

Supporting Continuity of Care for Poisonings with Electronic Information Exchange

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2. STRUCTURED ABSTRACT

Purpose: The purpose of this study was to describe the information requirements for health information exchange between poison control centers (PCCs) and emergency departments (EDs), describe current information exchange scenarios, and identify the clinical, operational, and legal considerations important for health information exchange between EDs and PCCs in support of individual patient care. **Scope:** Current communication between U.S. PCCs and EDs relies upon synchronous verbal, telephone communication with no routine sharing of documents or records. **Methods:** We analyzed call recordings corresponding to n=120 poisoning cases corresponding to a single PCC and its collaborating EDs, to identify information requirements and process characteristics. We interviewed care providers in varied roles to elicit a description of the current ED-PCC communication process. We conducted a national Delphi study to determine clinical, operational, and legal considerations important for potential ED-PCC health information exchange. **Results:** We identified information types used in current ED-PCC communication. Approximately half of these information types could be mapped to a standard clinical terminology system. Further terminology development is necessary in the domain of poisoning care. The current telephone based process of ED-PCC communication contains inefficiencies and potential safety vulnerabilities that may be ameliorated with a health information exchange process. The Delphi study evidenced support for health information exchange (HIE), with the caveat that HIE should support or replace routine information sharing, but not replace discussion important to the management of complex poisoning cases. **Key Words:** toxicology, emergency department, poison control center, informatics, health information exchange, Delphi, safety, care transition, communication

3. PURPOSE

U.S. poison control centers (PCCs) are important resources for poison information, clinical toxicology consultation and poison prevention education. Staffed 24 hours per day, seven days per week, these centers assess poisonings then provide consultation to both patients and emergency care providers. The poison control center specialists in poison information (SPIs) and emergency department care providers communicate with each other, exchanging patient information, treatment recommendations, and information about clinical effects and lab results. Information exchange is a central activity for poison control centers. However, the exchange of information between PCCs and emergency departments (EDs) is almost entirely conducted via telephone. This circumstance deserves closer examination because verbal communication is a known and frequent source of medical error, especially in EDs, where providers are known to experience heavy communication loads with frequent interruption. (1, 2) (3) It is possible that reliance on verbal communication creates safety vulnerabilities and delays in time to treatment. It may also result in data loss, or a lack of adequate information at the point of decision making. (3)

U.S. emergency departments require rapid access to decision-relevant information, especially when treating high acuity poisonings. Emergency departments have been identified as a high priority area for health information exchange, the electronic exchange of patient information. (4) Potential exists to reduce medical error, reduce time to treatment, and improve continuity of care for poisonings with health information exchange between PCCs and EDs. (3) health information exchange could also be used to “support communication, improve the availability of data and information to clinicians at the point of care, and ensure timely follow-up”. (3) This report describes our approach and progress in developing a knowledge base for health information exchange between EDs and PCCs, conducted through a grant from the U.S. Health and Human Services Agency for Healthcare Quality and Research (AHRQ). Due to the factual nature of the report’s content and the fact that we have published and presented the content elsewhere, large portions of this report are excerpted or closely paraphrased from previously published material and cited accordingly.

The purpose of this study was to describe the information requirements for electronic information exchange between poison control and emergency departments in support of individual patient care, describe current information exchange scenarios, and identify the clinical, operational, and legal considerations important for electronic information exchange between emergency departments and poison control centers in support of individual patient care.

Specific Aims:

1. Describe information requirements for electronic information exchange between poison control centers and emergency departments.
2. Describe current data/ information exchange scenarios between a regional poison control center and an emergency department.
3. Identify salient clinical, operational, and legal considerations related to electronic exchange of data and information between poison control centers and emergency departments.

4. SCOPE

4.1 Poisoning

Unintentional poisoning is currently the second leading cause of injury death in the United States. (5) The number of deaths due to unintentional poisoning has increased dramatically in recent years. The number of these deaths reported in 2006 was more than double that of 2000. In 2011, at least 615,869 patients were treated for poison exposures in U.S. health care facilities. (6) The annual cost of medical expenses related to poisoning in the U.S. has been estimated at over \$3 billion dollars. (7)

4.2 Poison Control Centers and Emergency Departments

PCCs are an important clinical and public health service with two primary functions: (1) advise the public and health care professionals in managing poisonings and poison exposures and (2) collect and manage data describing poison exposures. (8) (9) A national toll-free number (800-222-1222) connects a caller 24 hours/day to a local poison center. Specialists in Poison Information (SPIs) rapidly take a thorough history from the caller and based on the history, circumstances and toxicity of the poison, formulate a risk assessment and recommend a treatment plan. SPIs follow uniform data collection procedures and all calls to PCCs are documented in an electronic medical record. Because PCCs assess poisonings over the telephone, taking an accurate and effective history is critical to determine the nature of the exposure. SPIs routinely collect the following information while reassuring and calming the caller: route of the exposure (e.g., topical or oral), substance(s) involved, amount, time since initial exposure, and reason (e.g., accidental vs. intentional). Additionally, the specialist collects relevant data on the identified client's health status (e.g., chronic health condition, current symptoms, other medications) and other factors that may interact with the exposure (e.g., age, weight). Based on this information, the SPIs determine potential severity and make recommendations.

Poison centers collaborate daily with emergency departments to provide care for patients. Of the over 2.4 million poison exposures reported to US poison control centers in 2007, 24% were managed in a health care facility. Approximately 50% are treated and released from the emergency department (ED) while the remaining exposure cases were admitted for care. (10) In many of the cases, the poison patient is referred by the poison control center to the ED. In the remaining cases, the health care facility itself contacts the poison control center for consultation. In cases where the poison control center refers the patient to the ED, the specialist contacts the ED and provides information about the poison exposure to a nurse, mid-level provider or physician. In either case, the specialist in poison information (SPI) provides clinical toxicology consultation to the health care professional that includes information about the toxin, expected clinical effects, monitoring parameters and specific treatment. The poison center and ED share information about the patient, the patient status and circumstances surrounding the poison exposure throughout the ED visit. As situations evolve, the

poison center and ED are in regular communication. Both parties assess and reassess the situation as new information becomes available. The ED care providers share clinical information with the poison control center, including patient symptoms, general condition, and the results of certain laboratory tests. Poison centers frequently update treatment recommendations as additional information becomes available. Poison centers sometimes send (via facsimile) information from a clinical resource to aid the ED staff in managing the poison patient or provide updated references on a particular topic. The poison center specialist involved in the case may stay the same through the course of the patient stay in the ED or may change if the patient stay crosses a shift change. Likewise, information may be communicated to one or multiple ED care providers depending on the workload in the ED and the status of the poisoned patient or other patients in the ED.

4.3 Current communication process

It is commonly known that current information exchange between U.S. poison control centers and emergency departments is almost entirely conducted via telephone using verbal communication. “Like all patients, poisoned patients are often the subject of “hand-offs” with multiple providers caring for them throughout their treatment course. The poison center specialist involved in the case may stay the same through the course of the patient stay in the ED or may change if the patient stay crosses a shift change. Likewise, information may be communicated to one or multiple ED care providers depending on the workload in the ED and the status of the poisoned patient or other patients in the ED.” (3)

Emergency care providers carry a very high communication load, characterized by frequent interruption, and so they are particularly prone to verbal communication related errors. (1, 2) (11, 12) (3) Overcrowding and high patient volume magnify this vulnerability. (13, 14) “Both ED care providers and PCC specialists in poison information experience multi-tasking, shift changes, patient hand-offs, and interruptions. These circumstances complicate workflow and create opportunities for error. (15)” (3)

Data and information is collected by PCCs, but documented information is not usually sent to other health care providers, nor do other health care providers send documented information to the PCC. The electronic data that supports PCC patient care for toxic exposures remains isolated in the PCC’s clinical information system, as does the data of the ED in its own system. PCC SPIs and ED care providers verbally communicate a subset of data and information using phone calls and facsimile. This approach may allow for rich, expressive and targeted communication, but may also create ample opportunity for miscommunication, inadequate communication, and error. (16) (17) Additionally, any information moved among patient care settings via phone may or may not be stored in electronic form for continued use by the recipient ED. It is unknown whether the information persists in the patient record in some way, or whether it deteriorates over time.

4.4 Toward health information exchange supported communication

The Institute of Medicine’s seminal report “To Err is Human” attributed an estimated 44,000–98,000 deaths each year to medical error (18) (19). It succinctly observes: “When patients see multiple providers in different settings, none of whom has access to complete information, it becomes easier for things to go wrong”. ((18) ,p. 1-2) Both system and human factors influence error, and system interventions can be used to decrease the likelihood of human error. (19)

Interoperability, the ability of different information systems to electronically exchange data in such a way that the data retains its meaning and can be understood and used in diverse systems, is an important current priority in U.S. healthcare. Interoperable systems and health information exchange can be used to effectively support data and information sharing to support continuity of care. Indeed, interoperability and standardized health information exchange is a priority of the 2008-2012 ONC-Coordinated Federal Health Information Technology Strategic Plan, with goals of enabling information exchange in support of both patient

care and population health. (20) The information systems of America's poison control centers are no exception.

Unfortunately, there are some readily apparent barriers to electronic exchange of poison control center data. First, United States poison control center information systems are not believed to be interoperable and do not typically implement data standards that facilitate interoperability. Data standards are agreed upon processes and rules by which data is coded. Standards are an extremely important prerequisite for system interoperability, because they enable dissociated systems to communicate. If the data is coded in the same way by both systems, the data can be sent, received, and used by either system. Because poison control data are not typically coded according to a commonly accepted and referenced standard, it cannot be exchanged with other health care organizations without labor intensive custom programming.

Second, there is little funding to support standardization of poison center data for purposes of interoperability. Poison control centers are primarily locally funded, and rely on a patchwork of funding sources. The federal government provides some financial support to PCCs, but it is not a major source of funding. Custom interface programming and maintenance is an intimidating prospect for most poison control centers, and prohibitively expensive. U.S. poison control centers also use varied electronic medical record systems. These systems are proprietary and there has been little interest in merging to one system to ease sharing of poison center records between poison centers. While U.S. poison control centers do not share a common data model or a single information system, the information systems of all U.S. poison control centers contribute data to NPDS (National Poison Data System). NPDS data elements do not comprise a reference terminology that would support interoperability and health information exchange. NPDS data elements are structured in a way that supports population health surveillance and case reporting rather than individual patient care. However, common use of NPDS by U.S. PCCs could facilitate efforts at interoperability.

Clearly, one of the most difficult challenges facing health information exchange initiatives and organizations is assessing the value of services that emerge from the health information exchange to various stakeholders groups, and financial viability is at stake.(21-24) The potential value propositions for developing healthcare information exchange and interoperability between PCCs and EDs have not been explored or developed.

There exists a potential to improve continuity of care and patient outcomes through electronic exchange of data and information between PCCs and EDs. Electronic information exchange could improve and support communication, reduce error, improve the availability of data and information to clinicians at the point of care, and ensure timely follow up by poison control centers. It could also enable definitive linkage of emergency department patient records with poison control center patient records, replacing current probabilistic linkage approaches used in retrospective analyses of poisoning morbidity and mortality. This study sought to describe the information requirements for health information exchange between poison control and emergency departments in support of individual patient care, describe current information exchange scenarios, and identify the clinical, operational, and legal considerations important for electronic information exchange between emergency departments and poison control centers in support of individual patient care. We used multiple approaches, including interviews with clinicians and stakeholders, review of documents, analysis of recorded poison control center calls and process modeling. We also determined consensus among national experts on salient issues with a four round Delphi study.

5. METHODS

5.1 Aim 1: Information Requirements for Health Information Exchange (electronic)

“Setting. The setting was a single intermountain west poison control center. The type and distribution of calls received by this center is very similar to that seen on a national level: unintentional poisonings (US 83% and Site PCC 85%); intentional poisonings (US 13% vs. Site PCC 10%), on site management of poisoning (US 73% vs. Site PCC 76%), and emergency department care (US 12% vs. Site PCC 13%).^(10, 25) In 2011, the site

PCC responded to 49 375 calls for assistance and managed 42,544 human poison exposures, or an average of 15.4 poison exposures per thousand population.

Sampling. The analysis of PCC call recordings was a secondary analysis of call recording transcripts corresponding to a sample of 120 PCC cases. We selected an initial random sample of 500 cases involving ED-PCC communication during the calendar year 2009. From the initial random sample, we sequentially selected cases in 20 case increments, until saturation was achieved. We defined saturation as the absence of new information types for 40 additional cases. In subsequent 20 case increments, we identified additional data/information types, until no new information types appeared in 40 cases (2 sequential 20-case increments). This saturation sampling approach suited our purpose, ensuring an adequate sample size to describe information requirements for ED-PCC communication, while minimizing the use of potentially sensitive call transcriptions for that purpose.

Procedure. All calls to the poison control center are routinely recorded and stored on a secure server. In previous work, we developed a process for linking cases to call recordings, and extracting the call recordings for transcription.⁽²⁶⁾ We linked call recordings associated with each case, verified the linkage, exported the call recordings and converted them to digital format, and transcribed the call recordings. We then removed names of staff, patients, and specific health care facilities from the transcripts. Upon de-identification, we incrementally analyzed the transcripts, creating a formative list of information types evident in the communication. All coding of information requirements was validated by a second coder, with disagreements resolved through discussion by the research team. The process resulted in a list of information types and frequency of their occurrence, identified during telephone communication between a poison control center specialist and emergency care providers, regarding a poison exposure. It also resulted in a sample of call recordings suitable for an analysis of process characteristics for aim 2.” (27)

5.2 Aim 2: Current ED-PCC Communication and Information Sharing Process

In aim 2, we interviewed key informants who were physicians, nurses, pharmacists, and poison control center specialists who could describe the current process of communication between poison control centers and emergency departments. We also conducted a secondary analysis of observational data comprised of a random sample of transcribed call recordings from one intermountain west poison control center.

5.2.1 Interviews

As reported in Cummins et al (2013), “In order to describe the current process of ED-PCC communication, we conducted guided interviews with persons involved in workflow aspects of emergency care for poisoned patients. We conducted an initial set of interviews to generate data for creation of process diagrams that are visual representations of the current ED-PCC communication process. We conducted a second, smaller set of interviews in order to validate the process diagrams and address follow-up questions.

Setting. We conducted interviews with clinicians from three settings: the Utah Poison Control Center and two of its collaborating emergency departments. We selected two high volume emergency departments that frequently communicate via telephone with the poison control center, but are located separately from the poison control center and not affiliated with the same health care organization.

Sample. We recruited interview participants through collaborators, senior emergency medicine physicians who were our research contacts at these sites. Each ED collaborator provided a list of selected physicians, nurses, and staff pharmacists for potential interview, individuals knowledgeable about the current ED-PCC communication process, consistent with our non-random “key informant” sampling approach. Our PCC collaborator similarly provided a list of poison center specialists for potential interview. The names were added to a spreadsheet and assigned a random number. We sought six to eight participants at each ED site and three to four participants at the PCC site. Clinicians were invited to participate via e-mail, in random order, but we ultimately invited all identified clinicians to participate, in order to achieve adequate sample size.

Procedure. The interviews were conducted by the principal investigator or a trained research assistant with graduate education in biomedical and/or nursing informatics. All interviewers underwent training prior to data collection. The training was three hours in length, taught by an experienced clinical systems analyst (a paid consultant to the study), and focused on data collection and human subjects procedures, interview training, and mock interviews. Interviews were scheduled at a time and location convenient for the participants. Informed consent was obtained prior to each interview. We then conducted 30-40 minute semi-structured interviews to elicit a description of the current ED-PCC communication process. In the course of the interviews we requested copies of any mentioned documents or flow sheets used to support current processes of information exchange between the PCC and the EDs. Interviews were digitally recorded and transferred to a secure server, then transcribed. We analyzed content of the first phase transcripts and drafted a series of workflow diagrams, visual descriptions of the process as described in the interviews. In a second phase of interviews we validated the process diagrams and collected missing information. Transcripts of the second phase validation interviews were used to refine and complete the process diagrams.” (27)

5.2.2 Analysis of PCC Call Recordings

The aim one analysis resulted process resulted in a list of information types and frequency of their occurrence, identified during telephone communication between a poison control center specialist and emergency care providers, regarding a poison exposure. The process of identifying information types in the primary study involved substantial immersion in transcripts of ED-PCC communication by the research team. In analyzing the transcripts for information types, the research team repeatedly observed phenomena relevant to health information exchange - inefficiencies and vulnerabilities in the current telephone-based information exchange process. Although not originally proposed as a component of this study, we determined that a formal secondary analysis of these phenomena would provide additional observational data for process description. Upon analysis of call transcripts for approximately 60 cases, we created a formative list of observed phenomena that occurred during ED-PCC communication. The observed phenomena represented apparent or possible inefficiencies or potential safety vulnerabilities (considering patient safety literature), as well as general characteristics of the process and communication. We organized the observed phenomena into concept categories. When a phenomenon was observed multiple times, we assigned it a concept label, such as “Clinical information exchanged with non-clinical ED staff”. We created a list of these concepts, with a description. Using the list of concepts identified through this process, we proceeded to analyze the entire sample of transcripts for occurrence of the concepts using qualitative data coding techniques.

To conduct the sub-analysis for phenomena relevant to health information exchange, we imported the transcripts into qualitative analysis software, ATLAS.ti, then proceeded to re-analyze the transcripts, coding each occurrence of a concept in the full corpus of call recording transcripts corresponding to 120 cases.⁽²⁸⁾ We calculated the overall number and frequency of occurrence for each concept. We also calculated the number and frequency of cases in which each concept occurred. By analyzing the call transcripts in this way, we are able to consider the current process as described by key informants and represented in the process diagrams in the context of objective data describing inefficiencies and vulnerabilities.”

5.3 Aim 3: Clinical, Operational, and Legal Considerations

As reported in Cummins et al (2012), “we convened a panel of N=71 experts in emergency medicine, poison control, and informatics for a modified Delphi study, September – December 2010. (29) Delphi is a widely accepted technique for establishing consensus. (30-32) The technique entails asking expert panelists to express opinion by rating a series of statements over multiple rounds of surveys. In a Delphi approach, we invited an initial sub-group (n=11) of panelists to respond to a survey composed of open-ended questions. The invitees were selected on the basis of particularly relevant experience or leadership positions, and willingness to invest time in thoughtful responses to open-ended questions. Using thematic analysis, we converted the

responses to statements representing the spectrum of panelist opinion. We compared these statements to issues and barriers published in the literature, and we added statements to reflect literature-based concepts not evident in the sub-group's responses. This constitutes a variation in the traditional Delphi technique, in which all concepts emerge from the panel, and so we describe our method as a modified Delphi approach.

In subsequent surveys, the full panel reviewed lists of statements describing issues or concepts related to implementation, adoption, and potential outcomes of electronic information exchange. Panelists rated importance on a 7-point Likert scale. We also invited panelists to comment on any statement or provide general comments about electronic information exchange between EDs and PCCs. Once statements met the consensus criterion, we removed them from subsequent surveys. We analyzed open-ended comments after each round using a thematic analysis approach and added new statements if new concepts emerged from panelist comments in previous rounds. Statements that failed to meet the consensus criterion were presented again in the next survey round of surveys along with the associated numerical ratings and panelists' comments from the previous round. The purpose of the additional information was to aid individual panelists in moving toward consensus. If a statement did not meet the consensus criterion after being presented to the panel twice, it was determined to be a no-consensus statement. The survey ended after all statements were determined to be consensus or no-consensus statements. See figure 1 for a visual description of the process.

Selection of Panelists. Our national panel was non-random. Rather, it was purposefully composed of both leaders and experienced front-line professionals in emergency medicine and poison control, many with an informatics background, willing to offer perspectives and opinion on electronic information exchange to support care of poisoned patients. Purposeful, non-random sampling is consistent with the Delphi approach. (33) All were uncompensated volunteers. Panelists were recruited through professional networking, recruitment at emergency medicine and toxicology conferences, and calls for participation distributed through relevant listservs. In addition to expertise in either emergency medicine or poison control, we sought geographical diversity, leadership in professional organizations, informatics expertise, and emergency nursing expertise. We composed the panel of approximately equal numbers of panelists whose expertise was characterized as either emergency medicine or poison control. A sub-group of the panel was selected by the research team based on the team's subjective assessment of potential to provide rich, thoughtful responses to open-ended questions. It was purposefully composed of volunteer panelists known by the team to possess a high degree of interest, willingness to provide input, and/ or informatics expertise in the emergency medicine or poison control setting.

Retention Strategies. We facilitated recruitment, retention, and participation using several strategies. We directed prospective panelists to a web page that featured information about the study, the research team, and FAQ (frequently asked questions) about the study and Delphi participation. We communicated with panelists regularly during the time between recruitment and data collection. We reminded panelists of upcoming survey release dates and reminded non-responders of impending survey completion deadlines. During data collection, the principal investigator was available to panelists by cell phone for immediate assistance. The content of each full panel survey was dependent upon the results of the previous survey, and we sought to sustain panelist interest and engagement by minimizing the length of time between those surveys. To that end, we analyzed statement ratings data within 16 hours of survey closure and we analyzed open-ended comments within 2-3 days. This coordinated team effort allowed us to rapidly design, build, and release surveys for subsequent rounds within approximately one week's time." (29)

Measurement. We instructed panelists to rate statements on a 7-point Likert scale. ... "Consensus was based on the frequency of ratings at each level, and the consensus criterion was set at 80%, +/- 1 level, a priori. If at least 80% of panelists rated a statement within one rating level, the statement reached consensus at that level. When consensus was reached at more than one rating level, the rating with the highest frequency, +/- 1 level, was assigned.

Data Collection and Analysis. We used RedCap™ to design and administer the web-based surveys, collect data, track recruitment efforts, and manage communications with panelists. RedCap™ is an open

source software application for developing surveys and databases for the purpose of clinical research. (34) Statistical analyses were conducted using SPSS. We calculated the response rate of panelists for each round. Analysis of panelist ratings included percent agreement (+/- 1 level), mean, median, and range, in addition to visualization of distributions to evaluate for skewness, bimodal distribution, and variation in response between emergency medicine and poison control experts. "(29)

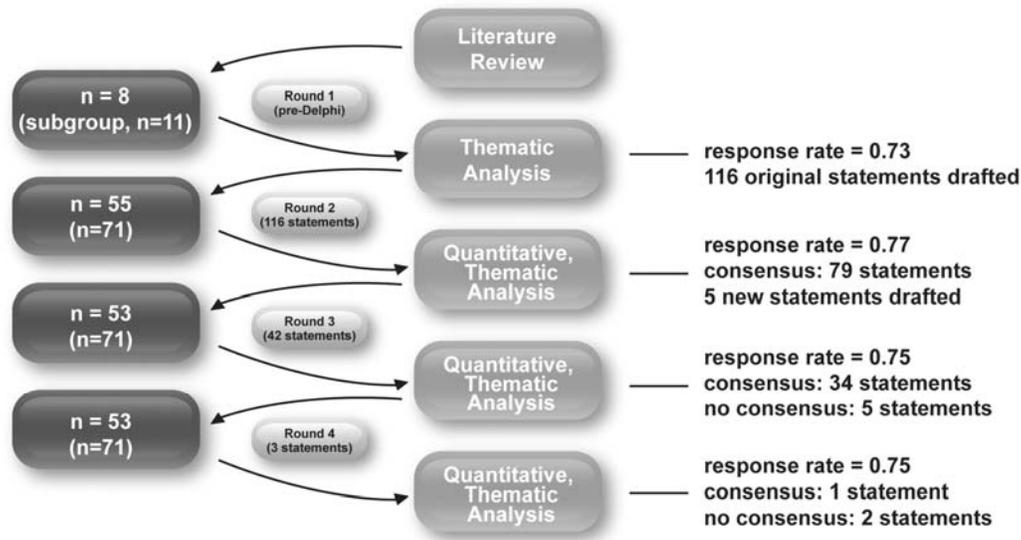


Figure 1. Delphi Process and Results (Round 1, N=11; Rounds 2-3, N=71)

Reproduced from Cummins et al (2012). (29)

6. RESULTS

6.1 Aim 1: Information Requirements for Health Information Exchange (electronic)

6.1.1 Principal Findings

In the analysis of call recordings, we reached sampling saturation upon analysis of 120 cases (six increments of 20). Information types were validated by a second coder to improve reliability. Inter-coder disagreement was infrequent and resolved through team discussion and review of transcripts. The research team reviewed the information types, and where appropriate, aggregated duplicate or nested concepts. After validation and aggregation, we identified 52 information types. The information content of analyzed calls included essential identifying information – information identifying both health care providers (location, type of provider, name) and patients (name, age, gender). It also includes essential health information about the patient, including current medications, allergies, and health history. Many information types related to the poison exposure incident. Information was exchanged about the poison, its characteristics and effects, and clinical treatment. Information was also exchanged about the poisoning scenario, including important circumstances that bear upon decision making related to care of the patient. Narrative information, the poisoning “story”, included information that helps discern whether the poisoning was intentional (overdose or suicide attempt) or unintentional, and information that helps to establish the certainty, dose, and timing of the exposure. For example, the narrative might include information about a parent’s estimate of the number of tablets remaining in a full prescription bottle, and the time at which a child was found eating tablets from that open bottle. Both the PCC and ED collect and share these types of information. The ED care providers assess the patient in person and shared information about the physical exam and appearance of the patient, clinical findings, and the results of any diagnostic testing. They also shared information about the patient’s plan of care, and treatment or management. The poison control center, acting as consultant, provided feedback on clinical findings as well as treatment and monitoring recommendations. This frequently entailed general communication about the type of poison, its characteristics, effects, and treatment in a type of communication

that appears to establish common ground for the discussion of the specific patient and exposure at hand. Communication also frequently included requests for information from the other party.

We conducted a preliminary mapping of these information types to the UMLS Metathesaurus and to commonly accepted clinical terminology systems using terminology browsers or coding manuals. None of the terminology systems provided complete coverage of the identified information types. NPDS (National Poison Data System) mapped to 38/52 information types (73%). Clinical terminologies LOINC and SNOMED-CT mapped to approximately half of the information types. A specialized set of data elements designed for the emergency department setting (DEEDS), mapped to 31/52 information types (60%).

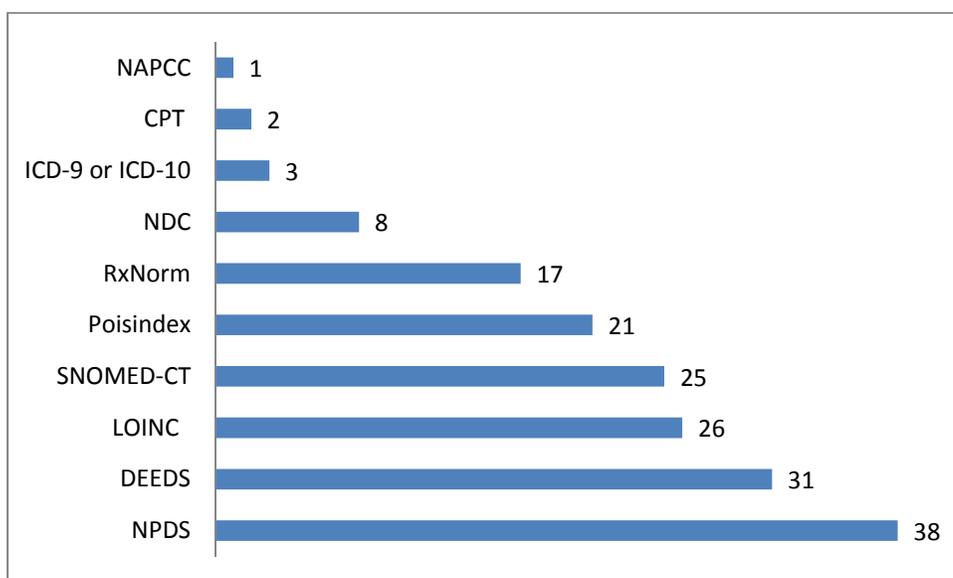


Figure 2. Terminology coverage of information types used in ED-PCC communication (preliminary mapping, unvalidated by domain expert).

6.1.2 Discussion and Implications

Approximately 50-60% of the information types identified in the analysis of call recordings map to the widely used clinical terminologies LOINC and SNOMED-CT, and a specialized set of data elements designed for the emergency department setting, DEEDS. However, many of the concepts are highly specialized to the context of poisoning scenarios and are not found in standard clinical terminology systems. ED-PCC communication about poison exposed patients involves types of information that are not commonly represented in standard clinical terminology systems. In order to accomplish standards-based health information exchange using data coded according to a standard clinical terminology system, additional terms must be proposed and adopted.

The National Poison Data System (NPDS) data elements mapped most successfully to the information types. However, NPDS is not structured as a clinical terminology. NPDS data elements were designed for the purpose of surveillance and not to support clinical information systems or patient care. Although used by all U.S. poison control centers, NPDS data elements are not currently mapped to any standard clinical terminology system, and do not facilitate interoperability with emergency departments. Moving toward interoperability, it is important to create a mapping of NPDS data elements to standard clinical terminology systems. Since the completion of this project, the principal investigator has continued an unfunded effort to map National Poison Data System data elements to the UMLS metathesaurus. The results of an initial automated mapping are currently under review, for presentation at a 2013 meeting of the American Medical Informatics Association.

6.2 Aim 2: Current ED-PCC Communication and Information Sharing Process

6.2.1 Principle Findings

Phases of ED-PCC Communication

As reported in Cummins et al, 2012, analysis of interview data revealed the following process. The following description is based upon information provided by eleven interviewed health care providers, including physicians (4), ED pharmacists (2), nurses (2), and poison control center specialists (3). The process is depicted in Fig. 2. “ED-PCC communication occurs in three phases:

1. *Notification.* The notification phase consistently occurs when the poison control center refers a patient to the emergency department for evaluation. The PCC specialist notifies the ED of the referral and provides basic information about the patient, the exposure, and PCC recommendations. The PCC places ongoing follow up calls to confirm patient arrival at the emergency department. In some cases, emergency department staff will notify the PCC of patient arrival, but this practice is inconsistent.
2. *Collaborative Care.* The collaborative care phase begins once a patient has arrived at the ED and the ED physician or other care provider calls the PCC to confer about a plan of care. In this phase, complex dialogues related to diagnosis and treatment often occur. If the PCC was not involved in the case prior to patient arrival at the ED, ED-PCC communication is initiated in this phase.
3. *Ongoing Data Collection and Consultation.* The ongoing data collection and consultation phase involves additional telephone calls, usually initiated by the poison control center, to confirm current PCC treatment recommendations are still applicable by monitoring the patient’s condition and evaluating the results of laboratory testing. These calls, which consist largely of information requests by the PCC, are usually placed by the PCC specialist to the ED nurse. The PCC specialist will sometimes update treatment recommendations on the basis of the information provided, communicating that updated recommendation to the ED nurse or other care provider via phone.” (29)

6.2.2 Characteristics of the ED-PCC Communication Process

Additionally, we observed that the emergency departments and poison control center enter information into electronic health records. These records are separate and unshared. Information verbally communicated between the ED and PCC may or may not become a part of the permanent medical record. Documentation is limited to a subset of information discussed in the call. The processes of notification, collaborative care, and ongoing data collection/ consultation are not supported in any way by a shared document, shared patient record, or electronic messaging. As reported in Cummins et al (2012), “information communicated to the ED by PCC is distributed as necessary among ED team members using some verbal communication and very limited written communication (referral form or sticky note). The process involves chained dialogues, in which information shared by the poison control center is repeated among ED care providers via a series of one person to one person communications.” (29) Patient handoffs occur commonly and reflect the shift-based staffing of both the ED and PCC.

6.2.3 Observations from Analysis of Call Recordings

In our analysis of call recordings between a poison control center and its collaborating emergency departments, we observed that “the purpose of telephone calls between the ED and PCC fell into one of three general categories: (1) The ED calls the PCC for consultation, (2) the PCC calls the ED to notify them of a referral, and (3) the PCC calls to follow-up on a case. Call type 1 was typically placed by the ED physician after an initial assessment of the patient, and involved a request for information of some kind – usually substance identification, substance quantification, and/or treatment recommendations. Call type 2 was placed by the PCC specialist when they referred a patient to the emergency department for medical care. Call type 3 was placed

to verify patient arrival, monitor the patient's condition and lab results, provide additional treatment recommendations and determine the outcome of the poison exposure. "(27)

We published an article in *Clinical Toxicology* (Cummins et al, 2013) that details the commonly observed types of communication, with fictional examples. (27) "Every telephone call included patient identification of some kind, using a name, characterization (fictional example of a characterization: "the child with the digoxin exposure"), identifying information such as a description of age, gender, and the poisoning scenario, or a combination thereof. Collaborative care planning was common, observed in 82% of cases. Most cases (81%) also involved some type of request for information, whether vital signs, laboratory results, or verification that a treatment was administered. We observed multiple examples of confirmation or clarification of information: for example, confirmation of exposure, confirmation of a patient's arrival at the emergency department, and confirmation of the plan of care." (27)

"We found evidence of both inefficiencies and communication breakdowns during analysis of the transcripts. A of the transcripts for these phenomena was not within the scope of the originally proposed study. However, given existing evidence linking process inefficiencies and communication breakdowns to medical error, these occurrences were sufficiently compelling to warrant analysis. (35-38) (39) Frequency and percentage of these occurrences is described in detail in the 2013 article published in *Clinical Toxicology*: "In over 10% of cases (each case involving multiple telephone calls), the emergency department registered nurse was unavailable to take a poison control center phone call. In 5% of cases, a telephone call was routed through multiple care providers in the process of locating the appropriate care provider. In 8% of cases, a non-clinical emergency department staff member exchanged clinical information about a patient with the poison control center. In over half of cases (55%), the patient was discharged from the emergency department before the poison control center and emergency department care provider ever communicated. Typically, in these cases, the PCC referred a patient to the emergency department, but the ED did not call back for consultation. In 9% of cases, the poison control center specialist telephoned the emergency department to obtain laboratory results, without success.

Additionally, we observed that ED-PCC communication frequently included ambiguous characterizations and interpretations. For example, lab results were commonly reported as "fine" or "good", instead of a specific measurement. Clinical condition and vital signs were similarly characterized, not described. In six cases, ED care providers and PCC specialists communicated about multiple patients during the same conversation." (27)

6.2.4 Discussion and Implications

As reported in Cummins et al (2013) and excerpted here: "The process of ED-PCC information exchange at the participating sites is believed fairly typical of U.S. poison control centers and emergency departments, although local variation is expected across settings. In our detailed study of both the workflow and content of current telephone-based information exchange, we identified substantial opportunity for gains in efficiency and information availability with electronic health information exchange. We also identified potential areas of vulnerability, characterized by dependence on verbal communication with threaded, synchronous dialogues and a lack of shared electronic or written patient information. These vulnerabilities could be ameliorated through process improvement including a system of health information exchange." (27)

6.2.4.1 Limitations

"Although the UPCC has been shown to be very similar to other U.S. poison control centers in service delivery, and in fact, has higher utilization than most U.S. poison control centers, it is possible that these results reflect idiosyncrasies of the Utah Poison Control Center and its collaborating emergency departments. These idiosyncrasies are unlikely to be related to the nature and treatment of poisonings, but would be related to local variation in systems, workflow, and information management. Indeed, the two EDs are tertiary, teaching

emergency departments with staff pharmacists and board certified emergency medicine physicians, and differ in nature from community emergency departments. However, the basic systems and processes employed by the UPCC are typical of other poison control centers, and so we anticipate that this study will yield good preliminary information. Information requirements and information exchange scenarios could be validated at other poison control centers in future work. Indeed, community emergency departments deserve particular attention, because they frequently lack board certified emergency medicine physicians, staff pharmacists, or toxicologists.

These findings emerged from a study of workflow and information requirements, and did not seek to describe the relationship between aspects of the process of ED-PCC communication and clinical outcomes. The number of nurses and physicians interviewed to establish the current process of communication was small, sufficient to describe the basic process, but insufficient to capture all nuances and variation. It was also insufficient to describe the nature and extent of individual variation from the process. However, the number of interviews was sufficient to describe the basic process of ED-PCC communication used by one poison control center and two of its collaborating emergency departments. Future studies could examine and measure individual and institutional variation in the process, as well as the relationship between process characteristics and clinical outcomes.” (27)

6.2.4.2 Interruptions

“Telephone calls are a known and frequent source of interruption in the ED environment, and yet telephone communication is the basis of all ED-PCC communication. The current telephone-based information exchange process requires synchronous dialogue. When the ED care provider initiates phone contact with the poison control center, this appears to work reasonably well. The ED care provider chooses the timing of the call, and the PCC specialist responds from a workflow designed for telehealth, including triage of incoming calls. The ED health care provider’s workflow is *not* based on telephone communication, but hands-on patient care delivered in physically distributed locations within the emergency department. Our study revealed the use of repeated telephone calls to verify a patient’s arrival at the emergency. Our study also shows that the poison control center routinely contacts the emergency department care provider to obtain information about a patient’s condition or lab results, in the event that the plan of care requires adjustment. However, they often have difficulty obtaining that information because it relies upon synchronous verbal communication with busy, often unavailable ED care providers. ED care providers are often engaged in direct, emergency patient care, and they are unavailable to take a telephone call. Additionally, the use of verbal communication to support information sharing introduces a greater possibility of error. Given the availability of technologies for electronic exchange of patient information, including the direct reporting of lab results to the poison control center, this obstacle to communication seems unnecessary.” (27)

6.2.4.3 Continuity of Care

“Our study of the ED-PCC communication process indicates that both the ED and PCC collect and document information about a poison exposure. However, this documentation is not typically shared in written or electronic form across settings. ED care providers lack access to PCC documentation, and PCC care providers lack access to ED documentation including lab results. Within the emergency department setting, some amount of information shared by the poison control center is documented by care providers. Depending on the form of documentation, this information may or may not become part of the permanent medical record, and may or may not be available to other team members during the ED stay. Information sharing during the course of the ED stay is more dependent upon chained dialogues, in which information is passed through a series of one person to one person communications. The communicating ED care provider shares information with other team members as necessary, using 1:1 verbal communication or implicit communication via written orders. Given the high number of potential patient handoffs in the course of treatment for poison exposure, this

reliance of information sharing on chained dialogues represents a vulnerability in which information is easily lost or miscommunicated. (40) Additionally, no written or electronic information from the poison control center about the poison exposure is readily available to the poisoned patients' health care providers in subsequent outpatient and inpatient care settings." (27)

6.2.4.4 Ambiguity of information

"Ambiguous communication of clinical findings and laboratory results occurred in approximately 1 out of 5 cases (22%). Lab results were often reported using qualitative characterizations such as "fine" or "a little low", without reporting of specific values. Lab results were almost never associated with a particular time/ date of specimen collection. Similarly, clinical findings were frequently communicated in terms of characterizations instead of observations. For example, "she's acting fine" or "she looks good". This level of detail and information sharing may adequately support the immediate decision making of the ED care provider and PCC specialist. However, the information is not sufficiently detailed for any kind of secondary analysis, and only marginally useful in ongoing patient care. Beyond the immediate decision making accomplished by the ED and PCC, the information is essentially lost. Additionally, the ambiguity of the information communicated creates vulnerabilities in the communication process, and therefore patient safety. (35, 40)" (27)

6.2.4.5 Vulnerabilities in safety

"Another safety vulnerability lies in the discussion of multiple patients during a single telephone call. This creates opportunity for error because information and recommendations could easily become confused. In some cases, the patients were exposed to an identical substance, and transcripts reveal repeated efforts by care providers to distinguish individual patients on the basis of age or other characteristics. Considering the use of telephone communication, it makes sense to communicate about the poisonous substance and exposure scenario in a single conversation. However, the treatment recommendations may differ based on individual patient information - information that could easily become confused in an information exchange process based solely on verbal communication. Other safety concerns arise from the exchange of clinical information with non-clinical staff answering emergency department telephones. This reflects the difficulty of achieving synchronous communication between the PCC and ED care providers, who are engaged in the care of multiple patients with the multiple associated communication, documentation, and physical care/ treatment activities." (27)

6.2.4.6 Routine vs. complex dialogues

"Several types of communication occur between the ED and PCC as they collaborate to care for poisoned patients. Some communication is quite routine. For example, notification about a new patient, unique patient identification, sharing of lab results, and patient disposition (admitted, discharged, transferred, etc...). Despite the routine nature of this communication, it is sometimes difficult to accomplish, due to its dependence on synchronous telephone communication. This routine information exchange between the ED and PCC begs an alternative model such as health information exchange. Other types of ED-PCC communication involve complex dialogues for collaborative care planning, substance identification, and discussion of observed vs. potential clinical effects. For example, we observed cases in which there was uncertainty related to the dose and timing of the poison exposure, and so the care planning involved considerable complex dialogue about worst case scenarios, the interpretation of symptoms, safe periods of time for observation and/or alternative decisions based on emerging information such as lab results. This type of communication is more complex and well suited to synchronous verbal communication. However, the capacity of the ED and PCC to achieve synchronous telephone communication is vulnerable to surges in patient or call volume, and there is no back-up system for information sharing during high-volume emergency situations. Therefore, some basic system of

information sharing that is not dependent on synchronous telephone communication is necessary. Considering potential disaster scenarios, a dependence upon telephone communication appears especially fragile.” (27)

6.2.4.7 Health Information Exchange and ED-PCC Communication

“Health information exchange could potentially improve and support communication, reduce error, improve the availability of data and information to clinicians at the point of care, and ensure timely and effective follow up consultation by poison control centers. It could also enable definitive linkage of emergency department patient records with poison control center patient records, replacing current probabilistic linkage approaches used in retrospective analyses of poisoning morbidity and mortality. This would vastly improve data quality for research and improve the historical health record for individual patients. However, elimination of all verbal communication between the ED and PCC is probably inappropriate. The findings of this study suggest that there exists potential to replace telephone calls for routine types of information sharing (such as notification about new patients and sharing of laboratory testing results) with health information exchange. More complex types of information sharing and communication (substance identification and collaborative care planning) may remain better suited to telephone communication supported by health information exchange.” (27)

6.3 Aim 3: Clinical, Operational, and Legal Considerations

6.3.1 Principal Findings

As reported in Cummins et al 2012, N=71 panelists volunteered to participate. 38 (54%) of panelists were identified as emergency medicine experts, and 33 (46%) were identified as experts in poison control center. Multiple panelists were identified as experienced in both environments. The geographic distribution of the panelists was nationwide. The panel was composed of 32 physicians, 4 pharmacists, 10 nurses, 10 poison center specialists (pharmacists or nurses), and 15 other/ unknown.

In a smaller initial round, a sub-group of eleven panelists responded to a series of open-ended questions; the response rate = 0.73 (n=8). Subsequent rounds included the full panel (N=71). For these, the second round response rate = 0.77 (n=55), third round response rate = 0.75 (n=53), and fourth round response rate = 0.75 (n=53). Upon completion of the fourth round, most (114/121) statements had reached consensus. Seven statements failed to reach consensus.

6.3.1.1 Adoption

As reported in Cummins et al (2012), “panelists reached consensus on the importance of almost all statements related to initial adoption of HIE processes (27/29). Generally, these statements were rated very to extremely important (rating levels 5 or 6) and reflected financial considerations, legal aspects, internal advocacy by users, and the availability of ready-to-use tools and processes. (See table 1). Panelists gave only one item a moderately important consensus rating = 4, “advocacy by professional organizations.” Panelists did not reach consensus on the importance of “evidence of decreased cost of care” for HIE adoption or the importance of a “process for handling disagreement between a poison control center and the bedside clinician.” Ratings on these two statements varied. A total of seven statements had more or less importance for ED personnel compared to PCC personnel. (29)

6.3.1.2 Implementation

As reported in Cummins et al (2012), “panelists reached consensus on all statements related to implementation and agreed upon an importance rating of 5 or 6 for almost all statements (19/22). These statements include topics of functionality, system design, and workflow integration, as well as user involvement in the implementation process. Three topics received a more neutral rating of 4, including the statement “Electronic exchange that supports, and partially replaces verbal communication.” One statement reached consensus with a rating = 2, indicating low importance: “Ability of patients to opt in or out of electronic

information exchange.” A total of eight statements had more or less importance for ED personnel compared to PCC personnel.” (29)

6.3.1.3 Outcomes

Statements describing potential outcomes comprised the majority of statements, and panelists reached consensus on most (65/70). Fifty-seven outcomes statements reached a consensus rating of 5 or 6. Seven additional statements reached consensus with a rating = 4, neutral. One statement, “Increase in time necessary for communication,” reached a consensus rating = 2, indicating low importance. A total of eight statements had more or less importance for ED personnel compared to PCC personnel (see table 3).

6.3.1.4 Key Themes from Open-Ended Comments

As reported in Cummins et al (2012), panelists offered open-ended comments during each round. Our analysis of the comments revealed multiple emergent themes, including discussion of potential disagreement between ED care providers and PCC staff and the legal implications of that disagreement, the important of user involvement and buy-in, and general support for a health information exchange process and its potential to improve the “clinical picture” of a patient. Panelists cautioned that electronic information exchange should not entirely replace verbal communication, distinguishing between the exchange of routine, unambiguous data/information and more complex discussion of a patient’s plan of care. They cautioned that the exchange of data and information shouldn’t reduce case discussion.

6.3.2 Discussion and Implications

6.3.2.1 Limitations

As described in Cummins et al (2012), “we did not select a representative sample of panelists for this study. Rather, we purposefully recruited and selected panelists able to characterize the salient legal, operational, and clinical considerations relevant for electronic information exchange. The results reflect the opinion of a large, national expert panel, but they are not representative of any particular population. Non-consensus statements were presented to panelists a second time for rating with information describing the other panelists’ ratings and opinion. This action was intended to change the ratings of some panelists, moving them toward consensus. The results should not be interpreted as a description of individual panelist opinion. It is the consensus of the panel as a whole.

We modified the Delphi process by adding 2 statements to the survey based on the research team’s review of the literature. We added the statements in order to assess the opinion of panelists on literature-identified factors for HIE initiatives that were not mentioned panelist responses to open-ended questions. Given the total number of statements (121), the 2 literature review-based statements comprise a very small proportion. Because each statement was independently rated, the addition of the literature review-based statements should not have influenced the results of other items.” (29)

6.3.2.2 Discussion and Implications

As reported in Cummins et al (2012), enthusiasm for this topic was evidenced by panelist comments and the fact that we successfully assembled a large expert panel to complete 3-4 web-based surveys using only uncompensated volunteers.

“Through ratings, percent agreement, and open-ended comments, panelists indicated that they believe electronic information exchange has potential to improve quality of care and promote positive patient outcomes. They value the potential of electronic information exchange to facilitate effective communication with supporting documentation that accompanies each patient through transitions in the health care system. However, they also expressed concern over potential issues of patient safety and outcomes in relation to

implementation of an electronic information exchange process. Panelists agreed that evidence of clear benefit and improved patient outcomes is important for adoption of electronic information exchange processes.

Panelists agree that good workflow integration and user involvement in the design of systems and tools is important. The panel strongly agreed upon the importance of minimizing extra work and avoiding additional complexity in busy emergency department and poison control center work environments. They also recognized the importance of advocacy by clinicians, especially physicians and poison control center specialists and directors. Overall ED and PCC personnel agreed on the items of high importance. While there were a few items in each of the categories where one group rated the median importance slightly higher, there were no specific themes that emerged from those minor differences.

Legal aspects of health information exchange arose during the Delphi process, primarily in relation to a process for handling disagreement between a poison control center and the bedside clinician. This appeared to relate to the situation in which the ED care provider disagrees with poison control center recommendations, and using their own clinical judgement, implements a different plan of care. In the event of a poor outcome and subsequent lawsuit, there is some concern that more extensive documentation resulting from a health information exchange process may be used against the ED care provider in court. However, the concerned panelists may be unaware of the extent of current poison control center documentation in the poison control information system, and the fact that all telephone calls with U.S. poison control centers are currently and routinely recorded. Perhaps the record is already more extensive than that imagined by these panelists, but it is unseen by them. The electronic information is siloed within the poison control center and not shared with the ED care providers to support individual patient care.

Electronic exchange of patient and exposure information could functionally support emergency department – poison control center communication using one of several basic models. It could supplement existing verbal communication, partially replace telephone communication, or fully replace telephone communication in some cases. Panelists rated electronic information exchange that supports, but does not replace, verbal communication with the highest level of importance. General comments by panelists indicate that electronic information exchange is desirable and welcome, as long as users are involved and systems demonstrate good usability and workflow integration.

Emergency departments are uniquely challenging work environments in which care providers need rapid access to information and the acuity of patients is high. (4) Through improved information availability, electronic information exchange between emergency departments and poison control centers could reduce medical error, reduce time to treatment, and improve continuity of care for poisonings. Additionally, electronic information exchange could improve and support communication, improve the availability of data and information to clinicians at the point of care, facilitate timely follow-up, and decrease telephone-related workflow interruptions.

For poison control centers, electronic information exchange could improve the clinical picture on which recommendations are based. It could result in more efficient, detailed, and accurate documentation of poison exposures, and reduce the burden of telephone communication for routine information requests.

Steps Toward Health Information Exchange. Despite potential benefits in relation to workflow and patient care, ED-PCC health information exchange may constitute a low priority IT project for emergency departments embedded within health care organizations. Without clear evidence of strategic benefit, health care organizations will focus resources on an array of competing, higher priority IT projects that involve health information exchange and enable HCOs to meet meaningful use criteria. Given this circumstance, ED-PCC health information exchange is unlikely to be prioritized by emergency departments in the near future.

For poison control centers, the potential gains in efficiency may prove enticing, and barriers to exchange of some types of patient information, such as laboratory results, are relatively low. There has been substantial progress in health information exchange in recent years, making it increasingly feasible at lower

cost. There are many regional health information exchange organizations that facilitate participation in health information exchange and provide HIE-specific technical expertise and support for otherwise daunting tasks ranging from negotiation of data use agreements to unique patient identification. The building blocks for an ED-PCC health information exchange process exist, but it is first necessary to design a process that integrates well with the unique workflow of the ED and PCC settings – a process that can be adopted by most poison control centers given the extent of typical IT resources, and adopted by emergency departments given the unique requirements of ED workflow. Our team is actively working to address this need.

The federal government continues to incrementally push health care providers and health care organizations toward health information exchange, with a vision of ubiquitous nationwide clinical health information exchange. (41) Federal incentives for HIE are tied to financial incentives and reimbursement for health care providers that bill for services. As a result, U.S. poison control centers have been left unchallenged in the way they currently manage and communicate patient information. However, given this growing trend in the management and communication of patient information, it is urgent that U.S. poison control centers begin to plan for HIE.” (29)

7. LIST OF PUBLICATIONS AND PRODUCTS

Cummins, M.R., Doing-Harris, K., Passman, J., & Mateos, B. (Under review, 2013). Automated mapping of NPDS data elements to the UMLS Metathesaurus (abstract). AMIA Annual Symposium.

Cummins, M.R., Crouch, B.I., Gesteland, P., Wyckoff, A., Allen, T., Muthukutty, A., Palmer, R., Peelay, J., Repko, K. (2013). Inefficiencies and vulnerabilities of telephone based communication between U.S. poison control centers and emergency departments. *Clinical Toxicology*, Early Online, 1-9.

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Poynton, M.R., Crouch, B.I., & Gesteland, P. (2012). Building a knowledge base for health information exchange between emergency departments and poison control centers (paper). Proceedings of HICSS45: Hawaii International Conference on Systems Science.

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