Ambulatory veterinary practitioners have unique business considerations compared to many other segments of the veterinary medical industry. First, the veterinarian and medical supplies often travel to the animals on the farm rather than having clients bring the animal to the hospital. Second, the owner or financially responsible party is often unavailable at the appointment. Third, technical help is often less available, requiring the veterinarian to perform medication labeling, billing, and sometimes records at the appointment. All of these factors may contribute to a frequent delay in invoicing the veterinary work performed. It is possible that this delay in entering charges could result in missed charges or loss of revenue.

In human medicine, a number of studies have evaluated the benefits of “point-of-service” billing. Studies of human hospitals suggest that billing charges at the point of service could improve revenues by 6% to 11% or more.1–3 Other studies have evaluated the use of billing algorithms or other recommendations for charge capture.4–8 The equine veterinary industry needs an evaluation of some of these same factors, as the cost of delayed invoicing has never been quantified. If similar to human medicine, equine veterinarians may be missing significant charges that may represent as much as 10% to 15% of the veterinary work actually performed. The financial implications for the veterinarians and owners of the practice would be very significant.

The purpose of this study was to evaluate the revenue effects of a delay in the entry of the invoice for an equine veterinary visit. Our objectives were to evaluate the influence of time between the date of work and charge entry and other relevant factors such as type of

OBJECTIVE
To evaluate the relationship in equine practice between the time delay for charge entry (time between when work was performed and when the invoice charges were entered) and the total amount of the invoice.

SAMPLE
A total of 67,597 invoices from 3 hospitals were included for analysis.

METHODS
Analysis of 67,597 invoices from 49 doctors working out of 3 hospitals was performed. Variables collected included invoice total, date of work, date of invoice entry, month of work, invoice category (A = ambulatory daytime, E = after-hours, I = hospital), and veterinarian. Time delay to invoice entry was the difference between the day of work and the day of charge entry. A generalized additive model was used to describe the relationship between the time delay for invoice entry and the invoice type, month of work, and invoice category. The best model was selected using the Akaike information criterion.

RESULTS
In the selected model, total invoice amount was associated with time delay for charge entry and invoice category. Invoices entered on the same day of work were $299 ± $345, as compared to those entered the next day ($255 ± $271) and those entered > 1 day after the work was performed ($193 ± $196; P < .0001).

CLINICAL RELEVANCE
If the observed relationship between time delay (time between work performed and invoice entry) and total invoice amount is causal, equine practitioners may have significant opportunity to improve revenues by simply entering charges on the same day the work is performed.

Keywords: invoice, charge capture, point of care, charge delay, emergency

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service (ambulatory, after-hours, etc) and time of year on total invoice. The hypothesis was that software delay in charge entry would negatively influence the amount of the total invoice after controlling for other factors.

**Methods**

The study was performed at 3 practices: Loomis Basin Equine Medical Center, Amador Equine, and Sierra Equine, all located in northern California. The 3 practices are in the same medical group and therefore share the same pricing structure, software, and procedure codes. All invoices from the years 2021 and 2022 were included for analysis and included a total of 49 doctors. Each invoice contained charges for a unique patient on a unique visit. In other words, invoices could not contain multiple patients and the same invoice would not include charges from a visit that took place in the field and in the hospital, even if they were on the same day. The following exclusion criteria were applied: (1) invoices that did not have a specific doctor identified (the main reason for this lack of specified doctor would be a refill medication where the doctor had authorized a certain number of refills, but the invoice was entered by the front office staff), (2) invoices that contained multiple dates (primarily hospitalized patients), and (3) invoices that contained multiple doctors.

After applying the exclusion criteria, variables collected from each invoice included the total invoice amount, date the invoice was entered, date the veterinary work took place, invoice category (A = ambulatory regular hours, I = at the hospital regular hours, E = after-hours ambulatory or at the hospital), and veterinarian who performed the work. The time delay (TD) for entering the invoice was calculated as the difference between the day the invoice was entered and the day the work was performed. The TD data were also used to create a categorical variable of category 0 (charges entered same day), category 1 (charges entered next day), and category > 1 (charges entered > 1 day after work was performed). Data were entered and managed in a commercially available software package (Excel 2018; Microsoft Corp).

Variables are reported as mean ± SD. Invoice total was compared for the 3 subgroups of invoice category and all 3 subgroups of TD (categorical variable) using a 1-way ANOVA with Tukey test for multiple comparisons.

Scatterplots were created to evaluate the linearity of the relationship between the outcome variable (total invoice) and the predictor variables. Based on the non-linearity of the relationship between total invoice and TD and its dependence on invoice type, a generalized additive model was used.

For modeling purposes, the total invoice amount for a given TD (number of days past due), month of work, and invoice category was averaged. The number of observations for that specific combination (TD, date of work, invoice category) was used to form model weights. Using these averaged data, the final best model was selected using the Akaike information criterion (AIC) with a statistical software program (R Core Team (2023). _R: A Language and Environment for Statistical Computing_. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>).

**Results**

A total of 100,205 invoices were available for evaluation during the 2-year period included in the study (2021 to 2022). Of these 100,205 invoices, 2,567 invoices were eliminated because they contained items (charges) that spanned more than a single day of work. An additional 30,041 invoices were excluded because they contained multiple doctors or did not have a doctor identified. The remaining 67,597 invoices were used for analysis.

The descriptive statistics for selected variables collected are shown in **Table 1**. A total of 49 doctors

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of invoices (n)</th>
<th>Total invoice ($)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoice total</td>
<td>67,597</td>
<td>280 ± 324</td>
<td>N/A</td>
</tr>
<tr>
<td>Delay to invoice entry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 day (same day)</td>
<td>52,113</td>
<td>299 ± 345</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>1-day delay</td>
<td>6,211</td>
<td>255 ± 271</td>
<td></td>
</tr>
<tr>
<td>&gt; 1-day delay</td>
<td>9,273</td>
<td>193 ± 196</td>
<td></td>
</tr>
<tr>
<td>Invoice category</td>
<td></td>
<td></td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Ambulatory</td>
<td>51,007</td>
<td>251 ± 264</td>
<td></td>
</tr>
<tr>
<td>After-hours</td>
<td>1,274</td>
<td>769 ± 711</td>
<td></td>
</tr>
<tr>
<td>At the hospital</td>
<td>15,316</td>
<td>337 ± 405</td>
<td></td>
</tr>
<tr>
<td>Ambulatory same day</td>
<td>39,017</td>
<td>264 ± 273</td>
<td></td>
</tr>
<tr>
<td>Ambulatory next day</td>
<td>4,793</td>
<td>237 ± 269</td>
<td></td>
</tr>
<tr>
<td>Ambulatory &gt; 1 day</td>
<td>7,197</td>
<td>186 ± 196</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>After-hours same day</td>
<td>1,106</td>
<td>800 ± 745</td>
<td></td>
</tr>
<tr>
<td>After-hours next day</td>
<td>112</td>
<td>619 ± 311</td>
<td></td>
</tr>
<tr>
<td>After-hours &gt; 1 day</td>
<td>56</td>
<td>418 ± 348</td>
<td></td>
</tr>
<tr>
<td>In-hospital</td>
<td></td>
<td></td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Hospital same day</td>
<td>11,711</td>
<td>366 ± 440</td>
<td></td>
</tr>
<tr>
<td>Hospital next day</td>
<td>1,466</td>
<td>285 ± 252</td>
<td></td>
</tr>
<tr>
<td>Hospital &gt; 1 day</td>
<td>2,139</td>
<td>203 ± 190</td>
<td></td>
</tr>
</tbody>
</table>

Mean ± SD for invoices entered during 2021 and 2022. Categories (invoice type and time delay) are compared using a 1-way ANOVA and Tukey test for multiple comparisons.

N/A = Not applicable.
were identified, with 1,380 ± 1,370 invoices each. All invoice categories (A, I, E) were different from each other, with ambulatory invoices having the lowest total amount and emergency invoices having the highest total amount ($P < .0001$). All TD categories (same day, 1-day delay, and > 1-day delay) were different from each other, with same-day invoices having the largest total invoiced amount and "delayed > 1 day" having the smallest invoice amount ($P < .0001$). Specifically, the total invoice for charges entered the day after veterinary work was performed was approximately 15% less than the total invoice for charges entered the same day the veterinary work was performed. Similarly, the total invoice for charges entered > 1 day after the work was performed was approximately 36% less than for charges entered the same day work was performed.

The model selected with the best AIC described the relationship between invoice total and TD and invoice category. The specific relationship was given as the following:

![Figure 1](image)

**Figure 1**—Scatterplot of log invoice total against log days past by CODE (color coded and faceted), with generalized additive model (GAM) fit (solid line) and a 95% confidence band (dashed line) for the averaged data. The size of individual points is based on the weights $w_{ijk} = \frac{n_{ijk}}{n}$. All 3 CODEs show a significant downward trend in invoice total with increasing days past. For the nonlinear fits (CODEs A and I), the significant trend tapers off, due in part to an inflation of the SE due to decreasing sample size (demonstrated by the smaller weights). CODE: A = Ambulatory. Days past = Number of days. E = After-hours. I = In-house.
gam(formula = log10(InvoiceTotal + 1) ~ CODE + s(log10(DaysPastContinuous + 1), by = CODE),
data = df_avg, weights = w)

where df_avg = is the data.frame with the averaged data, w = is a column vector of weights for each observation (based on the number of observations that were averaged), and CODE = ambulatory, in-house, or after-hours.

In other words, the TD in entering invoices and the invoice category (ambulatory, in-hospital, emergency) influenced the total invoice amount. Including the variable “month of work” in the model did not improve the AIC. Figures 1 and 2 depict the nonlinear interaction between the effects of invoice category (A, I) and TD on the total invoice amount. The invoice category E had a linear relationship between TD and total invoice amount. However, for all invoice categories, an increased TD was associated with a decreasing invoice amount.

Discussion

The results of this study suggest that the delay in charge entry for veterinary work performed is associated with a decrease in the total value of the completed invoice. Specifically, the total invoice for charges entered the day after veterinary work was performed.

Figure 2—Plot of derivative of GAM fit (solid line) by CODE (color coded and faceted) and a 95% confidence band (dashed lines). The red shaded regions show when the GAM fit derivative is not significantly different from zero. For the nonlinear fits (CODEs A and I), the red shaded regions provide an indication of when the downward trend tapers off. For the linear fit (CODE E), the estimated derivative shows a significant downward trend everywhere as expected.
was approximately 15% less than the total invoice for charges entered the same day the veterinary work was performed. Similarly, the total invoice for charges entered > 1 day after the work was performed was approximately 36% less than for charges entered the same day work was performed. In the final general additive model, the type of invoice (A, I, E) also had an effect on the total invoice amount.

The decrease in invoice value observed in the current study was greater than the 6% that has been described in human studies that have investigated the benefit of billing at the point of care.1,2 While challenges to timely billing may be different in the human hospital setting, it appears that the problem of missed revenue may be quite similar. Performing a point-of-care billing prospective study could be helpful in the equine industry, as the current study did not evaluate the location of billing but merely the timing. For example, there could be a significant difference between billing “truck side” when on the farm as compared to billing that night after the veterinarian returns home.

It is not possible from the results of this study to conclude that a delay in the entry of the invoice is the cause of the decrease in the amount billed on the invoice. Other factors not measured in this study could be associated with a delay in the invoice entry. For example, doctors or staff could rush to enter more complicated invoices for fear of forgetting some of the charges. This could lead to a bias in which larger invoices were completed in a timelier fashion. A prospective, randomized clinical trial would better determine whether the delay in the invoice entry was indeed the cause of the decrease total invoice amount. However, this type of trial would not be easy to conduct, as invoices would need to be randomly assigned to a date of entry. Other ways to evaluate missed charges could include video recording the appointment and subsequent comparison of the video to charges actually entered.

Estimating the monetary cost of a delay in invoicing using data from this study would be an interesting exercise. While the percentage decrease in invoice total was quite large, the effect was dependent on the number of invoices that were affected (delayed). Using this information in the subset of invoices analyzed in this study, it would appear that the overall loss in revenue to the practice would be approximately 5%. In other words, if the delay in charge entry was the cause of the decreased total invoice amounts, total revenues could be increased by 5% by changing this behavior. Given that salary is one of the problems associated with veterinary retention, a means to increase salary without additional work performed could improve the number of veterinarians remaining in the industry.3 Changes in human medicine policies used to improve charge delay have yielded increases in total revenues of approximately 3%, suggesting that the estimates in this study are reasonable.3

For the statistical modeling, data were averaged for a given category, number of days that billing was delayed, and month of work. The main interest for this type of study is the marginal behavior of a given doctor, and therefore averaging over the doctors and replications should maintain this goal. Averaging the outcome should reduce the variance and improve the model building overall.

A major limitation of the study was the accuracy of the data due to its retrospective nature. The computer software recorded when the invoice was created/submitted, but it is possible that invoices could have been edited at a later date. In this situation, invoices would still be counted as entry on the original date even if editing occurred days, weeks, or months later. A prospective study could have better controlled for this problem.

A second limitation was the removal of a large number of invoices (> 30,000) that did not have a specific doctor identified. While most of these represent subscription refills at the front desk, it is possible that other types of invoices could have been included. Additionally, if a more junior doctor (intern) helped a more senior doctor with a case, the junior doctor might have been expected to enter charges but the invoice would have been categorized under the senior doctor for the purposes of this study.

A final limitation of this study was that the procedures and policies associated with billing and charge entry likely varied between practices. If a practice already requires all veterinarians to invoice at the time work is performed, these results may have limited value. However, in the author’s experience many veterinarians do not enter billing exclusively on the day of work, and therefore the results of this study could apply to many individuals in equine practice. This study also did not evaluate which specific items could potentially be missed due to a delay in charge entry. Common examples in the author’s experience include medications, travel fee, and procedures that were added to the appointment at the last minute. It would be logical to expect that improving charge capture for these specific items would improve the results presented in this study.

In conclusion, a delay in the entry of charges on an invoice is associated with a decreased total invoice amount. Further research is warranted to understand the relationship between delays in invoice entry and the total invoice charge. If the causal relationship is confirmed, practices may wish to facilitate timely invoice entry and coach veterinarians on ways to improve this parameter. Benefits to the practice and doctor could be significant, with specific invoices increasing by as much as 36% and total practice revenue increasing by as much as 5%.

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