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The need for informatics to support forensic pathology and death investigation

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Abstract

As a result of their practice of medicine, forensic pathologists create a wealth of data regarding the causes of and reasons for sudden, unexpected or violent deaths. This data have been effectively used to protect the health and safety of the general public in a variety of ways despite current and historical limitations. These limitations include the lack of data standards between the thousands of death investigation (DI) systems in the United States, rudimentary electronic information systems for DI, and the lack of effective communications and interfaces between these systems. Collaboration between forensic pathology and clinical informatics is required to address these shortcomings and a path forward has been proposed that will enable forensic pathology to maximize its effectiveness by providing timely and actionable information to public health and public safety agencies.

Key words: Clinical informatics, death investigation, forensic pathology, public health, public safety

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INTRODUCTION

Clinical Informatics (CI) and Forensic Pathology would appear to be two subspecialties of medicine with little in common, as many equate informatics with the management of electronic medical records and forensics with the "criminal" investigation of homicides. These commonly held beliefs regarding forensics and informatics are simplistic and woefully incomplete. In reality, both fields are much broader, and there are opportunities for integration between forensics and informatics. Collaboration involving the expertise of the forensic pathologist in medicolegal death investigation (DI) and the skills of the clinical informatician to transform data into information can lead to the development of processes and systems that will better protect the health and safety of the public in an era of expanding threats from infectious disease, violent crime and terrorism.

WHAT IS CLINICAL INFORMATICS?

Clinical Informatics is a newly recognized subspecialty, with the first board examinations and certifications in 2013 and establishment of Accreditation Council for Graduate Medical Education accredited fellowships starting in 2014. CI is defined as "the subspecialty of all medical specialties that transforms health care by analyzing, implementing, and evaluating information and communication systems to improve patient care, enhance access to care, advance individual and population health outcomes, and strengthen the clinician-patient relationship"[1] CI is commonly confused with Information Technology (IT), yet there is a distinct difference between these two fields. IT emphasizes the tools that are used for data manipulation while not being overly concerned with the data content. In contrast, CI's primary focus is on the data and considers IT as only one of many tools at its disposal.

There are two subdomains within the broad field of CI that are most relevant to forensics: Pathology informatics (PI) and Public health informatics.

Pathology Informatics is "the study and management of information, information systems, and processes in Pathology."[2] This "subspecialty" of Pathology has grown to involve much more than the management of the huge volumes of data generated by anatomic pathology and the clinical laboratory. PI is involved with the entire testing process from the ordering of the test through presentation and interpretation of the results; in other words, the preanalytic, analytic and postanalytic phases of laboratory testing.[3]

Public health informatics is "the systematic application of information, computer science and technology to public health practice, research, and learning."[4] Public health is focused on populations instead of individuals, prevention instead of treatment of disease, and government agencies instead of health care systems.[5] Public health systems work at local, state, national and global levels to both prevent morbidity and mortality utilizing multiple modalities and to address emergent situations such as infectious disease outbreaks when they occur.

WHAT IS FORENSIC PATHOLOGY AND MEDICINE?

Forensic pathology is a subspecialty of pathology that concerns itself with the investigation of sudden, unexpected or violent deaths. While only formally recognized since the middle of the 20th Century, the origins of forensic pathology date back many centuries.[6] The major responsibility of the forensic pathologist is to determine the cause and manner of death for persons that fall under their jurisdiction. The forensic pathologist accomplishes this goal by correlating the data collected through conducting a death scene investigation, performing an autopsy, and ordering a variety of additional laboratory tests such as histology, toxicology, and microbiology. Forensic medicine is also involved with the examination and collection of evidence from living persons who are the victims of assault. The most common example of this in the United States is the examination of victims of sexual assault.[7]

There are two main DI systems in the United States, coroners and medical examiners. Both coroners and medical examiners are responsible for investigating sudden, unexpected or violent deaths and making rulings on the cause and manner of the death. Coroners represent an older system that was brought to the United States from England. Coroners are mostly elected officials with no specific training in DI or forensics. Medical examiners are an American system created about a century ago.[6] Medical examiners are all physicians (almost all have formal training in forensic pathology) and are appointed government officials.

DATA COLLECTION IN FORENSIC PATHOLOGY

As a result of their work, forensic health care professionals gather a large quantity of textual and image data about their patients. This data are not limited to histories, physical examination findings and laboratory results that parallel those collected in other fields of medicine, but also include data gathered at the scene of death and from law enforcement agencies investigating the death. This data are critical in assisting the forensic pathologist in determining the cause and manner of death. Frequently it is the investigative data from the scene instead of the physical findings of the autopsy that allows the forensic pathologist to distinguish an accident from a homicide or suicide.

This data have been historically collected in hard copy formats. While there has been progress toward collecting data in electronic formats in recent years, in 2011 approximately 18% of DI offices had no electronic case management system. Over half of the offices with electronic systems have idiosyncratic homegrown databases, many of them created in simple spreadsheet or database programs. Different data types (image, textual, laboratory results) are not often linked together by patient. For example, approximately 25% of both homegrown and vendor systems do not have direct access to scene and autopsy images.[8]

There are few interfaces between existing DI information systems and the information systems of law enforcement, supporting laboratories or public health. Toxicology laboratory results, which are critical in a large percentage of forensic deaths, are still submitted as paper requests and received as paper reports, instead of through a bidirectional interface between the laboratory and medical examiner information systems. Forensic pathologists manually enter cause of death data both into their own office's information system and their state's electronic death certificate. This represents both duplications of effort and a source for the increased incidence of transcription errors.

Solving this issue would appear to be simple, but is complicated by a variety of political, logistical and financial challenges.

There are approximately 2,000 distinct DI systems in the United States. In 2004, only sixteen states had a centralized statewide medical examiner system. The other states had a combination of county coroner and/or medical examiner systems. These county-based systems can represent large cities, medium suburban areas, or small rural communities. Over 80% of the DI systems are county coroner systems in small to medium-sized jurisdictions. Resources are heavily concentrated in a few large systems. Most offices serving jurisdictions of 25,000 persons or less have only one full-time equivalent and median annual operating budgets of under $20,000.[9]

This large number of DI systems of various sizes and with differing access to resources represents a challenge to consistent data collection. Larger DI offices with greater resources employ specially trained death investigators to systematically collect information regarding reported deaths, and are more likely to use electronic information systems to collect the information. Smaller offices typically rely on law enforcement, whose investigative focus is on the investigation of crime rather than death, and receive paper investigative reports that may or may not be scanned or integrated into an electronic system.

There are currently no standards regarding the structuring of data or interfaces for electronic DI databases. As a result, there is no effective way to transfer information between different agencies either in the same jurisdiction or between jurisdictions. This not only impedes efficient operations on a day-to-day basis, but also is crippling during multijurisdictional emergencies, such as mass fatality incidents or infectious disease epidemics, where the free flow of information is critical.

Despite well-documented issues regarding the lack of data standards and inconsistencies between DI offices there has been little political will to invest the resources to address these deficiencies. The 2009 National Academy of Sciences Report on Forensic Science recommended that DI offices should have case information databases that would enable trend analysis of deaths for public health and safety purposes and continuous quality improvement.[10] Yet there has been a little improvement or significant political will to provide funding or standards for DI offices since that time.[11]

EFFECTIVE USE OF FORENSIC DEATH INVESTIGATION DATA

There are numerous examples of how information generated as a result of the work of forensic pathologists has been utilized in meaningful ways.

DEATH CERTIFICATION

The collection and compilation of the cause of death statements from death certificates have long been used by public health for epidemiology studies, disease surveillance, and determining where to focus public health resources. Unfortunately, the causes of death on these certificates are incorrect as much as half of the time. This is true even for common causes of death such as cardiovascular disease and cancer. Common errors include incorrect causes of death, nonspecific causes of death, and the inclusion of irrelevant diseases as contributing to death.[12-14]

Forensic pathologists provide approximately 20% of the death certificates in the United States.[15] As they are specifically trained in the proper completion of death certificates, the accuracy of information provided is greatly increased as long as a full autopsy had been performed. However, due to limited financial and logistical resources in most DI offices, many natural deaths and a significant percentage of noncriminal violent deaths may not be autopsied. It has been well documented that forensic pathologists produce a significant number of errors in death certification when external examinations are performed instead of an autopsy.[16,17]

Death certificate information is not only used by local, state and national public health departments to help set public health initiatives, but is also used by other agencies reviewing deaths from specific causes. The United States Department of Transportation studies transportation-related deaths through their Fatality Analysis Reporting System, and this has resulted in many improvements in the designs of motor vehicles and roadways. Similarly, the United States Department of Labor's Census of Fatal Occupational Injuries and the National Institute for Occupational Safety and Health's Traumatic Occupational Injuries Research and Prevention Program have effectively used death certificate data to improve workplace safety.[18]

MEDICAL EXAMINERS AND CORONERS ALERT PROJECT

The United States Consumer Product Safety Commission's (CPSC) Medical Examiners and Coroners Alert Project (MECAP) was created in 1976 as a quick alert system to report deaths where consumer products played a significant role in the death. Excluded from MECAP are deaths involving automobiles (but not off-road vehicles such as All-Terrain Vehicles), firearms (except air rifles and BB guns), foods, cosmetics, medical devices, aircraft, boats and boating equipment, and products used solely in industrial or commercial environments. There have been over 9,000 “valuable cases” reported that resulted in product recalls or product standards development. The CPSC’s website provides detailed information regarding, which deaths should be reported. The program is voluntary and requires the medical examiner or coroner to proactively identify potential cases and take the time to report them. Reports can be accepted by phone, mail, fax or through a linked website.[19]

MEDICAL EXAMINER AND CORONER INFORMATION SHARING PROGRAM

The Medical Examiner and Coroner Information Sharing Program (MECISP) was created by the Centers for Disease Control and Prevention in 1986. This was envisioned as a national system to collect and analyze information on medical examiner and coroner deaths to enable public health to quickly identify and understand the causes of sudden and unexpected deaths, leading to strategies to reduce mortality.[20] As the first decade of data collection contained data in the many different formats used by the offices voluntarily contributing to the program, MECISP set a goal of standardizing data collection by creating guidelines for creating forensic data management programs and a standardized DI data set.[21] Despite some success, the MECISP program was essentially defunded by the mid-2000’s and is no longer functional.

NATIONAL VIOLENT DEATH REPORTING SYSTEM

The National Violent Death Reporting System (NVDRS) is another program created by the Centers for Disease Control and Prevention in 2002 to collect and study the causes of homicides and suicides. The premise is that all these deaths are potentially preventable and that comprehensive data collection will facilitate the creation of violence prevention strategies. NVDRS is a state-based system designed to combine data from multiple sources (death certificates, medical examiner and coroner reports, law enforcement reports, and crime laboratories) into a single searchable database. Initially deployed in 16 states, it is now collecting data from 32 states with the ultimate goal of covering the entire Unites States. In 2013 NVDRS went to a web-based system for easy accessibility to the data. The program has had many successes in studying deaths in children due to maltreatment, suicides among soldiers, intimate partner homicides, elderly suicides and geographic distributions of violence.[22-25]

NATIONAL MISSING AND UNIDENTIFIED PERSONS SYSTEM

The issues of missing persons and unidentified human remains have been described as a silent mass disaster. At any given time, there are over 100,000 active missing persons cases and over 40,000 unidentified human remains in the United States. Historically there have been multiple databases at state and federal levels containing a combination of unique and overlapping information attempting to address the problem, but creating a logistical nightmare for law enforcement agencies and medical examiners to match missing persons with unidentified remains.[26]

In response, the United States Department of Justice created the National Missing and Unidentified Persons System (NamUs). NamUs has three main databases: a missing persons database in which families or law enforcement may enter information regarding missing persons and follow cases; an unidentified persons database where medical examiners and coroners may enter information on unidentified persons and the general public can search; and an unclaimed persons database for persons who have been identified but where family has not been found. The missing and unidentified person’s databases interact to match information when entered into either system. As of October 2014, NamUs has resolved approximately 9000 cases of missing or unidentified persons.[27]

SHORTCOMINGS OF EXISTING SYSTEMS

While all of the above systems and programs have been effective, they have common shortcomings. With the exception of death certificates, the entry of information into these disparate databases is voluntary on the part of medical examiners and coroners. Much of the data entry is manual or semi-automated, requiring significant human effort to accomplish. These two factors complicated by the limited resources of many DI systems leads to partial participation, even when offices would prefer to contribute.

Despite the recognition that there need to be standards regarding what data are collected and how it is classified and organized in a DI database, little progress has been made on this front. The few electronic communications of information directly from forensic offices to outside agencies are in the form of customized reports. There is currently no communication standard that would allow information to flow freely to, from and between DI electronic information systems, even when they are provided by the same vendor. These issues hinder the ability of forensic pathologists to effectively transform the data they are collecting into actionable information that would better inform public health and public safety agencies.

A PATH FORWARD

A prerequisite for improving the current situation is recognition in the forensic pathology community of the value of their data beyond the individual case. The examples of the government-based data sharing programs described above support the opinion that it is unlikely the federal government will solve the overarching problem of data consistency and analysis in forensic pathology. DI organizations, such as the National Association of Medical Examiners (NAME) and the International Association of Coroners and Medical Examiners (IACME), need to take leadership of this issue. Both of these professional organizations are dedicated to advancing DI and have existing standards for accreditation of offices.[28,29] While these groups are experts in the area of DI, they lack the necessary informatics expertise that will ensure success.

The Association for Pathology Informatics (API), a professional organization of pathologists with expertise in informatics, is the obvious partner for this endeavor. API's focus on data standards in pathology and the informatics education of pathologists complements the focus on standards and education by NAME and IACME for forensic pathology and DI. API has a history of reaching out to collaborate with other professional organizations in pathology and CI, and already works with government and industry groups in the development of data and communication standards.[30]

Collaboration between these groups could address the challenges of sharing, merging and analyzing data from the large number of DI systems, each with their unique methods of organizing their data. Rather than attempt to start with a comprehensive solution, it may be advantageous to choose a handful of smaller projects to demonstrate value and to work through any issues that might become apparent. Data fields that are more likely to be consistent across different DI offices, such as basic demographics, cause of death and manner of death, are an obvious first step in this process. Toxicology and other laboratory results may be another potential "low hanging fruit" for collection and analysis. With some early successes, it will be easier to sit down and develop a more comprehensive solution, which should also include standards for the next generation of DI information systems.

The key is to develop a process by which data can be automatically transferred through an electronic interface from the individual DI office systems into a single database and subsequently back out to other systems for analysis. This includes several challenges that need to be addressed. Data fields in different systems may have different names, data types and conventions for expressing the data. For example, a field for manner of death may not only be named differently in different systems, but might be expressed as free text fields, defined text fields, abbreviations or even a numerical or symbolic representation for each manner of death. While it may seem like an insurmountable problem, the development of data standards has been accomplished in other areas of health care and is attainable for forensic pathology.[31] A communication standard for transmitting the data would also need to be selected or developed. A communication standard ensures that the receiving system understands the message from the sending system and can place the communicated data into the proper fields. One commonly used an example for health care is Health Level 7. Another major issue to address is the security of the data, especially given the sensitive nature of this subset of personal health information.

Once this data are collected, policies regarding storage and access to the data for analysis and study will need to be created. There are currently many examples of secure data storage "in the cloud" that could be utilized. Some of this data can have great value if freely accessible on the web. NamUS is an excellent example of the power of open information. NVDRS has a mixture of data that is freely accessible or restricted based on whether the data may lead to disclosure of the identity of victims or suspects, and may serve as a guideline. Another issue to consider is the needs of law enforcement to restrict access to data for cases that are actively being investigated.

In addition to the expertise of forensic pathologists and pathology informaticians, this effort would require significant financial support, including; travel for forensic and informatics subject matter experts to design the project and define the standards, creation and support for the database, storage costs for the data, design of mechanisms to access or transfer the data for study, and general ongoing support for the project. Given the value of this data to many different government agencies and departments, it is reasonable to pursue funding through these agencies. It should be understood that the control over the collected data would reside with the professional organizations and not with the government itself since the subject matter experts are the best custodians of the data.

CONCLUSIONS

Forensic pathology contains a wealth of information that is invaluable for many purposes. The current spectrum of information systems available to medical examiners and coroners are woefully inadequate to support the efficient use of this data. Data standards for DI and forensic information systems need to be developed. Standard communication protocols would enable the efficient automatic transfer of this data directly from medical examiner and coroner offices to national programs such as NVDRS and NamUs, to other public health, public safety and homeland security surveillance systems, and increase the timeliness and usability of this information. Clinical/PI needs to collaborate with forensic pathology to create systems to better utilize DI data to protect the public health and safety.

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