviors, and health conditions. To take effective action by decision-makers, the information and analysis obtained from surveillance systems must be used to determine the problem and the magnitude of the maltreatment problem and its relationship to other issues, along with the likelihood of preventing maltreatment (6). Due to the importance of child abuse and the management and control of this event, this study was conducted to design and evaluate a child abuse surveillance system.

2- MATERIALS AND METHODS

Following a previous study, the content of CASS was determined by a research team. The seven data axes included demographic data, incident-related data, medical history, diagnostic tests, incident nature, therapeutic measures, and the other required data. More details are available at Karbasi et al. (14).

Phas1: In this applied study, we first designed the system. The system was designed and evaluated at Tehran University of Medical Sciences. The use-case diagrams, sequence diagrams, class diagrams, and activity diagrams were drawn using the unified modeling language (UML). UML is a modeling language that incorporates various concepts and guidelines to design and visualize software systems (15). The suitable design of the user interface causes user interaction and satisfaction and proper viewing of the system capabilities and outputs (16). The system was designed in Visual Studio version 2017 using the C# programming language and ASP.NET framework. SQL Server was used to store the data. Given the importance of

maintaining confidentiality, access to information is determined by the role of the users.

Phas2: The design of the child abuse surveillance system was evaluated according to the usability evaluation. In the evaluation phase, the heuristic evaluation method was performed to diagnose the design problems of the system's UI (user interface). We evaluated the UI design of the CASS based on Nielsen's 10 principles (17), including visibility of system status, the match between the system and the real world, user control and freedom, consistency, and standards, helps for the users to recognize, diagnose, and recover the errors, error prevention and recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, as well as the help and documentation. In this study, five experts (in health information management and medical informatics), independently, evaluated the system using a heuristic evaluation method. The severity of usability problems was calculated based on the three factors of Nielsen, and the degree of severity (18) of each problem was considered. The problems identified by the evaluators were discussed and resolved. Data was analyzed using the Excel software.

The study was approved by the ethics committee of Tehran University of Medical Sciences (Ethical code # IR.TUMS.VCR.REC.1396.4212).

3- RESULTS

The minimum data set was indexed to collect and store data on abused children by the standard format. **Fig. 1** shows the results for determining the minimum data set. The data were entered in the following seven information entry forms: demographic data, incident-related data, medical history, diagnostic tests, incident nature, therapeutic measures, and other required data. Web-based CASS has 3 types of users (system administrator, information registrar, and supervisor). In this system, the system administrator is responsible for managing the users, the information, and reporting. The registrar is responsible for recording and storing data. The system supervisor is responsible for reviewing, completing, and editing the file information.
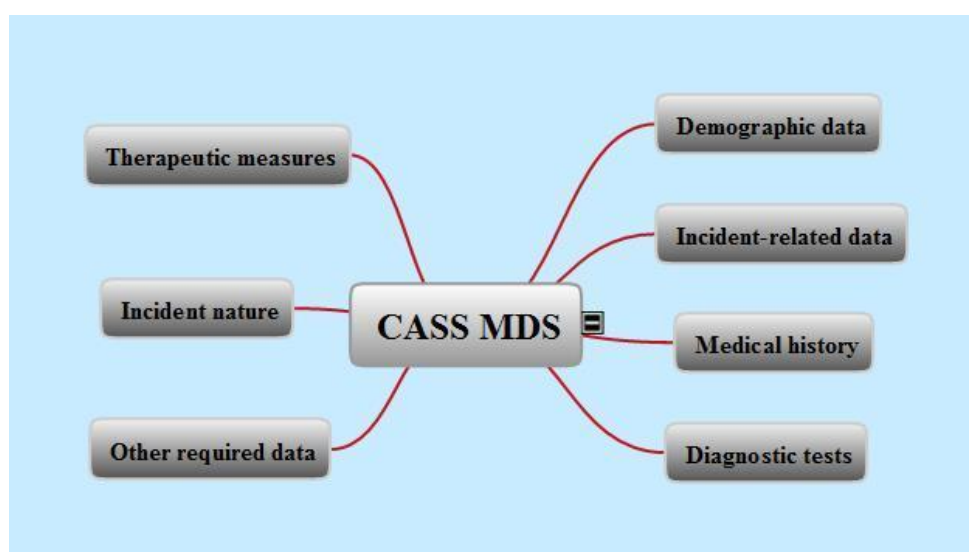
Fig. 1: Results of determining the minimum data set of the CASS. Full details of determining the minimum data set are provided in (14)

Each user can log in by a username and password based on his/her role-based access control. By entering the system, the program's main page will be opened for "searching and recording information". By selecting the icon named "search or register patient information," the page including the information entry forms will appear. This page will contain the necessary information about child abuse and the occurrence of child abuse in the seven specified forms (**Fig. 2**). Based on the medical history form shown in **Fig. 3**, one's data can be entered or selected in the related checkboxes and boxes. Accordingly, appropriate forms have been designed to record, store and retrieve information. At admission on this page, the registrar enters the necessary information in each of the forms. After completing the information, the file is sent to the system supervisor. If the file is complete, the supervisor will approve it. Otherwise, the file will be referred to a registrar.
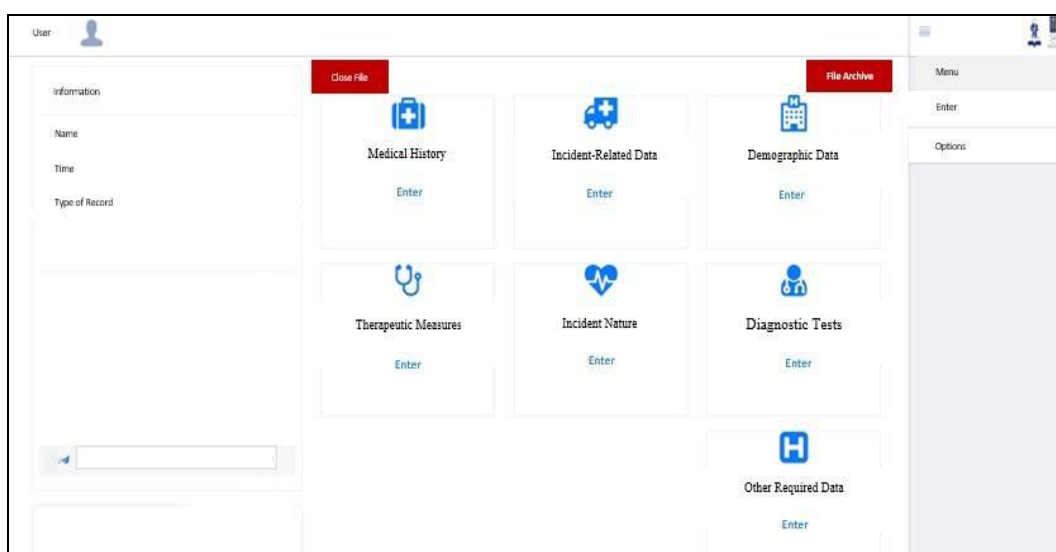

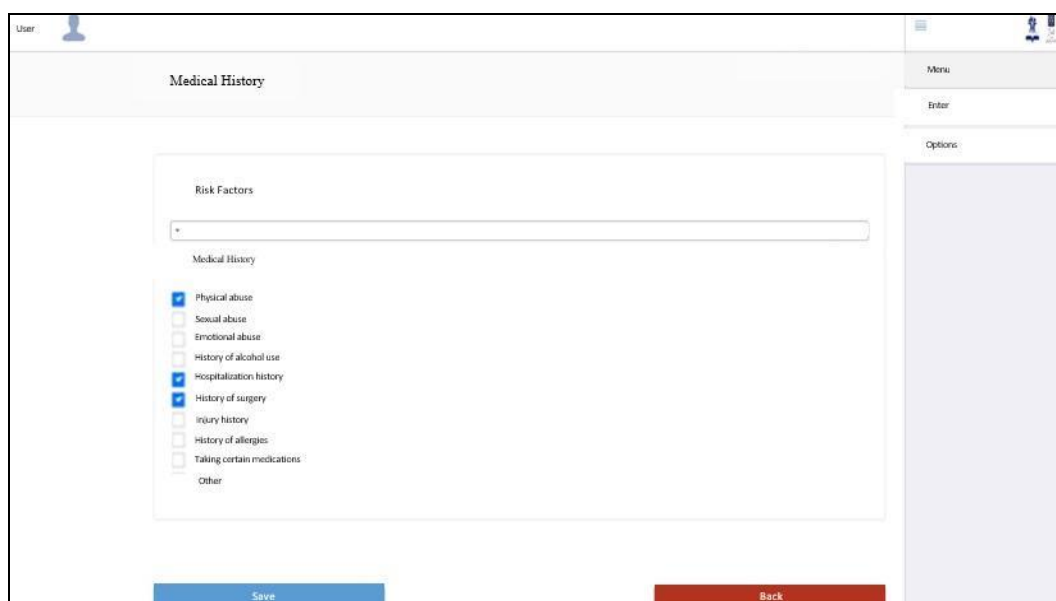**Fig. 2:** Information entry forms in the CASS

Fig. 3: Medical history information form in CASS

Based on the heuristic evaluation, 152 problems were identified, 84 of which were similar and repetitive. After eliminating the duplicates, 68 problems were investigated. **Table 1** shows the usability problems for each evaluator separately. The system evaluation results showed that of all the identified problems, the highest number of problems were related to the principle of "help and documentation" (n = 13). The lowest number of problems were related to the two principles of "flexibility and efficiency of use" (n = 3) and "aesthetic and minimalist design" (n = 3).

Table-1: The problems identified based on the heuristic method

Principles of heuristics evaluation	Total number of problems (%)	Average severity	Number of problems identified by evaluators				
			The first evaluator	The second evaluator	The third evaluator	The fourth evaluator	The Fifth evaluator
1. Visibility of system status	7 (10.29)	0.4	2	2	2	0	1
2. Match between system and the real world	6 (8.83)	0.5	1	1	0	2	2
3. User control and freedom	8 (11.76)	0.2	2	3	2	1	0
4. Consistency and standards	9 (13.23)	1.31	3	2	1	2	1
5. Error prevention	5 (7.35)	1.74	1	1	0	0	3
6. Recognition rather than recall	6 (8.83)	1.56	1	2	1	1	1
7. Flexibility and efficiency of use	3 (4.42)	0.4	2	1	0	0	0
8. Aesthetic and minimalist design	3 (4.42)	0.3	0	0	1	1	1
9. Help users recognize, diagnose, and recover from errors	8 (11.76)	2	4	0	1	1	2
10. Help and documentation	13 (19.11)	2.9	3	3	4	2	1
Total	68 (100)	11.31	19	15	12	10	12

The problems having the highest severity on average were in the "help and documentation" principle (mean = 2.9), which was in the "big problem" category. The problem with lowest severity on average was related to the "user control and freedom" principle (mean = 0.2). **Figure 4** shows the usability evaluation results.
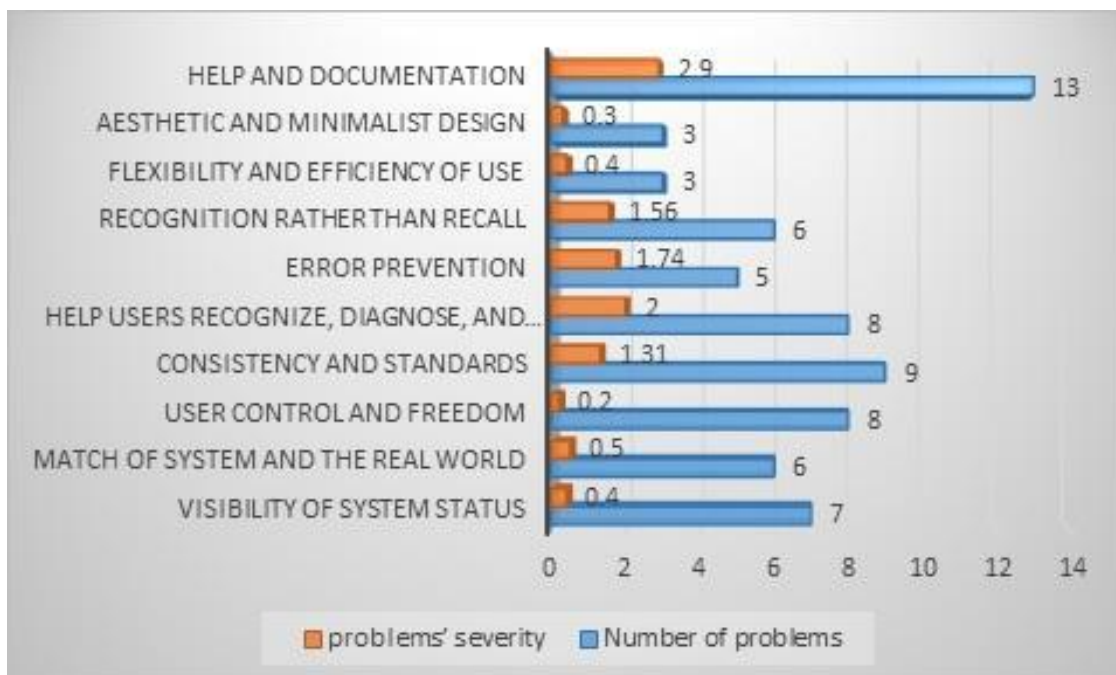
Fig. 4: Usability evaluation of the child abuse surveillance system based on Nielsen's ten principles

4- DISCUSSION

To investigate the impact of prevention efforts, it is necessary to collect reliable and accurate data. According to the Centers for Disease Control and Prevention (CDC), to identify the magnitude of child abuse and neglect, data collection should be followed up on a regular and continuous basis. Researchers and specialists can track changes in child abuse or maltreatment using this data (19).

The web-based system designed in this study facilitates and manages the storage, retrieval, and organization of information related to abused children, focusing on physical harm. According to the injury surveillance guidelines, good surveillance systems should have the following features: generate the required data in the simplest way possible; complete confidence of system data accuracy; they must provide up-to-date information, be practical, cost-effective, and knowledge-enhancing about the problem (20). The user interface of the CASS is interactively

designed. In addition to maintaining simplicity and comprehensibility, it reduces the possibility of errors when entering data into the system. To comply with the principles and considerations of data ownership and confidentiality, the users' access was restricted based on their roles and duties. The data is stored in a patient-based manner so that each patient can have only one record. The program environment is convenient and straightforward. Most data can be selected with the check box in this program, and report results are easily transferable to SPSS and Excel. Like the National Child Abuse and Neglect Data System (NCANDS) (21), the CASS is a vital source of information for decision-makers, managers, and researchers.

This study considered and examined the effective factors in creating a surveillance system for physical injuries caused by child abuse. The research team tried to create a system to properly examine and measure various aspects of the child abuse incidents due to the complexity of the

event's dimensions and make the necessary changes in the design and establishment of the surveillance system. According to Boothby's study, surveillance systems and goal identifications provide an appropriate response to child abuse and clarify data collection goals (22).

Various stages of the system life cycle must be evaluated. Usability evaluation is a complex and multifaceted concept that involves a variety of methods. Various conditions such as evaluation purpose, system type, system performance, user adaptability, and resources effectively choose the evaluation method. Because this method is inexpensive and fast and is usually used to evaluate software systems (23), it was selected for this study. Based on the heuristic evaluation section results, the most common problems were related to the principle of help and documentation. Other problems associated with Nielsen's principles were small and minor problems. This indicates the proper design of the system for the user. Various studies (24-26) have used heuristic evaluation methods to examine health systems. Identifying

usability problems in systems is possible through heuristic evaluation. Failure to evaluate problems will increase errors and reduce data quality and patient safety (24). The most important point in evaluating health systems is to perform the evaluation process with sufficient speed and accuracy, solving problems and improving and strengthening the system (27). Based on this, the identified problems were prioritized for correction.

Fig. 5 shows a schematic model of the child abuse monitoring cycle using the CASS. The CASS collects, stores, and analyzes data in an organized manner. Using the information obtained from this system, information related to the types of injuries inflicted on the child as a result of child abuse can be monitored. In the monitoring cycle of this event, care and monitoring organizations can use the information obtained from this system to make informed decisions to manage and reduce the occurrence of child abuse. Planning and policy-making in this regard are facilitated using the models provided through the collected information.
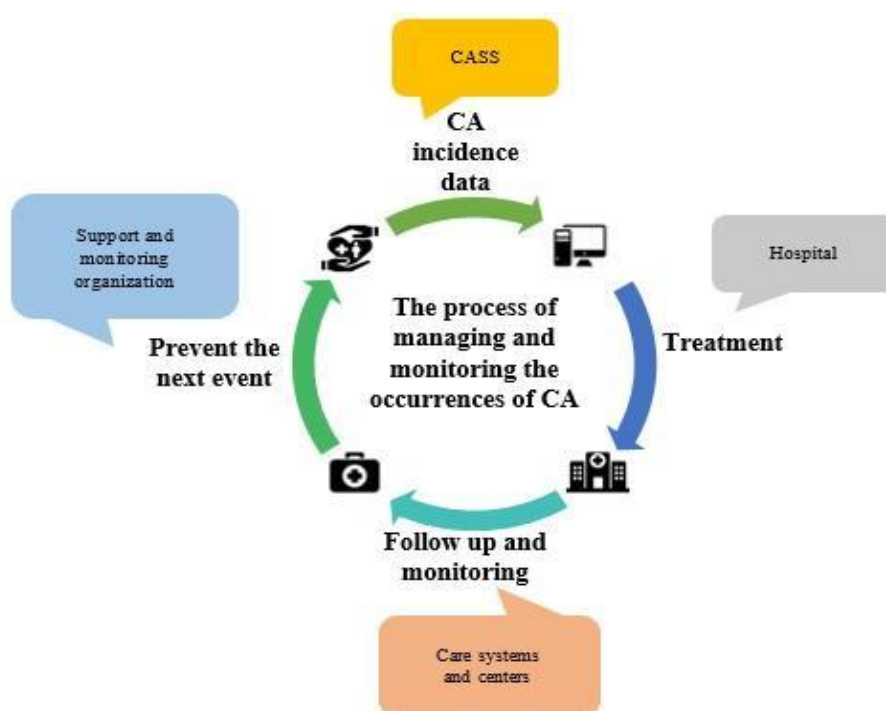
Fig. 5: Schematic view of the monitoring and management process of child abuse

One of the most important strengths of this study is the participation of pediatricians, along with the health information management and medical informatics specialists in various stages of system design, development, and evaluation, which led to the creation of a system tailored for a needs-based information management. Other strengths of this web-based system include collecting reliable monitoring data for decision making and planning, identifying at-risk individuals, and monitoring violence.

4-1. Limitations of the study

The limited number of data collection and monitoring systems in child abuse and lack of access to them wsa the first limitation of this study, and the second one was the low number of studies in this field for comparison. Diagnosis and identification of cases were other problems related to the study.

5- CONCLUSION

Designing a CASS is a practical step in managing and controlling the data of abused children. By storing and organizing information, it provides a comprehensive source of information for abused children. Based on this, the necessary management and control actions can be taken for this event. Registration of information via this system will help professionals, managers, and stakeholders make the right decisions to take care of injured children with up-to-date information. Due to the magnitude problem of child abuse, the information of the surveillance system can be used to investigate the prevalence of the event and its relationship with other factors. The usability evaluation results show the potential of the system for its appropriate response and its usefulness in the monitoring process. Future studies should consider performance evaluation methods.

8- CONFLICT OF INTEREST

None.

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