

Implementation and User Satisfaction With Forensic Laboratory Information Systems in Death Investigation Offices

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Abstract: The use of laboratory information management systems (LIMSs) in forensic pathology and death investigation systems has lagged behind the greater pathology community. Yet the logistical needs of a modern medical examiner or coroner office could be well served by a robust forensic LIMS, and the data stored in a forensic LIMS could be effectively mined for the protection of the public's health and safety.

In spring 2007, the National Association of Medical Examiners conducted a survey of its members to determine the use of and satisfaction with forensic LIMS. This survey was repeated in the fall of 2011. The responses to the 2 surveys were compared to note any trends or changes to LIMS use by medical examiners and coroners.

Although the use of LIMS has increased in the 4 1/2 years between surveys, 18% of death investigation systems still do not have a forensic LIMS. The percentage of offices with home-developed systems has increased, whereas the user's satisfaction with these systems has decreased. This may be due to limited budgets to either purchase or develop systems. The integration of images into these systems has increased, but not nearly to the level that should be present in an image-dependent field. Users of these systems are cognizant of the features that a forensic LIMS should have to ensure the smooth operation of a death investigation office.

Key Words: coroner, laboratory information management system, medical examiner

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The use of laboratory information management systems (LIMSs) has been prevalent in the daily practice of anatomical and clinical pathology for decades. From its beginnings as an improvement over manual specimen tracking and data reporting, LIMSs have grown to be an integral component of laboratory operations. Laboratory information management systems are critical to the efficient administration of the pathology laboratory, the management of the laboratory workflow, and the analysis of ever growing amounts of data.¹ Pathology LIMS has evolved to offer remote access through a thin-client Web application,² efficient scanned document management within the LIMS,³ opportunities for pre-sign-out quality assurance,⁴ and even applications for tracking patient deaths and hospital autopsies.⁵ Even with increased use of electronic medical records throughout medicine, the pathology department still represents between 60% and 80% of all the data contained in the electronic medical record.⁶

The use of LIMS in forensic pathology and death investigation has lagged behind the larger pathology community. One of the earliest published reports on computerization of medical examiner data is from the Fulton County (Atlanta, Ga) Medical Examiner's Office. Starting in 1984, the office went from a single personal computer to a simple in-office computer network to perform basic office operations with numerous beneficial effects.⁷ Articles describing general principles in using an electronic medical examiner database⁸ and a review of 4 commercially available software systems for death investigation systems⁹ were published in 1993. Surveys of medical examiner offices for computerization were performed by the National Association of Medical Examiners (NAME) in 1994¹⁰ and 2007.¹¹

Death investigation data have been shown to be extremely valuable in many instances. Automated coding of injuries from autopsy reports was demonstrated to be useful in gathering accurate information on trauma victims who did not reach a hospital.¹² More recently, several coding systems were evaluated for their value in a statewide medical examiner system.¹³ Medical examiner data have been useful for injury and suicide prevention,^{14–16} for surveillance for fatal infectious disease and bioterrorism,^{17,18} and for evaluation of substance abuse deaths.^{19,20}

This article presents a survey of death investigation offices conducted in 2011 to evaluate the implementation of electronic information systems and the user's satisfaction with these systems.

MATERIALS AND METHODS

In 2007, the NAME Data Committee performed a survey of medical examiners regarding the software used for case management purposes. A copy of the survey and the report was obtained.

A nearly identical survey was conducted from August to October 2011. This survey was constructed using Wufoo (www.wufoo.com). The only change between the NAME 2007 survey and the 2011 survey was the addition of microscopic and radiologic images to the question regarding imaging contained within the software. Members of NAME were notified of the survey through a global e-mail sent by the NAME office.

The survey questions were as follows:

1. What is the name and location of the office in which you work?
2. Pick the one that best describes the medical examiner case management software in your office: The office developed its own system; The office purchased a system from a vendor; or The office does not have a case management database system.
3. If you developed your program, what type of program or software did you use?
4. What is the name of the medical examiner software product that you use?
5. How long has this software been in use in your office?
6. Indicate your overall satisfaction with the software you are using: 0-Poor; 1-Fair; 2-Average or Mediocre; 3-Good; 4-Very good; or 5-Excellent.

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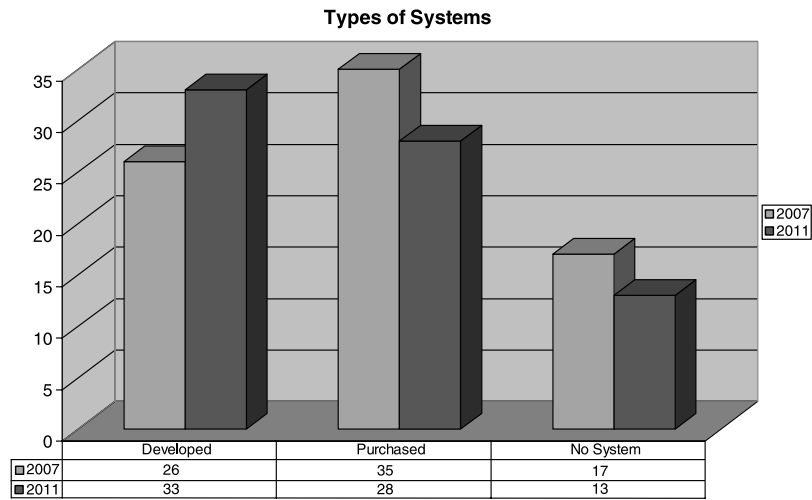
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TABLE 1. Types of Systems Reported in 2007 and 2011



7. Describe the strengths of your software program:
8. Describe the weaknesses or limitations of the software:
9. Would you recommend the software to another medical examiner's office? Would recommend; Would not recommend; or Unsure
10. How many dollars has your office spent for the software?
 - a. Initial Purchase Cost: b. Ongoing fees:
11. Can you access the database from a computer that is on your desk or in the office in which you sit?
12. What digital images can you view using the database? Check all that apply: Scene; Autopsy, Microscopic; or Radiologic.
13. Your name or a code word you will remember:
14. May your responses be shared (excluding your name) with others in a summary report for NAME?
15. If you would like a copy of the overall results, when complete, enter your e-mail address:

The survey was open from August 20, 2011 through October 19, 2011.

RESULTS

There were a total of 85 responses to the survey. Four of the responses were not useable because either the responder was

retired and provided no information on the office or there were no data provided except for the name of the office. The remaining 81 responses represented 74 death investigation systems (there were multiple responders from 7 offices) from 31 states and 2 foreign countries. A total of 27 death investigation offices from 20 states responded to both the 2007 NAME survey and the 2011 survey.

Types of Case Management Systems

The 3 responses to this question were as follows: the office developed its own system (33 offices or 44.6% of responses), the office purchased a system from a vendor (28 offices or 38.3% of responses), or the office does not have a case management database system (13 offices or 17.8% of responses). These data and the corresponding 2007 data are presented in Table 1.

For the offices that developed their own software system, the software program that was used to create the system is presented in Table 2. Microsoft products (Access, Excel, Foxpro, and SQL Server [Microsoft, Redmond, Wash]) were most commonly used. Vendor-purchased database systems are shown in Table 3. The most commonly used vendor system is CME by VertiQ (Morgan Hills, Calif).

Of the 13 offices that reported that they do not have a case management system, 3 offices indicated that they use Microsoft

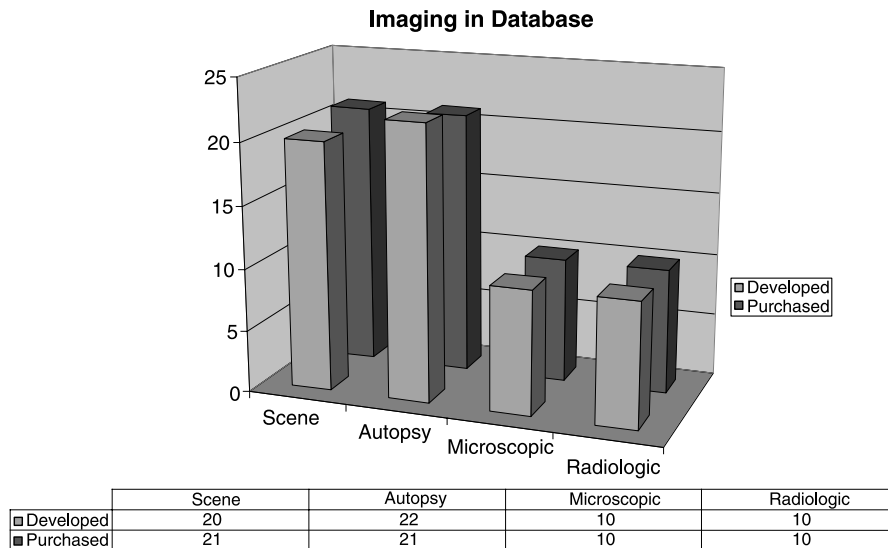
TABLE 2. Software Used to Develop In-House Forensic LIMS

| Program | No Offices |
|------------|------------|
| Access | 8 |
| Excel | 6 |
| SQL Server | 6 |
| .Net | 3 |
| Oracle | 3 |
| Filemaker | 2 |
| Coldfusion | 1 |
| Foxpro | 1 |
| Unknown | 3 |
| Total | 33 |

TABLE 3. Vendor Purchased Forensic LIMS Systems

| Vendor System | No Offices |
|---------------------|------------|
| CME/VertiQ | 12 |
| Justice Trax | 4 |
| Case Manager/Quincy | 3 |
| MDI Log | 3 |
| Coroner/ME | 2 |
| Lablynx | 1 |
| Themis/Veripac | 1 |
| Tiburon | 1 |
| VAST | 1 |
| Total | 28 |

TABLE 4. Imaging in Forensic LIMS



Excel, and 1 reported using Microsoft Access to keep track of case information.

Accessibility and Images

Of the 61 offices that reported either purchasing or developing their own system, 59 (97%) reported being able to access the database from a computer in their office or desk, and 2 (3%) stated that they did not have this access. This compares to a 90% accessibility reported in the 2007 survey.

The responses regarding images that can be viewed using the database are presented in Table 4. Similar percentages of the developed systems (27%) and purchased systems (25%) did not provide direct access to any images. Access to multiple types of images was common in both developed (21/33) and purchased (21/28) systems. The most common combination of image availability was scene and autopsy images without microscopic or

radiologic images (7 of developed systems and 8 of purchased systems) or all 4 image types (6 of developed systems and 7 of purchased systems).

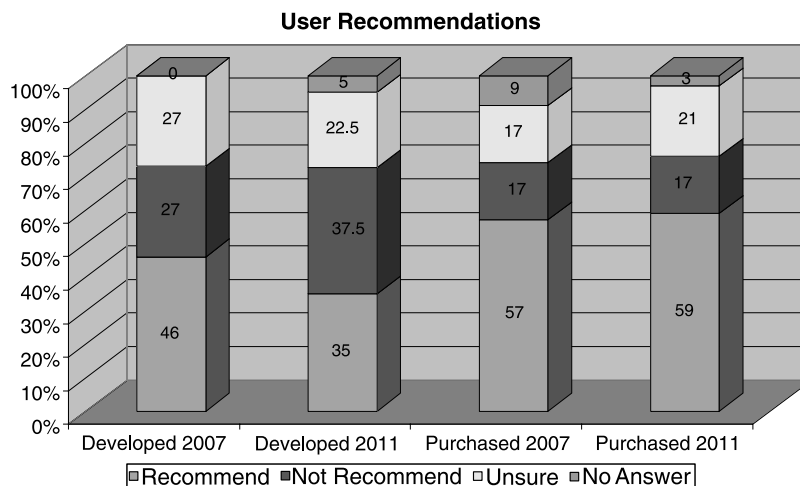
User Satisfaction and Recommendations

For the evaluation of the questions regarding user satisfaction and recommendations, all individual responses from offices with more than 1 responder were considered.

The average user satisfaction for the in-house developed database systems is 2.925 of 5, and the average user satisfaction with the purchased database systems is 3.071 of 5. Both types of systems were rated by users at all satisfaction levels from 0 (poor) to 5 (excellent).

For in-house developed systems, 14 (35%) of respondents would recommend the system, 15 (37.5%) would not recommend the system, 9 (22.5%) are unsure, and 2 (5%) did not answer.

TABLE 5. User Recommendations



For vendor-purchased database systems, 17 (59%) of respondents would recommend the system, 5 (17%) would not recommend the system, 6 (21%) are unsure, and 1 (3%) did not respond. A comparison of recommendations between the 2007 and 2011 surveys is provided in Table 5.

Strengths and Weaknesses

Users reported both the perceived strengths and weaknesses for the developed and purchased systems. Based on these individual responses, a list of desired attributes for a forensic LIMS was derived. The features include the following:

- The system is intuitive to use and has a good user interface.
- It operates with and not against the office's workflow processes.
- The ability to access all aspects of case from a single portal.
- Searches should be easily customizable and quick.
- There should be robust and customized report generation.
- A good balance between meaningful security and access for authorized users.
- Repetitive data should only need to be entered once and then populate other tables.
- The program should integrate with outside systems.
- The system should support the use of portable data entry devices.
- There should be body-, specimen-, and evidence-tracking capabilities (radio-frequency identification/barcode).
- The existence of good, reliable, and timely IT support.
- Upgrades need to include meaningful importing of old cases.
- The system should support a "paperless" office.

DISCUSSION

This survey evaluated the use of and satisfaction with LIMS in death investigation systems (medical examiners and coroners).

The practice of forensic pathology and its processes are well suited to LIMS technology. Death investigation offices collect data from numerous external sources, including a variety of health care records, law enforcement investigation reports, scene images, and outside laboratory results. Positive identification needs to be established and documented. The office needs to track the body, multiple specimens, and pieces of evidence from each case, and these items need to follow a secure chain-of-custody mechanism for legal purposes. Numerous images, reports, and forms are generated relating to a death investigation. The ability to communicate electronically with other agencies and laboratories (eg, transmitting cause of death statements to state electronic death registries) is important. Offices need to be able to track the status of uncompleted cases and monitor the efficiency of the office. Annual or other periodic reports need to be created. Ideally, surveillance of the data for emerging or developing trends should be conducted. A forensic LIMS can provide all these features and maintain needed security and promote efficiency throughout the office.

Although the percentage of offices without a computerized data management system decreased from 22% to 18% in the 4 1/2 years between the 2 surveys, there are still an unacceptably high percentage of death investigation offices without a LIMS. Given the importance and value of the health data generated by a death investigation office and the increased efficiencies that an electronic database can provide, more offices should convert from paper to electronic records. There are examples of low-cost and open-source software version of LIMS that could be used in offices with limited budgets.^{21–23}

It is interesting to note that the percentage of offices with software systems developed in-house increased from 33% to

45%, whereas the percentage of purchased systems decreased from 46% to 38% between 2007 and 2011. At the same time, users are less likely to recommend their home-grown systems in 2011 than they were in 2007, with the "recommended" percentage decreasing from 46% to 35% and the "not recommended" percentage increasing from 27% to 37.5%. At the same time, the percentages for the purchased systems recommend status remain basically unchanged. This may be a reflection of the nature of the platforms for the home-developed systems, many of which are based on simple spreadsheets or rudimentary database programs. For example, most of the developed systems without any images are Access or Excel based.

Very few responses included information regarding costs for the various systems. Systems developed in-house or by the government IT department using relatively simple platforms would cost a small fraction of the cost of a full-featured system, whether purchased or created by the individual office. Given the change in the economic situation for governments between the 2 surveys, this might explain these results. However, a poorly designed and supported LIMS does not well support the functions of the office and will not provide the efficiencies and improved quality of service that are realized with superior systems. In fact, these "inexpensive" systems might actually increase inefficiency and personnel costs within the office and promote the concept that LIMS are not useful for forensic work.

Encouragingly, it appears that most of the respondents have a clear impression of the potential capabilities of a forensic LIMS and can critically evaluate their system for its strengths and weaknesses. This suggests that given an improvement in the economic climate or the wider availability of low-cost or open source LIMS software, more offices will either adopt LIMS technology or improve their existing technology.

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