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Development of a Minimum Data Set (MDS) for C-Section Anesthesia Information Management System (AIMS)

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Abstract

Background: Caesarean section, also known as C-section, is a very common procedure in the world. Minimum data set (MDS) is defined as a set of data elements holding information regarding a series of target entities to provide a basis for planning, management, and performance evaluation. MDS has found a great use in health care information systems. Also, it can be considered as a basis for medical information management and has shown a great potential for contributing to the provision of high quality care and disease control measures.

Objectives: The principal aim of this research was to determine MDS and required capabilities for Anesthesia information management system (AIMS) in C-section in Iran.

Methods: Data items collected from several selected AIMS were studied to establish an initial set of data. The population of this study composed of 115 anesthesiologists was asked to review the proposed data elements and score them in order of importance by using a five-point Likert scale. The items scored as important or highly important by at least 75% of the experts were included in the final list of minimum data set.

Results: Overall 8 classes of data (consisted of 81 key data elements) were determined as final set. Also, the most important required capabilities were related to airway management and hypertension and hypotension management.

Conclusions: In the development of information system (IS) based on MDS and identification, because of the broad involvement of users, IS capabilities must focus on the users' needs to form a successful system. Therefore, it is essential to assess MDS watchfully by considering the planned uses of data. Also, IS should have essential capabilities to meet the needs of its users.

Keywords: Anesthesia, Cesarean Section, Information System, Information Management, Data Set

1. Background

Caesarean section, also known as C-section is a very common and increasingly frequent surgical procedure in developed countries as well as most developing countries (1, 2). The ratio of C-section to vaginal delivery differs in different countries and ranges from 10% in countries like Sweden, Denmark, and Netherlands to 20% - 30% in the United States, France, India, and England, and going as high as 47% in Brazil (3). The ratio of C-section to vaginal delivery in Iran is three times more than the average global ratio (4). There have been made many efforts to assess the impacts of obstetric anesthetic techniques on the growth and behavior of newborn child, and what has been found is the momentarily effects of these techniques on some aspects of neonatal development (5). Also, the adoption of some techniques and medication can be useful in managing post-anesthetic complications like using Magnesium sulfate (MgSO4) as anti-shivering (6), adding tramadol to lidocaine (7), and postoperative pain management for relieving acute pain after C-section operation (8). The presence of these effects highlights the importance of adopting and implementing safe anesthesia procedures in C-section operations (3). In this context, establishing and maintaining a comprehensive database could prove beneficial for both patients and anesthesiologists (9), as it will lead to improved safety in surgical and post-surgical care and will facilitate the planning and management of operation schedules as well as staff and instrument utiliza-

tion. Another outcome of such system will be the availability of highly reliable documents and records regarding each patient (10). Establishing such database and systems, however, requires some tools for adequate collection, integration and interpretation of data from various groups of health centers, their staff, and patients (11).

The most important step of any information management endeavor is data collection, and minimum data set (MDS) is one of the emerging data collection tools providing accurate access to health data. MDS is defined as a set of data elements holding information regarding a series of target entities to provide a basis for planning, management, and performance evaluation as it has found a great use in health care information systems (12). MDS can be considered as a basis for disease information management and has shown great potential for contributing to provision of high quality care and disease control measures (13). Also, MDS aims to standardize the healthcare data instances with uniform definitions to make sure that all data are compatible and comparable (14). The structured method provided by MDS allows healthcare organizations to develop and adopt effective data-centered plans and allows researchers and policymakers to decide what data elements should be gathered and ensure that terminology and data elements are standard, uniform, and consistent (15). While there is a growing interest in Iran to adopt MDS, the application of MDS for anesthesia in C-section operations has not yet been studied. The physical, psychological, and economic concerns of C-section operations for a family necessitate the presence of an adequate information management system to improve the quality of this health service.

2. Objectives

The aim of this paper is to develop essential data elements and capabilities required for a C-section anesthesia information management system in Iran.

3. Methods

The research presented in this paper is a descriptive cross-sectional study. The raw data required for research were gathered from popular search engines including Yahoo, Google, reputable databases such as Google Scholar, Cochrane, PubMed, and MagIran, and credible websites. The index terms such as anesthesia information, anesthesia form, anesthesia (anaesthesia) data, MDS, MDS form, cesarean delivery anesthesia form, and cesarean section anesthesia form in English equivalents were used for searching to identify the studies relevant to the subject of research. Only studies conducted between 2000 and 2016 were evaluated. A set of inclusion criteria was determined to separate the most relevant studies and the data provided by these studies were incorporated into our study. The population of this study comprised 115 anesthesiologists with at least three years of work experience in medical centers performing C-section surgery. An electronic questionnaire was sent to anesthesiologists via e-mail, and the required data were collected from the responses. The used questionnaire was composed of three parts; the first of which gathered the demographic information of participants including their gender, age, work experience, and the university where they had graduated. The second part of the questionnaire was composed of 8 major sections overall containing 95 data elements. The major sections of the second part of questionnaire included demographics of patient, patient's pre-anesthetic condition, type of administered anesthesia, monitoring, airway management, Intake/Output, post-anesthesia report, and medication. The final part of the questionnaire was related to some important capabilities required for anesthesia information management system in C-section surgery. The experts participating in the study were asked to score the items according to the importance perceived by them based on a five-point Likert scale. In this scale, a score of 1 naturally represented the "lowest level of importance" and a score of 5 represented the "highest level of importance". Only the data elements with average score of 3.75 and higher were allowed into the MDS. This part of work revealed the capabilities required for a C-section-anesthesia information management system. The credible scientific studies and opinions of a group of experts composed of anesthesiologist, health information managers, nurse anesthetist, and anesthesia technician were used to evaluate the validity of the instrument. To evaluate the reliability of the instrument, the Cronbach's alpha was calculated and the value of this parameter for the entire questionnaire was obtained to be 0.942. All statistical analyses performed in this paper were conducted using SPSS software.

4. Results

We managed to collect 115 filled questionnaires out of 145 that had been distributed (79%). The mean age of respondents was 46.36, their average work experience was 15.79 years, and about 40 percent of them were female. Overall, we managed to identify 8 classes of data comprising 81 data items in the system. Table 1 shows the data items that were identified by experts as important or highly important (mean score $\geq$ 3.75) and Table 2 shows the most important capabilities required for C-section-anesthesia in-

formation management system. The final set included the most 81 important data elements as follows:

Table 2. Required Capabilities Approved by the Experts for C-Section AIMS Put in Order (Range 1 - 5)

Required Capabilities	Mean	S.D
Airway management	4.70	0.65
Hypertension and hypotension management	4.58	0.76
Reporting by anesthesiologist	4.55	0.68
Drug dosage management	4.50	0.76
Drug allergies management	4.50	0.76
Management of anesthetics in complex situations	4.50	0.82
Ability to connect to other information systems	4.50	0.60
Drug-drug interaction management	4.45	0.82
Pain management	4.45	0.68
Critical events detection	4.45	0.88
Depth of anesthesia estimation	4.40	0.68
Nausea and vomiting management	4.40	0.68
Documentation auditing and tracking	4.20	1.15
Reporting by anesthesia technician	4.20	1.05
Reporting by nurse anesthetists	4.20	0.95
Accessibility to the system without time restrictions	4.15	1.08
Reporting	4.15	1.04
Definition of new information needs	4.05	0.94
Preanesthesia antibiotic drugs management	4.00	0.82
Body temperature management	4.00	0.85
Accessibility to the system without places restrictions	3.95	1.14
Scheduling	3.95	1.05
Measuring speed of system response	3.95	1.05

Patient demographics: type of admission (emergency/elective), blood group, date of birth, anesthesia date, name, weight, literacy, national code, height, file number, father's name.

Pre-anesthesia evaluation: airway anatomy, underlying disease, review of body systems, family history of anesthetic problems, allergies, history of previous anesthesia, dental position, ASA class, physical examination, history of previous surgery, drug consumption, drug abuse, laboratory data, preoperative hemoglobin, cause of cesarean section, physical status, disabilities, consultations, smoking, history of blood transfusion, communication problems, prostheses.

Type of anesthesia: general / mask / endotracheal, regional / epidural / spinal, intravenous.

Airway management: tube insertion assessment, intubation problems, mouth or nose intubation, breathing sound checkup, type and size of endotracheal tube, intubation techniques, mask, Airway pressure, Intubation (asleep/awake), cuff (presence or absence), time of intubation and extubation, maximum breath pressure, tidal volume / cc, type and size of laryngoscope, breaths / minute, airway position.

Patient monitoring: pulse oximetry, pressure and pulse, capnography, electrocardiogram, urinary output, oxygen analyzer, thermometer.

Drugs and medication: drug names, unusual patient responses to drugs, amount / concentration of drugs, path / route of drugs, frequency / time.

Intake /output: bleeding, crystalloid, blood products, urinary output, vasodilator, colloid.

Post-anesthesia reporting: baby position, start and end times of anesthesia, post anesthesia complications, unexpected patient responses, anesthesiologist signature, postoperative pain, general situation, atonia of uterine and interventions done reports, surgery consent form, anesthesia consent form, time and date of visit, date of anesthesia.

5. Discussion

MDS could be a major step toward uniformity and integration of data recorded and used in different healthcare centers. In a study by Bauer et al. (2006), it has been stated that the MDS is a primary step required for standardizing and integrating the data using for diagnosis of malnutrition and evaluating the status of the present knowledge (16).

In a research by Avidan et al. (2012) entitled "record completeness and data concordance in an anesthesia information management system using context-sensitive mandatory data-entry fields", it has been indicated that MDS provides a more effectual angle of approach to the use of information systems, as it allows to determine the required information and collect data as needed. This study assessed not only the MDS, but also the use of an anesthesia-centered information management system with context-sensitive mandatory data-entry fields, and ultimately reported that this system has a very good applicability (17). The necessity of standard and consistent definitions regarding specific data elements and events for uniform documentation has also been expressed by Ehrenfeld et al. (2011) (18). Hawes et al. (1997) have also proven the role of MDS in providing an accurate and comprehensive database of medical records of citizens, facilitating comprehensive healthcare plans, and improving the quality of provided healthcare services, duration of hospitalization, and quality of life. These authors have reported that MDS has a positive impact on all the mentioned aspects (19).

The objective of this paper was to develop an MDS and qualities required for C-section anesthesia information management system in Iran. The initial MDS was defined based on a comparative study on the registry systems. The 8 determined classes of data elements included demographic information of patient, pre-anesthesia evaluation, type of anesthesia, medication, monitoring, Intake/Output, airway management, and post-anesthesia reporting. Some of the data elements were identified as important or highly important by the experts and organized in these 8 classes, which were quite similar to what had been found significant by the experts of other fields, e.g. for minimum datasets of speech therapy (20), Cystic Fibrosis (21), burns (22), breast cancer (23), nursing (24), hemodialysis adequacy information system (25), orthopedic injuries (26), and outpatient oncology clinical nursing (27). This similarity may indicate that these categories are highly important for many fields of health care system. But it may also be attributed to the various potential applications of MDS for patient and healthcare monitoring, performance evaluation of healthcare service and related organizations, as well as comprehensive national and international comparisons (21). Also, MDS allows the conceptual interoperability of all these levels to be realized (28).

In a study by Junger et al. (2001), 35 data items organized in 4 classes including patient variables, operation variables, anesthetic variables, and postoperative variables were found to be important for the prediction of antiemetic rescue treatment at the post-anesthesia care unit (29). The subclasses into which these items were categorized included demographic features such as age, gender, weight, and height, ASA physical status, and smoking.

The study conducted by Galvez et al. (2015) found 46 data items organized in 8 classes for an anesthesia information management system (AIMS). The classes reported by this work included AIMS record requirements, OR management, pre-surgery evaluation, post-surgery care, EHR integration, safety, data storage, and reporting. Of all the assessed data elements, 32 which were organized in 6 categories were selected by experts to be applied in the MDS of anesthesia information management system (30). The present research identified 105 data elements and organized them into 8 categories. Of these 105 assessed data elements, 81 that were determined by the experts as the most important elements belonged to the classes of demographic features of patient (admission type (emergency/normal), name, date of birth, height, weight, national code, blood type, and anesthesia date), pre-anesthesia evaluation (airway anatomy, underlying disease, review of body systems, medical history, allergies, history of previous anesthesia, dental position, ASA class, physical examination, history of previous surgery, drug consumption, drug abuse, laboratory data, preoperative hemoglobin, cause of cesarean section, physical status, disabilities, consultations, smoking, history of blood transfusion, communication problems, prostheses), type of anesthesia (general / mask / endotracheal, Regional / epidural / spinal, intravenous), airway management (tube insertion assessment, intubation problems, mouth or nose intubation, breathing sound checkup, type and size of endotracheal tube, intubation techniques, mask, airway pressure, intubation (asleep/awake), cuff (presence or absence), time of intubation and extubation, maximum breath pressure, tidal volume / cc, type and size of laryngoscope, breaths / minute, airway position), patient monitoring (pulse oximetry, pressure and pulse, capnography, electrocardiogram, urinary output, oxygen analyzer, thermometer), drugs (drug names, unusual patient responses, amount / concentration , path / route, frequency / time, intake /output (bleeding, crystalloid, blood products), post-anesthesia reporting (baby position, start and end times of anesthesia, post anesthesia complications, unexpected patient responses, anesthesiologist signature, postoperative pain, general situation, atonia of uterine and interventions done reports, surgery consent form, anesthesia consent form, date of anesthesia).

In a study conducted by Muravchick et al. (2008) entitled “Anesthesia information management system implementation: a practical guide”, the authors identified 25 data elements enquired for an AIMS. All but 3 elements, including insurance data, CPT code, and gender, were also identified in our study. In case of gender element, this difference is because the MDS studied in this paper is designated for C-section operation. The data elements reported in that study included name, date of admission, preliminary physician, date of birth, the status of outpatient/inpatient, code of medical record, ASA physical status, date of surgery, name of anesthesia provider, medical direction concurrency, type of anesthesia, times of start and end of anesthesia, monitored anesthesia care, total time of anesthesia, and procedure attestations (31). In a study by Ahmadi et al. (2015), the authors tried to develop an MDS for the burn injuries information management system (13). This article reported that the MDS of burns must absolutely include the data elements pertaining to insurance. In the present study, however, the experts did not identify insurance data as significantly important.

Sun (2006) in another study has reported that IS capabilities such as interactivity (good user interface), personalization (to be able to specify and modify requests), and context awareness (to understand the preferences of users) can help users meet their information needs (32). The results obtained in the present study showed that the majority of capabilities required for Anesthesia informa-

tion system pertain to classes of blood pressure management, airway management, anesthesiologist reporting, drug dosage control, drug allergy checks, and control of anesthetics in complex conditions.

5.1. Conclusion

Accurate and complete data collection is the most important part of any information management, and minimum data set (MDS) is one of the most effective tools providing rapid access to accurate health data. Also, MDS can be considered as a basis for information management systems and has shown a great potential for contributing to the provision of high quality care and disease control measures through these systems.

MDS provides an angle of approach for gathering comprehensive, standard, reliable, and comparable data at both regional and national levels. Because of massive scope of healthcare issues and the importance of successful implementation of healthcare information system, the design of these information systems is mostly focused on MDS and identification of information system capabilities according to specific needs and requirements. Therefore, an accurate evaluation of MDS according to application-specific requirements is of great importance. Development of an MDS for anesthesia procedure performed during C-section operations can contribute to the provision of high quality care and improved record-keeping and enhanced efficiency in hospitals and clinical centers performing this operation. Future studies on this subject are recommended to use Delphi studies in focus-groups to develop other application-specific MDSs and IS capabilities for other domains of anesthesia.

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Table 1. MDS Approved by the Experts for C-Section AIMS Put in Order

Data Class	More Than 75%
Patient demographics	Type of registration (emergency/elective)
	Blood group
	Date of birth
	Anesthesia date
	Name
	Weight
	Literacy
	National code
	Height
	File number
Pre-anesthesia evaluation	Airway anatomy
	Underlying disease
	Review of body systems
	Family history of anesthetic problems
	Allergies
	History of previous anesthesia
	Dental position
	ASA class
	Physical examination
	History of previous surgery
	Drug consumption
	Drug abuse
	laboratory data
	Preoperative hemoglobin
	Cause of cesarean section
	Physical status
	Disabilities
	Consultations
	Smoking
	History of blood transfusion
	Communication problems
	Prostheses
Type of anesthesia	General / mask / endotracheal
	Regional / epidural / spinal
	Intravenous
Airway management	Tube insertion assessment
	Intubation problems
	Mouth or nose intubation
	Breathing sound checkup

	Type and size of endotracheal tube
	Intubation techniques
	Mask
	Airway pressure
	Intubation (asleep/awake)
	Cuff (Presence or absence)
	Time of Intubation and extubation
	Maximum breath pressure
	Tidal volume / cc
	Type and size of laryngoscope
	Breaths / minute
	Airway position
Monitoring	Pulse oximetry
	Pressure and pulse
	Capnography
	Electrocardiogram
	Urinary output
	Oxygen analyzer
	Thermometer
Drugs and medications	Drug names
	Unusual patient responses to drug
	Amount / concentration of drugs
	Path / route of drugs
	Frequency / time
Intake /output	Bleeding
	Crystalloid
	Blood products
	Urinary output
	Vasodilator
	Colloid
Post-anesthesia reporting	Baby position
	Start and end times of anesthesia
	Post anesthesia complications
	Unexpected patient responses
	Anesthesiologist signature
	Postoperative pain
	General situation
	Atonia of uterine and interventions done reports
	Surgery consent form
	Anesthesia consent form
	Time and date of visit
	Date of anesthesia