

***Modeling the Likelihood of Interviews and Refusals:  
Using Call History Data to Improve Efficiency of  
Effort in a National RDD Survey***

Roberta L. Sangster and Brian J. Meekins  
Bureau of Labor Statistics, Washington, DC  
2004 JSM Survey Research Methods Section

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It will be difficult to ever know what calling strategy works best for telephone surveys. The variety of populations and topics, varying lengths of calling periods, differences in training and experience of the interviewing staff, and independent decisions made for specific surveys make this goal problematic. However, given the increasing effort required to conduct telephone surveys, it is fruitful to create a calling method that addresses call patterns with a very low probability of making contact and/or being a valid sample unit. Reducing the number of calls made to those cases and increasing the effort for more viable call patterns for making contact and completing an interview is a useful endeavor. Current calling methods are based on calling strategy research with the focus on establishing eligibility and completing interviews within the first few call attempts. Research has not really focused on what to do about the sample beyond the first few calls. The goal of this study is to focus on the total call history rather than the first few attempts. Proportional hazards modeling will be used to assess the ability to contact residences and complete interviews. The first model addresses the ability to contact and determine eligibility and the second model addresses the likelihood for interviews and refusals.

**Background of Telephone Calling Strategies**

RDD calling strategies were optimized in the early 1990s. The studies focused on the first few call attempts and tended to only include the never contacted cases. The goal was to maximize the efficiency of completing interviews and removing ineligible cases from the sample. Call schedulers typically use a priority score or contact probability approach to schedule calls (Weeks, F., Kulka, R. A., and Pierson, S. A. 1987; Groves 1989; Brick, Allen, Cunningham, and Marker, 1996).<sup>1</sup> Groves (1989) notes the little is

<sup>1</sup> The contact probability approach uses algorithms for noncontact cases that are either a fixed probability for each time slot or a conditional probability that adjusts the probabilities based on earlier noncontact calls (Weeks 1988:410). The priority score approach weights each noncontact every time the call scheduler is run. The weights are based on a variety of characteristics that produce a probability score used to schedule the next contact attempt (See Stokes and Greenberg (1990) and Greenberg and Stokes (1990) for a discussion).

known whether the different algorithms used for call scheduling or survey management decisions made during the calling period actually reduce nonresponse bias.

Other related research focuses on the best days and times to contact a household and to remove ineligible numbers. Time and day of calling research has shown that evenings and weekend calls are optimal for making contact and completing interview (Weeks 1987; Kulka and Weeks 1988; Greenberg and Stokes 1990).

Massey and his colleagues (1996) found that the greater mix of calls during the evening and weekends increased the probability of contacting household and completing an interview; however increasing the chances of contacting the household also increased the probability of a refusal. They found it optimal to complete one weekday call during the first three attempts to remove businesses from the sample frame. While sample management is still largely left to call schedulers, more and more decisions are being made by survey managers about what to do about calls after the first few attempts. This is largely due to the increasing effort required to attain acceptable response rates.

*Timing Between Call Attempts*

The timing between call attempts research is less clear. Stokes and Greenberg (1990) found that the number of days between attempts was significant, while Brick, Allen, Cunningham and Maklan (1996) did not find this to be the case. Brick and his colleagues (1996, p.148) believe the difference in the lag between attempts was a factor. The lag was almost always greater than two days, while for the Stokes and Greenberg's study (1990) two days was the largest lag between calls (due to a shorter survey period).

Others have speculated that the outcome for the second attempt may be dependent on the timing of the first call attempt (Groves, 1989; Kulka and Weeks, 1989). Brick et al., (1996) found this not to be the case, but again noted it might be study specific due to differences in call protocols. Another study in California (Edwards, DiSoga, and Yen, 2003) found that calling back refusals at the same time and day was the least effective time for refusal conversion attempts.

*Increasing Effort to Maintain Response Rates*

Today, the number of call attempts necessary to complete an interview has increased, while the ability to contact respondents and respondent cooperation has decreased (Brick, Martin, Warren, and Wivagg, 2003; Curtin, Presser, and Singer, 2000). Research interest

has shifted from call scheduling to the effort necessary to complete an interview and maintain response rates.

Effort includes increasing the number of call attempts, lengthening the survey period, and recalling people after an initial refusal. Other types of effort include inducements to respond such as advance letter with/without incentives and refusal conversion letters with/without incentives. Additional manipulated factors include the timing between call attempts, the priority placed on previous call outcomes, and the time and day of each attempt.

Currently, the vast majority of interviews, refusals, and ineligibles occur by the sixth or seventh call attempt (Brick, Allen, Cunningham, and Maklan 2003; Sangster and Meekins 2003). In our first study using these data, we found that by the 20<sup>th</sup> call attempt the chances of completing an interview are less than two percent (based on an eight week calling period and completing 30 or more call attempts). The probability of noncontact was never less than fifty percent, while the probability of an interview never rose above ten percent (Sangster and Meekins, 2003, p.6).

### The Current Study

In this second study, we use proportional hazard models for competing risks to examine calling (case) history's relationship to interview and refusals. The premise is that completed interview and refusals share similar risks for noncontact. However, the underlying structure may be different. For example, a sampling unit with five answering machine outcomes early in the survey period may be more likely to refuse to participate, while a sampling unit with no answering machine outcomes may be more likely to participate. By modeling the likelihood for refusals and interviews, we hope to find ways to develop calling rules that improve efficiency and optimize the chance of reducing nonresponse bias.

The call history includes all outcomes, but the study focuses on six major call outcomes:

1. Interview
2. Refusal
3. Appointment Callback (CB)
4. Answering Machine (AM)
5. Ring-No-Answer (RNA)
6. Busy Signal (Busy)

These six outcomes represent the majority of the call record outcomes recorded in call history files (Table 1).

The call history proportional hazards model comparisons are whether an event ever occurred (Ever) and the proportion of events (Prop.) for call outcomes that occurred between 4<sup>th</sup> to 25<sup>th</sup> attempt. The 25<sup>th</sup>

attempt was chosen as the cut off because the models tended to be less stable toward the end of the call distribution as the sample size diminished

Controls for the study include regional differences as defined by Census Regions (Northeast, Midwest, South, and West), seasonal difference based on the four quarters the surveys were conducted (January to March, April to May, June to August, September to December), and size of the Primary Sampling Units (PSU size). The PSUs include areas with over 1.5 million households (PSU A Class) and those with 1.5 million or less (PSU B Class) and Non-metropolitan areas (PSU C Class). PSU C class cities tend to be around 25,000, with several under 10,000 households.

### Call History Records

The study uses call history records for two years of a large national RDD survey, Telephone Point of Purchase Survey, TPOPS, (January 2001 to April 2003). This includes first quarter interview outcomes of every call attempted for 143,616 cases (764,640 call attempts). Each survey was conducted over an eight week period. Calling is limited by three calling rules. One rule limits calling to no more than 30 call attempts per sampling unit. This rule gets adjusted by survey managers, so a limited number of cases continue past the 30 call rule (Range 1 to 49 call attempts). A second calling rule limits the number of ring-no-answer (RNA) outcomes to no more than 12 consecutive RNA. The TPOPS attempts one refusal conversion for all but the hard refusal cases. After the second refusal, calling is stopped for the sample unit.

Three US Census call centers conduct TPOPS for the BLS. Calling occurs between 9 AM to 9 PM Monday through Saturday. Sunday calling begins at 11 AM and goes to 9 PM. However, interviews may work at other hours of the day when needed. The majority of the interviewers work between 3 PM to 8 PM; most work a five hour shift. This truncates the calling times.

### Interviews and Refusals

Partial interviews were included in the completed interviews for this study (*Interviews*). The criterion for a partial complete is the respondent must pass the introduction of the survey and complete the first question. TPOPS uses refusal conversion, which means that a call history record might include an initial refusal, but end as a completed interview, an appointment callback, answering machine, or some other types of noncontact as the final outcome. The *refusal* group includes all cases with a terminal outcome of refusal.

*Appointment Callback*

“Ever Callback” includes all cases with at least one instance of contacting someone in the residence that indicates willingness to complete an interview (Ever CB); the proportion is used for cases with that fall between the fourth and 25<sup>th</sup> call attempts (Prop CB). The appointment scheduler ranges from the interviewer guessing at the best time to callback (Soft CB) to a hard appointment callback (Hard CB) that specifies a day and time to call.

*Answering Machines, Ring-No-Answer and Busy*

Answering Machines includes all cases with at least one instance of contacting an answering machine with a message that indicates a household. Answering machines outcomes can also continue with the residential status as unknown. Ever AM, Ever RNA, and Ever Busy are used for the comparison for the first three call attempts and the proportions are used for cases with 4 to 25 call attempts (Prop AM, Prop. RNA, and Prop. Busy)

*Weekday Calls*

To reexamine the Massey et al., (1996) findings we include a “mix-in-three” variable (MIX). This variable consists of a weekday, weeknight, and weekend call being completed within the first three call attempts. Ever weekday and proportion weekday are also measures for day time calling.

*Average Days Between Attempts*

To examine the impact of timing between call attempts a measure was created based on minutes between call attempts transformed into average days (e.g., .25 days .5 days, 1 day) between call attempts (Avg. Day Betw).

*Statistical Analysis*

The study uses Cox Regression for competing risks for a contact model that includes the overall ability to make contact (Contact) and the ability to determine eligibility for residence and nonresidence (including business and other geographical screen-outs). The second competing risk analyses examine contacted cases for interviews and refusals. Number of call attempts represents time in the analyses.

Cox regression is similar to logistic analysis, but it deals with right censored data and accounts for time to event. Both are a concern when examining call history data. Time to event varies as the number of cases left in sample diminishes and according to calling algorithms used in call schedulers. Number of call attempts also varies.

**Results**

*Call Outcomes Across All Call Attempts*

Table 1 shows the total call attempt distribution broken down by Interview (I), Noncontact (NC), and Not Eligible (NE). Of all call attempts completed (n=764,640), about twenty-one percent of the cases result in some type of human contact: ten percent of all attempts are an interview or refusal, and another 11 percent are an appointment callback. Only six percent of all calls are a busy signal, while the vast majority of call attempts end as an answering machine or a ring-no-answer (58%). About 14 percent are not eligible, mostly due to telephone problems and nonworking numbers (a small portion are cell phones).

**Table 1. Percent All Call Attempts Outcome**

Category	Percent	Attempts
I Interview	4.6	35343
NC Refusal	5.4	41097
Appt. Callback	10.9	83237
Answering Machine	27.7	211696
Ring-No Answer*	30.2	231229
Busy	5.9	45308
Other Noncontacts <sup>†</sup>	1.1	8425
NE Phone Problem	5.1	39362
Nonwork\Cellphone	6.9	53054
Other Ineligible	2.1	15889
<b>Total Attempts</b>		<b>764640</b>

\*Includes the 12 consecutive RNA cases

<sup>†</sup>Includes physical and mental limitations and language barriers

Table 2 (next page) shows the percentages for the call outcomes broken into number of call attempts over the eight week calling period. As found in prior studies, the majority of interviews and refusals occur around the 6<sup>th</sup> to 12<sup>th</sup> call attempt. When the numbers with twelve consecutive ring-no-answers’ are removed, there is a shift between the 7-12 and 13-20 calls. Despite fewer cases to call, the efficiency is not improved for completing interviews, refusals tend to increase somewhat, and the numbers of busy signals decline somewhat. However, the majority of the shift occurs between the RNA and AM’s.

Among the not eligible telephone numbers, nonworking and cell-phones are mostly removed by the third telephone call, while phone problems climb until the 12 consecutive RNAs are removed.

By the 32<sup>nd</sup> call attempt after the 30 call attempt rule is enforced, the shift switches back to more RNA and fewer AMs outcomes. Phone problems also appears to creep back up and the number of busy signals also

increase somewhat when the 30-attempt rule is enforced. These outcomes are probably a function of reducing the sample to less than one- percent of the sample.

**Table 2: Percent Outcomes by Number of Call Attempts**

Outcomes	Number of Attempts					
	1 – 3	4 – 6	7 - 12	13 - 20	21 – 32	33 – 45
Complete	6.7	5.0	2.6	2.5	1.6	0.5
Refusal	7.3	5.8	3.3	3.7	2.7	1.2
Appt. Callback	11.1	12.0	8.8	13.5	10.9	9.1
Answering Machine	22.3	26.9	24.4	48.3	50.5	18.0
Ring-No Answer	21.1	34.7	44.3	22.7	26.2	54.9
Busy	6.5	5.8	6.2	3.9	3.7	6.0
Other Noncontacts	1.1	1.2	0.9	1.5	1.2	1.1
Phone Problem	3.8	5.8	8.0	2.7	2.6	8.5
Nonwork\Cellphone	16.3	1.2	0.7	0.6	0.4	0.6
Other Ineligible	3.8	1.5	0.8	0.6	0.3	0.1
Total Attempts	302785	149462	196485	71301	42545	2082
n=	143616	56646	39327	12246	5575	783

**Proportional Hazard Models for Contact, Nonresidence, and Residence**

The first analysis uses proportional hazards model for all attempts for the ability to make Contact and for the ability to determine Nonresidence and Residence status. ). Time to event is calculated as the number of days from the beginning of the calling cycle. Censored cases are those where no contact was established. We show only the final model in the interest of space Separate models were run for each group; the only significant interaction was for the Nonresidence model.

*All Call Attempts*

In Table 3, only Nonresidence is impacted by Region and PSU size differences. In comparison to the West, it is more difficult to reconcile a Nonresidence case in the Northeast and the Midwest and metropolitan areas with over 1.5 million residences. Overall, spring (April to June) is the best time to make contact. For the calling history comparison groups, a MIX of weekday, weeknight, and weekend calls within three first attempts improves reconciling Nonresidence cases. Ever busy improves reconciling the Nonresidence status, but has a negative impact on Contact and determining Residence status, while ever RNA has a negative impact on all three groups. The interaction between MIX for Ever RNA and for Ever Busy has a rather larger positive impact on reconciling Nonresidence, but was not important to the model for Contact or Residence.

**Table 3. Estimate of Proportional Hazards by All Attempts Exp (b)**

Categories	Contact	Non-Residence	Residence
Region West	---	---	---
Northeast	0.970	0.847*	1.011
Midwest	0.940	0.767*	0.955
South	1.009	0.944	1.032
PSU C	---	---	---
PSU A	0.982	1.175*	0.943
PSU B	1.027	1.000	1.037
Season Oct-Dec.	---	---	---
Jan-March	0.998	0.039	0.989
April-June	1.224*	1.249*	1.244*
July-Sept.	1.083	1.061	1.100*
MIX	0.909	0.125*	1.086
Ever Busy	0.604*	1.340*	0.393*
Ever RNA	0.367*	0.150*	0.420*
Ever Busy*MIX	xxxx	4.602*	xxxx
Ever RNA*MIX	xxxx	2.426*	xxxx

*Four to 25 Call Attempts*

When examining call history for 4 to 25 call attempts, calls made to the Midwest have a negative impact on all three comparison groups (See Table 4). Compared to the West, all three Regions have a negative impact on Nonresidence. The largest PSU size has a negative impact on Residence, but is no longer a factor for Nonresidence. The NE continues to be a counterproductive factor for reconciling nonresidence status. Once again, compared to October through December, spring is the best time to make contact for all three groups, and with greater persistence summer (July to Sept.) also becomes a positive factor for all three.

Longer average number of days between calls improves Contact and Nonresidence, but has little impact on Residence. After the third attempt, MIX is no longer important, and calling during the daytime has a negative impact for all three groups. When an interaction is added between proportion of daytime calls and proportion of RNA the ability to contact and resolve the case improves for all three groups.

The direct effect for the proportion busy is a somewhat negative impact on Contact and Residence, while proportion RNA direct effect is a negative impact on Contact and Nonresidence. However, the interaction between proportion of RNA and Busy negates the negative impact, and instead has very positive impact on Contact and Nonresidence; this same interaction was not important to the model for Residence. The interaction for the proportions of RNA and daytime calls also has a positive impact.

**Proportional Hazard Model for Interview and Refusal**

The next proportional hazard models include only the cases that were contacted (n=76440). Censored cases are those that were contacted but did not refuse an interview or complete an interview. Time to event is again calculated in days from the beginning of the calling cycle. The final models are presented in the interest of space. In this analysis the call history contributes more to the models than in the latter two analyses. Once again calls made in the spring and to the west yield the best chance of making contact and completing an interview or encountering a refusal.

*All Attempts*

For the comparison of all attempts for interview and refusal shown in Table 5, Ever Weekday, AM, Busy, and RNA decreases the chance of an interview or refusal, while hard and soft callbacks are not effective for interviews, and tends to increase refusals. The interactions between Ever Busy and Ever RNA and

**Table 4. Estimate of Proportional Hazards for 4-25 Attempts Exp (b)**

	Contact	Non-Residence	Residence
Region West	---	---	---
Northeast	1.056	0.843*	1.057
Midwest	0.889*	0.755*	0.883*
South	1.078	0.851*	1.079
PSU C	---	---	---
PSU A	0.906	1.035	0.894*
PSU B	0.951	1.027	0.943
Season Oct .Dec.	---	---	---
Jan. March	1.009	0.888	1.011
April June	1.329*	1.337*	1.336*
July Sept.	1.120*	1.185*	1.119*
Avg .Days Betw.	1.057*	1.105*	1.055
Prop. Day	0.888*	0.085*	0.882*
Prop. Busy	0.067*	1.004	0.045*
Prop. RNA	0.070*	0.917*	0.048
Prop. Busy*RNA	5.260*	39.922*	---
Prop. RNA*Day	1.534*	78.580*	3.009*

Ever AM and Ever RNA indicate that any type of contact other than RNA increases the chance of contact, and thus, an interview or refusal.

Hard callbacks direct effect is to decrease refusals, and soft callbacks direct effect is to decrease interviews and increase refusals. However, the interaction between the two tends decrease refusals and have not impact on interviews.

**Table 5. Estimate of Proportional Hazards for Interview and Refusal All Attempts Exp (b)**

	Interview	Refusal
Region West	---	---
Northeast	0.769*	1.078
Midwest	0.913	0.883*
South	0.913	0.970
PSU C	---	---
PSU A	0.826*	0.958
PSU B	0.928	1.015
Season Oct. Dec.	---	---
Jan. March	1.030	1.122*
April June	1.110*	1.347*
July Sept .	1.010	0.972
Ever Weekday	0.530*	0.532*
Ever Busy	0.394*	0.560*
Ever RNA	0.200*	0.328*
Ever AM	0.837*	0.628*
Ever Hard CB	1.021	1.158*
Ever Soft CB	0.897*	1.369*
Ever AM * RNA	1.934*	1.734*
Ever Busy * RNA	1.651*	1.378*
Ever CB Hard * Soft	0.974	0.659*

The final analysis is shown in Table 6: the proportional hazards model for 4 to 25 call attempts for Interview and Refusal.

**Table 6. Estimate of Proportional Hazards for Interview and Refusal 4 to 25 Attempts Exp (b)**

	Interview	Refusal
Region West	---	---
Northeast	0.774*	* 1.302*
Midwest	0.875*	1.036
South	0.863*	1.125*
PSU C	---	---
PSU A	0.812*	0.952
PSU B	0.905*	0.954
Season Oct. Dec.	---	---
Jan. March	1.003	1.051
April June	1.281*	1.645*
July Sept.	1.067	1.054
Avg. Days Betw.	0.872*	1.112*
Prop. Weekdays	0.913	1.087
Prop. Busy	0.389*	0.345*
Prop. RNA	0.208*	0.312*
Prop. AM	1.471*	0.775*
Prop. Hard CB	12.462*	2.615*
Prop. Soft CB	7.291*	2.450*
Prop. AM * RNA	3.227*	7.186*
Prop. Busy * RNA	0.199*	0.579
Prop. CB Hard * Soft	0.004*	0.003*

After the third call attempt, greater time between calls decreases the chance of an interview and increases the odds of a refusal, while the inverse is true for the number of AM outcomes encountered. Not surprisingly, weekday calling loses its effectiveness after the first three call attempts.

The proportion of Busy and RNA and the interaction between them is related to the ability to contact a person, so both interviews and refusals are less likely to occur the more times busy and RNA take place. Similarly, the interaction between AM and RNA, improves the odds of completing an interview and getting a refusal.

The direct effect of scheduling callbacks (Hard CB and Soft CB) appears to be very positive for completing interviews, and also yields more refusals. However, the interaction between the two suggests interplay between Hard and Soft CBs that yields fewer interviews and refusals.

**Conclusions**

The ability to contact and resolve residency status is integral to completing interviews and refusals. This should be considered together when drawing

conclusions from the analysis. Many of the outcomes for the interview and refusal models are related to the ability to contact a person in the household. The ability to contact a person tends to increase the odds of an interview and refusals simply because someone answered the telephone. It was somewhat surprising to learn that only six percent of all call attempts resulted in a busy signal. The vast majority of calls ended as a RNA (30%) or AM (28%). Callbacks (11%) were as common, as were interviews and refusals combined (10%). This underscores the importance of understanding the relationship between these call outcomes

*Regional, PSU Size, and Seasonal Differences*

The trend of households in the larger metropolitan areas in the Northeast and Midwest to be more difficult to contact and gain cooperation holds for this study. Contact and cooperation tend to improve during the spring and into the summer and declines as household schedules get busier and colder weather occurs.

*Weekday Calls*

The usefulness of calling during the weekday, weekend, and weeknight within the first three call attempts continues to be important for removing nonresidential numbers from the sample.<sup>2</sup> However, continuing to call during the weekday has a negative impact on making contact and determining eligibility.

When contact has been established, weekday calls have no impact on Interviews or Refusals after the first three calls. There was also an indication that the proportion of RNA and busy signals could be important to weekday calling for contacting and resolving nonresidential cases. These finding warrants further study.

*Average Days Between Attempts*

The average days between calls had a small impact on contact and cooperation. The greater amount of time between attempts decreases the odds of an interview but increase the odds of a refusal. These effects are modest in size compared to others. In addition, the average number of days between attempts for those with only one attempt is given as zero, making a nonlinear relationship between average days between and the log odds of refusal or interview very possible. Further exploration of this relationship is needed.

<sup>2</sup> Currently, the TPOPS does not use the Marketing Systems Group improved sampling method for removing nonresidential and nonworking numbers (as discussed by Brick et al., 2003). Improving the residency rate would likely decrease the efficiency of weekday calling.

*Answering Machines, Ring-No-Answer and Busy*

The interplay between AM, RNA, and Busy also warrants further analysis. The ability to contact is related to the proportion RNA and they should be considered together for weekday calling. The interaction between RNA and Busy indicates that call schedulers should take this into account, especially for calls made after the first three attempts. The interaction changes from negative direct effects to a positive outcome for interviews (and noted inverse for refusals).

It appears that AM are also worth future examination. AM seems to be *not* important in the contact models, but *become* important after contact has been accomplished for both interviews and refusals. The interaction between RNA and AM also indicates that this should be taken into account for call schedulers.

*Appointment Callback*

Probably the most surprising finding is the influence of callbacks on interviews and refusals. Callback scheduling methods need improvement because it is unclear how effective callbacks are when both soft and hard callbacks are present. If we look at the interactions, it appears that we might do as well not scheduling callbacks at all. We suspect that soft and hard callbacks are more like a refusal the more times they occur.

This research suggests that call scheduling, at least for the TPOPS, is less than optimal. The TPOPS scheduler is based on the research conducted by Greenberg and Stokes (1990), which was modified to account for the longer calling period (2 weeks versus 8 weeks of calling). It is clear that further modifications are warranted.

Calling rules need to be established for callbacks and AMs. The call limits might also be examined with survey managers to better understand the decisions made toward the end of the calling period. In general, it is also helpful to complete daytime calls when RNA and/or Busy signals are present in the call history. When RNA and Busy are present, daytime calls aid in cleaning up Nonresidence anytime in the calling period, but more importantly it can lead to residences in later attempts. While this study is influenced by the calling methods used for TPOPS, most of the issues discussed are likely true for other RDD surveys.

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