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## Survey of electronic veterinary medical record adoption and use by independent small animal veterinary medical practices in Massachusetts

Lauren M. Krone, DVM, MPH, Catherine M. Brown, DVM, MS, MPH, and Joann M. Lindenmayer, DVM, MPH

Department of Environmental and Population Health, Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA 01536 (Krone, Lindenmayer); and the Division of Epidemiology and Immunization, State Laboratory Institute, Massachusetts Department of Public Health, 305 South St, Jamaica Plain, MA 02130 (Brown)

### Abstract

**Objective**—To estimate the proportion of independent small animal veterinary medical practices in Massachusetts that use electronic veterinary medical records (EVMRs), determine the purposes for which EVMRs are used, and identify perceived barriers to their use.

**Design**—Survey.

**Sample**—100 veterinarians.

**Procedures**—213 of 517 independent small animal veterinary practices operating in Massachusetts were randomly chosen for study recruitment. One veterinarian at each practice was invited by telephone to answer a hardcopy survey regarding practice demographics, medical records type (electronic, paper, or both), purposes of EVMR use, and perceived barriers to adoption. Surveys were mailed to the first 100 veterinarians who agreed to participate. Practices were categorized by record type and size (large [ 5 veterinarians], medium [3 to 4 veterinarians], or small [1 to 2 veterinarians]).

**Results**—84 surveys were returned; overall response was 84 of 213 (39.4%). The EVMRs were used alone or together with paper records in 66 of 82 (80.5%) practices. Large and medium-sized practices were significantly more likely to use EVMRs combined with paper records than were small practices. The EVMRs were most commonly used for ensuring billing, automating reminders, providing cost estimates, scheduling, recording medical and surgical information, and tracking patient health. Least common uses were identifying emerging infectious diseases, research, and insurance. Eleven veterinarians in paper record-only practices indicated reluctance

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Address correspondence to Dr. Lindenmayer, Joann.Lindenmayer@tufts.edu.

Dr. Krone's present address is Department of Clinical Sciences, Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA 01536.

Dr. Lindenmayer's present address is Humane Society International, 2100 L St, NW, Washington, DC 20037.

Dr. Krone was a fourth-year veterinary medical student at the time of the study.

<sup>c</sup>AVIMark, Piedmont, Mo.

<sup>d</sup>ImproMed Infinity, Oshkosh, Wis.

to change, anticipated technological problems, time constraints, and cost were barriers to EVMR use.

**Conclusions and Clinical Relevance**—Results indicated EVMRs were underutilized as a tool for tracking and improving population health and identifying emerging infectious diseases. Efforts to facilitate adoption of EVMRs for these purposes should be strengthened by the veterinary medical, human health, and public health professions.

Electronic veterinary medical records are tools designed and used for health documentation and business functionalities, similar to the purposes for which EMRs are used in human medicine. Use of EVMRs is intended to maximize the ability of veterinary medical practitioners to capture patient medical information and owner contact and billing information. In human medicine, an ideal EMR system has efficient search and retrieval capabilities, uses standardized diagnostic coding, and protects patient and client confidentiality while maximizing patient health, quality of care, practice efficiency, and profit.<sup>1-4</sup> However, few EVMR models with these capabilities exist in the veterinary medical profession; these include proprietary systems in use by large networks of hospitals,<sup>a</sup> systems used by veterinary medical teaching hospitals,<sup>1</sup> and commercial programs employed by independent clinics and hospitals.<sup>b-e</sup>

It has been suggested that limited market availability of quality, user-friendly EMR and EVMR systems contributes to the finding that, despite well-documented evidence of the benefits that accrue to their use, until 2010, fewer than 50% of physicians used any EMR system,<sup>4-7</sup> although the percentage who did increased by 21% between 2012 and 2013, presumably in response to the Health Information Technology for Economic and Clinical Health Act of 2009.<sup>8</sup> By contrast, most veterinarians do not use electronic records.<sup>4,9-10</sup> Researchers have found a significant relationship between perceived benefits and barriers to EMR adoption and hospital size.<sup>5,11</sup> The result in the human medical profession is an increasing digital divide between hospitals and physician offices that have adopted EMR systems and those that have not.<sup>12</sup> The American Hospital Association researchers identified cost as a major barrier to EMR adoption by smaller hospitals, with larger hospitals making use of more health information technology than smaller ones.<sup>4,11</sup>

Survey data and qualitative research about the benefits of and barriers to adopting EVMR systems have been limited. A review of the literature and anecdotal reports suggests that veterinary medical professionals may face the same barriers as their human medical counterparts in this regard.<sup>13</sup> In addition to financial barriers (including inadequate capital),<sup>4,5,11</sup> other barriers to adoption highlighted by human medical informatics research include inadequate technical capabilities, lack of health information data standards, gaps in system interoperability, clinician reluctance to change, perceived loss of productivity, interruptions in access to the Internet, and lack of interest in existing products.<sup>4,14,15</sup> Nevertheless, results of a 1997 telephone survey of animal hospitals demonstrated an interest among veterinary professionals in adoption and use of medical records database

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<sup>a</sup>Banfield Pet Hospital, Portland, Me.

<sup>b</sup>IDEXX Cornerstone, IDEXX Laboratories Inc, Westbrook, Me.

<sup>c</sup>IntraVet Patterson Technology Center, Effingham, Ill.

software to improve patient care.<sup>9</sup> The desire for a simple, complete EVMR was highlighted in a commentary that lauded electronic systems for their potential to improve quality of patient care and reduce medical errors.<sup>16</sup>

In the United States, it has been estimated that 44,000 human deaths/y result from clinical errors in the medical profession, imposing a \$17 billion burden on the healthcare system and society.<sup>2</sup> Electronic medical records improve communication among members of medical teams, which facilitates the implementation of care guidelines and decision-support tools to improve patient safety and reduce medical errors through 8 core functionalities defined by the Institute of Medicine. These functionalities are health information and data, results management, order management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting and population health.<sup>17</sup> Electronic veterinary medical record systems available to the veterinary medical profession are believed to include some of these capabilities, although they have not been described as specifically having or lacking these functions.<sup>1,10,13,14</sup> Receiving greater attention recently, however, is the potential of EVMRs to contribute to understanding the epidemiology of animal diseases, including those that have zoonotic potential.<sup>18</sup> A comprehensive literature review in 2001 found that 868 of 1,415 (61%) infectious human pathogens were zoonotic and 132 of 175 (75%) pathogenic species associated with EIDs were zoonotic.<sup>19</sup> An updated literature review and a review of EID events between 1940 and 2004 reached similar conclusions.<sup>20,21</sup> Data such as these create additional incentive to establish and use EVMRs, and interest in an animal health database for animal disease surveillance and public health is increasing.<sup>18</sup>

A 2006 report<sup>22</sup> described the use of electronic health records maintained by a large network of primary care veterinary hospitals for surveillance of clinical syndrome and disease patterns as well as emerging and zoonotic diseases among companion animals in the United States. The EVMR system used in that study<sup>22</sup> remains proprietary, however, and the extent to which patient health records from independent small animal veterinary medical clinics are being used for similar purposes is unknown. To our knowledge, no recent study has addressed the factors that influence EVMR adoption by veterinarians, compared veterinary medical record systems with those used in human medical practices or facilities, or provided empirical data on EVMR functionality, usability, or costs and benefits.<sup>13</sup> The purpose of the study reported here was to estimate the proportion of independent small animal veterinary medical practices in Massachusetts that use EVMRs, determine the purposes for which these EVMR systems are used, and identify barriers to EVMR adoption. We also sought to identify practitioners' degree of satisfaction and reasons for dissatisfaction with EVMR systems where these were in use. Our hypotheses were that size of veterinary medical practice was not related to use of an EVMR and that there was no difference in EVMR functions used in practices that had EVMRs only, compared with those that used EVMRs in combination with paper records.

## Materials and Methods

The study design was submitted for review to the Institutional Review Board at Tufts Medical Center and Tufts University and was classified as exempt from review.

## Sampling frame

All independent small animal veterinary medical practices operating in Massachusetts during June and July 2010 were identified by use of the Massachusetts Veterinary Medical Association database and Massachusetts telephone listings for all cities and towns. Forty-two practices that were owned by (or franchises of) large organizations known to maintain and use common EVMR systems were excluded from the sampling frame. We also excluded relief veterinarians from the sampling frame because they might work in > 1 practice and be less familiar with medical record systems than would staff veterinarians. The final sampling frame comprised 517 independently operated small animal veterinary medical practices, including 2 mobile veterinary medical practices.

## Sampling methodology

Anticipating that approximately 23% of practices would use EVMRs for any purpose (similar to estimates reported for human medical practices in Massachusetts in 2005<sup>11</sup>) and in order to detect a difference of 10% with 95% confidence, we determined that a minimum of 60 veterinary medical practices would be required for our target sample. The final target population was 100 independent clinics, which allowed us to adjust for anticipated nonresponse.

Veterinarians were recruited for study participation by telephone call following a standardized telephone script. The 517 practices in the final database were numbered sequentially, and a random sample of 100 practices was identified through use of standard data management software.<sup>f</sup> The caller specifically asked to speak to the veterinarian owner or an associate veterinarian; the practitioner who was most readily available at the time of the telephone call was asked to complete a hardcopy survey on behalf of the practice in which they were employed. If several practices were owned by the same practitioner and operated in the same manner, only one of these hospitals was included in the study. If a veterinary medical professional declined to participate, the next practice in the randomly generated sample was contacted. Only 1 representative from each veterinary medical hospital or practice was asked to complete the survey to ensure that each hospital included in the study was represented only once.

## Survey design

A 3-page survey<sup>g</sup> that included multiple choice and open-ended questions was developed to identify practice size (determined according to the number of full and part-time veterinarians employed), types and uses of medical record systems, and perceptions regarding EVMRs. A small practice was defined as one that operated with 2 veterinarians, a medium-sized practice as one with 3 or 4 veterinarians, and a large practice as one with 5 veterinarians on staff. Practices were categorized on the basis of the types of medical records that were used (EVMR only, paper only, or EVMR and paper). Surveys did not ask for respondents' identifying information.

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<sup>f</sup>Excel, Microsoft Corp, Redmond, Wash.

<sup>g</sup>A copy of the survey instrument is available upon request from the corresponding author.

Respondents in practices that used EVMRs were asked about the purposes for which the systems were used. On the basis of discussions with veterinary medical professional colleagues and a lack of established functionalities for veterinary medical practice health records similar to those established by the Institute of Medicine for human medical records, we developed a list of 16 potential uses for veterinary medical record systems.<sup>7,8,17</sup> These uses were based on 4 general functions: scheduling, medical recordkeeping (patient health), public or population health, and business. Respondents in practices that used EVMRs only or both EVMRs and paper records were asked to select the functionalities used in their practices and to indicate any additional functionalities that their systems had which had not been included in the list. These individuals were also asked to estimate the duration that their present EVMR has been in use, their degree of satisfaction (on a scale of 1 to 4, where 1 = dissatisfied, 2 = somewhat dissatisfied, 3 = somewhat satisfied, and 4 = satisfied) with the existing software system, and whether the practice recordkeeping system was intended to change in the future.

Respondents working in paper record-only practices were asked to select functionalities (from the list developed by the investigators) for which EVMRs might be viewed as beneficial. They were also asked to indicate their degree of satisfaction with the existing paper record system (on the same rating scale used for EVMRs), whether the practice recordkeeping system was intended to change in the future, and, if it was not, to list reasons why no change was planned.

### Survey administration

Veterinarians who agreed to participate in the study were mailed hardcopy surveys between June 1 and June 11, 2010. The survey was accompanied by a self-addressed stamped envelope for return to investigators. Participants were asked to complete the survey on their own (without input from veterinarian colleagues) within 1 month. Responses were accepted up until 3 months after the date of the last mailing.

### Statistical analysis

A standard statistical software package<sup>h</sup> was used for analyses. Descriptive statistics were used to determine proportions of practices categorized as small, medium-sized, and large. To assess whether practice size was a determinant for the type of record system used, we performed  $\chi^2$  analyses or Fisher exact tests (where expected cell sizes were  $< 5$ ) to determine whether associations were likely to have occurred by chance alone. When the probability of associations occurring by chance alone was calculated to be  $< 5\%$ , we calculated the strength of the associations with ORs and 95% CIs. For all comparisons on the basis of practice size, small practices were used as the reference group.

Visual inspection of the distributions of years that present EVMR systems had been in use in EVMR-only and EVMR and paper-record practices indicated the data were not normally distributed. For this reason, a Kruskal-Wallis test was used to determine whether these data were significantly different.

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<sup>h</sup>Stata/IC, version 11.2, StataCorp LP, College Station, Tex.

We also calculated point estimates and 95% CIs for proportions of EVMR-only and EVMR and paper-record practices reported to use the described EVMR functionalities, the differences in these proportions, and proportions of respondents in paper record-only practices indicating that these functionalities were potentially beneficial to the practice. Point estimates for the differences were calculated by subtracting the point estimates for EVMR and paper-record practices from those for EVMR-only practices. The cutoff for significance for each test was initially set at  $P < 0.05$ . However, because multiple comparisons were made, a Bonferroni adjustment for the specific number of tests was used to determine overall significance. With no correction for multiple comparisons, the chance of finding 1 significant difference among 16 tests with no correlation and an  $\alpha$  of 0.05 was 0.5599. The  $P$  value to reject the null hypothesis was adjusted to account for multiple comparisons, and values of  $P < 0.0031$  ( $0.05/16$ ) were considered significant.

## Results

### Responses

To achieve the goal of 100 veterinarians who agreed to complete the survey, 213 of 517 eligible practices identified were contacted by telephone with an invitation to participate in the study. Although the initial sampling frame had included mobile practices, none were randomly selected to receive a survey invitation. Veterinarians who declined to participate at this stage were unanimous that their reasons for not participating were related to lack of time. Of the 100 surveys mailed, 84 (84.0%) were returned; the overall response (on the basis of the number of practices contacted by telephone) was 84 of 213 (39.4%). Not all respondents answered every question.

### Practice characteristics

The 84 respondents represented 84 of 517 (16.2%) independent small animal veterinary medical practices in Massachusetts during June and July 2010. Of the 83 practices for which size information was provided, 21 (25.3%) were small ( $\leq 2$  veterinarians), 41 (49.4%) were medium sized (3 or 4 veterinarians), and 21 (25.3%) were large ( $\geq 5$  veterinarians). The median number of veterinarians in a practice was 2 (range, 1 to 40). Eighty-one of 83 (97.6%) practices employed between 1 and 7 veterinarians.

### EVMR use

Of 82 practices for which medical record type was reported, 14 (17.1%) used EVMRs only and 16 (19.5%) used paper records only. The remaining 52 (63.4%) used both types of record systems. Of 81 practices with both size and medical record type reported, nearly half (47.6%) of small practices used paper records only, compared with 10.3% of medium-sized and 9.5% of large practices (Table 1). Most medium-sized (69.2%) and large (81.0%) practices used both EVMR and paper record systems. However, the odds for use of EVMRs alone were not significantly different for large practices (OR, 2.50; 95% CI, 0.13 to 44.12;  $P = 0.568$ ) or medium-sized practices (OR, 5.00; 95% CI, 0.73 to 39.29;  $P = 0.122$ ), compared with those for small practices. The odds for use of both EVMRs and paper records were significantly greater for large practices (OR, 12.14; 95% CI, 1.76 to 130.97;  $P = 0.007$ ) and



medium-sized practices (OR, 9.64; 95% CI, 1.93 to 52.85;  $P = 0.002$ ) than for small practices.

### Duration of EVMR use

The mean duration of use for the present EVMR system at the time of the survey was 8.5 years (median, 7.0 years; range, 1 to 29 years) in EVMR-only practices ( $n = 13$ ), and that in EVMR and paper record practices was 9.4 years (median, 10.0 years; range, 0 to 23 years; 38). Among 51 respondents who answered the question, 16 (31.4%), 20 (39.2%), and 15 (29.4%) indicated their practices had implemented EVMRs < 5 years, 5 to 10 years, and > 10 years prior to the survey, respectively. Eight practices had used EVMRs alone or in combination with paper records for  $\geq 20$  years. The 13 practices that used EVMRs only appeared to have adopted their electronic record systems more recently than did the 38 practices with both types of records, but this difference was not significant.

### EVMR functionalities

Use of EVMR functionalities described in the survey was summarized for EVMR-only and EVMR and paper-record practices (Table 2). Percentages of each practice type that used a given functionality were compared. After Bonferroni correction, significantly ( $P < 0.0031$ ) greater proportions of EVMR-only practices used their systems for tracking patient health, compared with practices that used both types of records, and no other significant differences in use were detected. More than half of the respondents from both practice types indicated EVMRs were used for scheduling, automating client reminders, recording medical and surgical information, ensuring billing, automatic billing, providing cost estimates, reviewing veterinarian performance, and marketing. Less than half of the respondents in both groups reported EVMR use for care credit (a credit card that is purchased and used for health costs and is interest-free for a specified period of time), identifying EIDs, insurance (ie, providing the record of a paid medical bill to the client to submit to an insurance company for reimbursement), and research purposes. Additional EVMR functionalities reported by respondents in EVMR-only and EVMR and paper-record practices included interfacing with laboratory test results and email systems, tracking clinic inventory, storing diagnostic (radiographic, ultrasonographic, and endoscopic) images and videos, accommodating patient discharge comments and client instructions, and communicating with referring veterinarians.

More than three-quarters of respondents in paper record-only practices identified recording medical and surgical information (10/13), tracking patient health (10/12), ensuring billing (10/13), automatic billing (10/13), tracking population health (10/13), identifying EIDs (9/11), and research (7/9) as functions for which EVMRs might be beneficial (Table 3). Other uses identified by more than half of these respondents included scheduling (6/11), automating client reminders (9/12), improving population health (5/9), and marketing (6/10). For most functionalities (scheduling, automating client reminders, recording medical and surgical information, tracking patient health, improving patient health, ensuring billing, automatic billing, providing cost estimates, extending care credit, improving population health, reviewing veterinarian performance, and marketing), the proportions of respondents in paper record-only practices who indicated that EVMRs could be of benefit were smaller than the proportion indicating use of these functionalities in EVMR-only practices. The

proportions of respondents in paper record–only practices who indicated EVMRs were potentially beneficial for insurance purposes, tracking population health, identifying EIDs, and research were larger than the proportion in EVMR-only practices who reported these uses. However, these values were not compared statistically.

### **EVMR satisfaction**

Ten of 14 respondents in EVMR-only practices indicated that they were satisfied (score, 4/4) with the EVMR in use at the time of the survey, and the remaining 4 indicated that they were somewhat satisfied (score, 3/4). In contrast, 16 of 46 (34.8%) respondents in EVMR and paper–record practices reported being satisfied with their EVMR, 28 (60.9%) indicated they were somewhat satisfied, and 2 (4.3%) reported some degree of dissatisfaction (scores 2/4) with their EVMRs. Of the 34 respondents who reported being less than satisfied with their EVMR, 28 provided 1 reason. Specific explanations were categorized as general concerns, problems with appearance, completeness of record, cost, data entry, flexibility, software problems, information retrieval, ability to interface with other programs, speed, and time for learning and availability of training (Table 4).

### **Intention to change recordkeeping systems**

Respondents from 61 of 66 practices that used EVMRs alone or in combination with paper records provided responses regarding planned record-keeping system changes. Of these 61, 4 (6.6%) reported plans to expand use of the current EVMR system, 10 (16.4%) reported plans to adopt a new or additional EVMR system, 41 (67.2%) reported no plans to change the present system, and 6 (9.8%) did not know of plans to make changes to current record systems.

Respondents from 15 of 16 paper record–only practices answered the question concerning planned system changes. Five reported intentions to adopt use of EVMRs, 6 reported no plans to use EVMRs, and 4 did not know of any such plans. Concerns cited by 9 of the 15 respondents regarding adoption of an EVMR system were grouped into categories that included no desire for change (6 responses), anticipated technical problems (6 responses), time constraints (1 response), and cost (1 response; Table 5).

## **Discussion**

In the present study, a large proportion of randomly selected independent small animal veterinary medical practices in Massachusetts (66/82 [80.5%]) was found to use EVMRs alone or in combination with paper records, whereas 16 (19.5%) practices operated with paper records only. Investigators who conducted a similar survey among human medical practices in Massachusetts in 2005 estimated that only 23% of such practices used EMRs for any purpose,<sup>11</sup> a much smaller proportion than our estimate for small animal veterinary practices in the same state in 2010. Given that many veterinary medical practices in our study reported adopting EVMRs after 2005, we consider it likely that the same trend has occurred in human medical practices and the proportions of both types of practices that use electronic recordkeeping systems may be similar today. Although the earliest use of EVMRs for any purpose at practices in our study occurred almost 3 decades ago, approximately one-



third of all practices were reported to have transitioned to partially or completely electronic recordkeeping systems within the 5 years before the survey. At the time of the study, 8 practices had used EVMRs for > 20 years; 1 respondent reported developing a type of EVMR nearly 30 years prior to the study, before anything of its kind was available for purchase, and that the record system was still in use.

Our results indicated that practice size was, to some extent, associated with EVMR use. Large and medium-sized practices were significantly more likely to use EVMRs in combination with paper records than were small practices; however, use of EVMRs alone did not differ for large or medium-sized practices, compared with small practices. It may be that practice size influenced the decision to adopt an EVMR system, whether in part or in full, separate from a decision to eliminate the use of paper records entirely. It is also possible that, when stratifying practices by size, the number of large practices (which were fewer than medium-sized practices) was too small to permit meaningful analysis of the relationship between practice size and use of EVMRs. Constraints to small practices adopting use of EVMRs may be proportionately greater in terms of cost, time required to learn the software, or other factors than they are for medium-sized or large practices. Recent veterinary medical graduates, who may be accustomed to use of EVMRs during their education and training, may be more likely to join large or medium-sized practices than to join small practices or to establish 1-veterinarian practices, thereby influencing EVMR adoption and use in larger practices. A similar relationship between practice size and EMR adoption has been demonstrated among human medical practices in Massachusetts,<sup>11</sup> although this information must be interpreted carefully because of slight differences in practice size categories between the 2 studies.

Our use of practice size as a proxy for the number of active patient records has precedence. A previous study<sup>23</sup> indicated that even a large, tertiary care Massachusetts veterinary medical hospital operating with an electronic records database that incorporated records for patients seen between 1999 and 2010 could only provide general estimates of numbers of active patient records. Additionally, the Massachusetts statewide survey of physician practices with which we planned to compare our results stratified the study sample by the number of physicians rather than the number of active patient records.<sup>11</sup> We made an assumption that there would be a positive relationship between the number of patients seen and the number of veterinarians employed at any practice.

The EVMR systems used at practices in our study appeared to provide the same general functionalities as do EMRs, including those identified by the Institute of Medicine (health information and data, results management, order management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting and population health)<sup>17</sup> and the National Center for Health Statistics.<sup>7,8</sup> Respondents were not asked about EVMR functionalities of storing and sharing digital images, videos and laboratory tests, and tracking clinic inventory; however, some respondents specifically listed these as additional functionalities and others may have subsumed these functionalities under recording medical or surgical information about patients.

Differences in the relative emphasis of electronic record functionalities between veterinary and human medicine may exist; EVMRs appeared to be used more frequently for practice management and economic purposes (scheduling, billing, automating reminders, and providing cost estimates for clients, reviewing veterinarian performance, and marketing) at practices in the present study than they were used to track and improve patient and population health. This concerns us for several reasons. As has been reported in human medicine, EMRs improve medical care and patient safety beyond the capacity of paper medical records to do so by reducing the number of medical errors associated with illegible handwriting, incorrect prescribing practices, and inappropriate use of tests and procedures. They can also be used to contribute to the early identification of emerging health problems and adverse health events.<sup>9,13,16,24,25</sup> These capabilities allow practitioners to tailor medical practice to the unique individuals or populations they serve by applying appropriate preventative medicine treatments and practices, identifying protocols effective for the reduction of adverse events and frequency and severity of disease, and practicing evidence-based medicine for the treatment of common diseases and conditions.

If veterinary medical practices use EVMRs primarily for business rather than health reasons, veterinarians are likely missing opportunities to apply best practices to their patient populations for reasons unrelated to client willingness to pay for services. To our knowledge, studies of the functions used in our report have not yet been conducted in human medicine, but several studies have looked at performance of the 8 general functions developed by the Institute of Medicine,<sup>7,8</sup> which can be used to group the functionalities used in this report.<sup>16</sup> However, comparisons with use in human medicine should be tempered by the understanding of 2 factors. First, publication bias in the human medical literature could possibly explain why reports of EMR use appear to focus more on patient and population health care and improvement than they do on economic or cost-related features. Second, substantial differences exist in the degree to which veterinary and human medicine are regulated, insurance plans cover the costs of health care, and decision-making and information technology support are available from regulators, the insurance industry, or professional organizations. These resources are not as widely available in veterinary as in human medicine and may help to account for the apparent differences observed between EVMR use for health and business reasons.

Members of both the human and veterinary medical professions have acknowledged that medical records have the potential to be considerably more useful than the limited ways in which they are currently applied.<sup>9,11</sup> With regard to the present study and reports published by investigators from the field of human medical informatics,<sup>7,8</sup> data suggest that with increasing adoption of EMR and EVMR systems, improved software system availability, and ease of use, it will be possible to exploit medical records more effectively to improve patient safety and health outcomes.

Beyond the use of EVMRs to track and improve the health of individual clinic patients or populations, it should be possible one day to link independent, stand-alone veterinary medical practices that use different EVMR software. This would allow the veterinary medical profession to monitor and track patient health over wider geographic areas than the catchment areas of their individual practices. Achieving this would require development,

widespread adoption, and use of interoperability standards among practices that use different EVMR systems as well as agreement on standard terms for diagnoses, tests, treatments, and procedures. In veterinary medicine, the capacity for information on diseases under surveillance to be extracted and analyzed is limited but growing.<sup>18</sup> Surveillance systems for reportable veterinary diseases are generally less formalized, owing to the lack of widespread use of standardized medical terms for diagnoses, treatments, and procedures in veterinary medicine. With few external incentives to adopt and use EVMRs to their full potential, individual practices that use paper records or a variety of electronic record software packages will continue to limit state, regional, or national surveillance for diseases of veterinary and public health importance. Additionally, the finding that 10 of 14 veterinarians in EVMR-only practices reported being satisfied with their recordkeeping systems, compared with only 16 of 46 (34.8%) in practices that used EVMRs in combination with paper records, may have indicated that EVMRs in the latter situation were not meeting expectations and veterinarians kept paper record systems to fill gaps left by EVMRs.

We found it interesting that the proportions of respondents in paper record–only practices who indicated EVMRs might be of benefit for tracking population health, identifying EIDs, insurance, and research appeared greater than those in EVMR-only practices who indicated their systems were used for these purposes. Future research should investigate whether veterinarians in practices that use EVMRs exclusively elect not to use some functionalities of the systems or whether EVMR software limitations prevent some uses.

Our results are consistent with findings in human medical informatics research with respect to perceived barriers to electronic records adoption and use. Both human and veterinary medical professionals in Massachusetts cited lack of infrastructure, reluctance to change, technical factors, and financial constraints among the most common barriers to electronic records adoption by practices that use paper records exclusively.<sup>11</sup> Furthermore, recent commentaries have suggested that the US electrical grid is becoming less reliable,<sup>26,27</sup> which, if true, could adversely affect the electronic transmission of data of any kind in this country.

Peer pressure and mentoring, widespread adoption and use of data collection and management standards by the profession, inherent interest of clinicians in documenting treatment outcomes and marketing services to clients, more widespread use of pet health insurance by clients, and consolidation of veterinary medical practices may provide incentives and cost savings to help support adoption and full use of EVMRs in veterinary medicine, as they have in human medicine.<sup>24</sup> Some have argued for better companion animal surveillance systems for public health purposes,<sup>18</sup> a goal that is likely to be achievable only through greater use of EVMRs.

Strategies to enhance adoption and use of EMVRs must involve multiple levels of the veterinary medical profession, from individual veterinarians to national organizations as well as the human medicine and public health sectors, and those strategies must be mutually complementary and supportive. Schools of veterinary medicine could seek out applicants who have electronic data management and analysis skills, and for matriculated students who do not, courses in epidemiology, public health, biostatistics, or elective programs could be

modified to include sessions on the importance, structure, utility, and operation of electronic records systems. Entities such as schools of veterinary medicine and state, regional, and national veterinary medical professional organizations should broaden their educational offerings to include more sessions relevant to electronic health records. Veterinarians who use EVMRs for patient and clinic population health could, with sufficient incentive, serve as mentors for other veterinarians who wish to do the same. Veterinarians are the primary consumers of commercial EVMR systems, and in that capacity, they may have the ability to influence EVMR system providers to modify and improve software so that health information on individual patients and clinic populations is more easily accessible and tailored to the needs of individual practices. State boards that license veterinarians should consider whether they will, at some time in the future, require veterinarians to demonstrate proficiency in EVMR use; if sufficient continuing education credits are available to veterinarians, licensing boards could also consider requiring a specific number of credit hours be devoted to topics related to EVMRs. National veterinary professional organizations such as the AVMA and the American Animal Hospital Association may wish to consider adopting policies that recommend the use of EVMRs. Finally, in an era when the concept of one health has advanced beyond just theory, institutions with inherent interests in public health such as the CDC or private philanthropic foundations that fund public health and health services initiatives might be convinced to lend their support to efforts that would tap the data resources of independent veterinary medical clinics and hospitals.

Our study sample may not have been representative of all independent small animal veterinary medical clinics in Massachusetts; we had no comparable information for veterinary medical practices where our telephone invitation to participate in the study was declined or the survey a practitioner had agreed to complete was not returned. If our results are representative of small animal practices in Massachusetts, they may not be generalizable to other states because of differences in practice, client, or small animal patient populations. Also, the field of health informatics is dynamic, and our study results may only provide a snapshot of veterinary health records in Massachusetts at the time the study was conducted. Given the speed with which changes are taking place in the field of medical informatics, it is likely that EVMR adoption and extent of use are more widespread at the time of this report than they were at the time the study was conducted. Finally, use of the term EVMR is a potential limitation because the definition is controversial and dynamic.

The use of EMRs holds great promise for monitoring and improving the health of individual human and animal patients as well as human and animal populations. Independent veterinary medical practices have the potential to contribute to the veterinary medical profession's understanding of the natural history of and risk factors for diseases in animals, the effectiveness of treatments and procedures, and the prevention of modifiable diseases among animals and humans. A great deal of effort is being directed toward development and use of industry-wide standards for veterinary medical terminology, data field definitions, and interoperability standards,<sup>28-30</sup> and these efforts deserve close attention and investment from key stakeholders, including public health and human medical organizations in addition to veterinary medical professionals. Promotion of all these undertakings will undoubtedly improve the extent to which EVMR software is adopted and used by veterinarians to contribute to the improvement of animal and human health.

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## Abbreviations

<b>CI</b>	Confidence interval
<b>EID</b>	Emerging infectious disease
<b>EMR</b>	Electronic medical record
<b>EVMR</b>	Electronic veterinary medical record

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**Table 1**

Number (percentage) of independent small animal veterinary medical practices in Massachusetts reported to use various types of medical records in a survey of 84 veterinarians between June and July, 2010.

Record type	Small	Medium	Large	All
EVMRs only	4 (19.1)	8 (20.5)	2 (9.5)	14 (17.3)
Paper only	10 (47.6)	4 (10.3)	2 (9.5)	16 (19.8)
EVMRs and paper	7 (33.3)	27 (69.2)	17 (81.0)	51 (63.0)
<b>Total</b>	<b>21 (25.9)</b>	<b>39 (48.1)</b>	<b>21 (25.9)</b>	<b>81 (100.0)</b>

Practice size was determined by the number of veterinarians employed (small [ 2], medium [3–4], or large [ 5]). Not all respondents answered every question.

**Table 2**

Functionalities of EVMRs employed by 66 small animal veterinary medical practices in Massachusetts that used EVMRs only (n = 14) or EVMRs and paper records (52).

Functionality	EVMRs only			EVMRs and paper records			95% CI	Percentage difference	95% CI	P value
	No. of responses	No. (%) of practices	95% CI	No. of responses	No. (%) of practices	95% CI				
Scheduling	14	14 (100.0)	—	50	43 (86.0)	73.0 to 93.3	14.0	4.4 to 23.6	0.138	
Automating client reminders	14	13 (92.9)	60.2 to 99.1	51	48 (94.1)	82.8 to 98.2	-1.2	-16.2 to 13.7	0.862	
Recording medical and surgical information	14	14 (100.0)	—	48	29 (60.4)	45.7 to 74.5	39.6	25.7 to 53.4	0.005	
Tracking patient health	14	14 (100.0)	—	50	21 (42.0)	28.9 to 56.4	58.0	44.3 to 71.7	< 0.001*	
Improving patient health	10	9 (90.0)	49.0 to 98.8	38	17 (44.7)	29.4 to 61.2	45.3	20.9 to 69.7	0.011	
Ensuring billing	14	14 (100.0)	—	51	47 (92.2)	80.4 to 97.1	7.8	0.5 to 15.2	0.279	
Automatic billing	14	11 (78.6)	48.7 to 93.4	49	35 (71.4)	57.0 to 82.6	7.2	-17.8 to 32.1	0.595	
Providing cost estimates	14	14 (100.0)	—	51	46 (90.2)	78.1 to 96.0	9.8	1.6 to 18.0	0.223	
Insurance	14	1 (7.1)	0.1 to 39.7	42	7 (16.7)	7.9 to 31.7	-9.5	-27.1 to 8.1	0.378	
Care credit	14	5 (35.7)	34.7 to 63.4	47	23 (48.9)	-13.2 to 42.1	-13.2	-42.1 to 15.7	0.384	
Tracking population health	14	8 (57.1)	30.3 to 80.4	47	13 (27.7)	16.5 to 42.5	29.5	0.6 to 58.4	0.042	
Improving population health	12	8 (66.7)	35.6 to 87.8	40	9 (22.5)	11.9 to 38.5	44.2	14.5 to 73.8	0.004	
Identifying EIDs	14	4 (28.6)	10.5 to 57.8	45	6 (13.3)	6.0 to 27.2	15.2	-10.4 to 40.9	0.184	
Research	14	3 (21.4)	6.6 to 51.4	44	6 (13.6)	6.1 to 27.8	7.8	-16.0 to 31.6	0.483	
Reviewing veterinarian performance	14	11 (78.6)	48.7 to 93.4	49	32 (65.3)	50.7 to 77.5	13.3	-12.0 to 38.6	0.347	
Marketing	14	10 (71.4)	42.3 to 89.5	47	29 (61.7)	46.8 to 74.7	9.7	-17.7 to 37.2	0.506	

Point estimates for the differences were calculated by subtracting the point estimates for EVMR and paper-record practices from those for EVMR-only practices.

\* Percentage was significantly ( $P < 0.0031$ ) different between practice types.

— = Not applicable.

**Table 3**

Functionalities of EVMRs selected as potentially beneficial by respondents from 16 veterinary practices that used paper records only.

Functionality	No. of responses	No. (%) of respondents that selected feature	95% CI (%)
Scheduling	11	6 (54.5)	24.4–81.7
Automating client reminders	12	9 (75.0)	41.6–92.7
Recording medical and surgical information	13	10 (76.9)	44.9–93.2
Tracking patient health	12	10 (83.3)	48.6–96.4
Improving patient health	8	4 (50.0)	17.0–83.0
Ensuring billing	13	10 (76.9)	44.9–93.2
Automatic billing	13	10 (76.9)	44.8–93.2
Providing cost estimates	13	8 (61.5)	32.1–84.4
Insurance	11	3 (27.3)	7.9–62.0
Care credit	10	2 (20.0)	4.3–58.5
Tracking population health	13	10 (76.9)	45.0–93.1
Improving population health	9	5 (55.6)	22.2–84.5
Identifying EIDs	11	9 (81.8)	45.2–96.1
Research	9	7 (77.8)	37.4–95.4
Reviewing veterinarian performance	8	4 (50.0)	17.1–82.9
Marketing	10	6 (60.0)	26.8–86.0

**Table 4**

Summary of reasons provided by 28 of 34 survey respondents (working in practices that used EVMRs exclusively or in combination with paper records) for being less than satisfied with the EVMR system in use at their practice at the time of the survey.

Category	Explanation
General concerns	Has outgrown usefulness
	Not easy to implement
	Difficult to use
	Cumbersome
	Not up to desired standards
Appearance	Poor formatting and difficult to view
Completeness of record	Cannot include images
	Cannot get surgical monitoring input into record
Cost	Too expensive
Data entry	Inflexible
	Time-consuming
	Does not always save data and some data need to be reentered
Flexibility	Inflexible schedules
	No support for operating system
	Limited capacity for discounts
	Difficult to customize
	Too many steps for each procedure
	Not enough space to record all written information needed
Software problems	Lost history when system freezes
	Many software glitches
	Defects or flaws (bugs)
	Viruses
	Cannot correct small glitches
	Occasional glitches when program is updated
Information retrieval	Not searchable
	Cannot recall medical information other than vaccinations
	Some parts don't access all data desired
Ability to interface with other programs	Does not allow email and accounting and financial software interfaces
Speed	Slow and unreliable
	Retrieval of written (hardcopy) information is faster
	Has decreased the speed of processing
Time for learning and training availability	Users do not know every feature provided
	Not intuitive
	Not being used as effectively as could be
	System is not used to full potential or many features not being used
	Much of the data required to be input is not useful
	No formal training from software company

Category	Explanation
	Updates do not provide substantial improvement

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**Table 5**

Summary of concerns regarding adoption of an EVMR system listed by 9 of 15 respondents in veterinary practices that used only paper records.

Category	Explanation
No desire for change	Accustomed to handwritten records
	Do not want to commit to electronic records, computer
	Owner does not like change
	1-veterinarian practice
	Not interested; will retire in 8 to 10 years
	Only employee of practice
Anticipated technical problems	Lack of proper infrastructure
	Computer glitches
	Internet issues
	No software updates
	Worry about system failure (crashing)
	Worry about technical support
Time constraints	Not enough time to research new programs
Cost	Financial constraints will not allow it