# DMAIC
# ANALYZE PHASE

**1. Complete an ANOVA single-factor experiment comparing response rates for each team.**

$H_0$: Overall response rates for each time are all statistically equal.
$H_A$: At least one overall response rate is uneqal to the others.
Significance level: $\alpha = 0.05$

| | Success Rates | | Overall |
|---|---|---|---|
| | **Letters** | **Phone Calls** | |
| Baseline | 55.00% | 60.71% | 58.33% |
| CKD | 47.37% | 33.33% | 39.53% |
| Complex | 43.48% | 48.15% | 47.92% |
| Diabetes | 33.33% | 48.15% | 42.22% |
| Health Home | 41.18% | 53.57% | 48.89% |
| Housing | 23.08% | 47.37% | 37.50% |
| ICM-Gen | 55.56% | 50.00% | 53.45% |
| ICM-HF | 65.00% | 48.28% | 55.10% |
| MLTC | 53.57% | 64.71% | 57.78% |
| Post Discharge | 57.14% | 40.74% | 47.92% |
| Respiratory | 55.00% | 42.11% | 48.72% |
| **Overall** | 46.25% | 49.06% | 49.40% |

We have 10 different treatments $\rightarrow df_{treat} = 10 - 1 = 9$
We have 500 different measurements $\rightarrow df_{tot} = 500 - 1 = 499$
$df_{treat} + df_{res} = df_{tot} \rightarrow df_{res} = 499 - 9 = 490$

$$SS_{treat} = \sum \hat{A}_i^2 \cdot \#measures$$
$$= (0.0893)^2 \cdot 48 + (-0.0987)^2 \cdot 43 + (-0.0148)^2 \cdot 48 + (-0.0718)^2 \cdot 45 + (-.0051)^2 \cdot 45 + (-0.1190)^2 \cdot 32 + (0.0405)^2 \cdot 58 + (0.0570)^2 \cdot 49 + (0.0838)^2 \cdot 45 + (-0.0148)^2 \cdot 48 + (-0.0068)^2 \cdot 39$$
$$= 2.0812$$

$$SS_{tot} = \sum_{i,j} \left(y_{ij} - \hat{\mu}\right)^2$$
$$= (1 - 0.494)^2 + (0 - 0.494)^2 + \cdots (1 - 0.494)^2$$
$$= 124.982$$

$SS_{tot} = SS_{treat} + SS_{res}$
$SS_{res} = 124.982 - 2.0812$
$SS_{res} = 122.9008$

$$MS_{treat} = \frac{SS_{treat}}{df_{treat}} = \frac{2.0812}{9} = 0.2312$$
$$MS_{res} = \frac{SS_{res}}{df_{res}} = \frac{122.9008}{490} = 0.2508$$

$$F = \frac{MS_{treat}}{MS_{res}} = \frac{0.2312}{0.2508} = 0.9219$$

This large F value implies that the effect of the treatment is relevant.

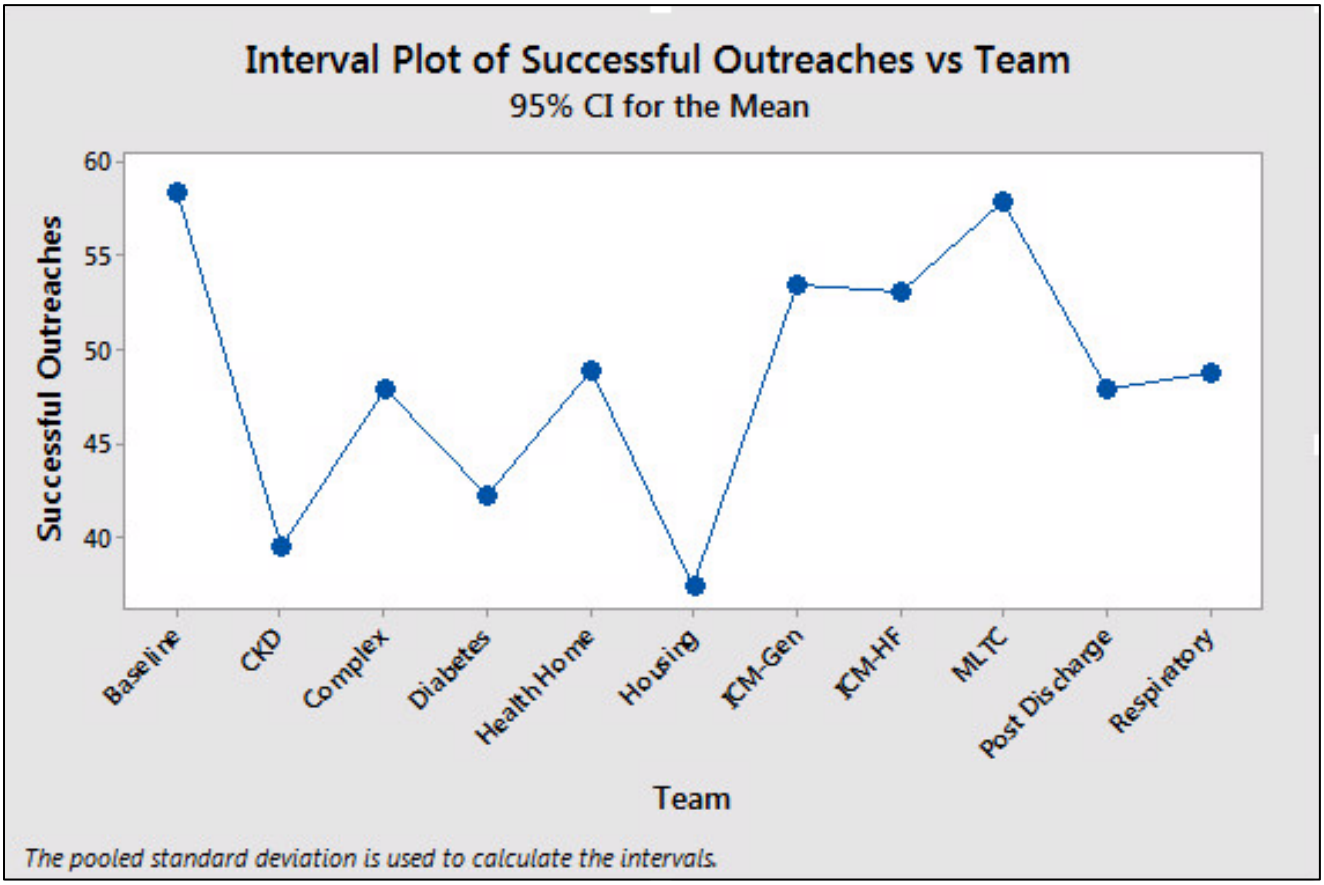
Calculate the critical value for the level $\alpha = 5\%$ with degrees of freedom 9 and 490.

$\alpha = 5\% \rightarrow \quad F_{9,490}^{krit} 5\% = 1.89898340$

We have calculated $F = 0.9219 < 1.8990$.
Consequently we FAIL TO REJECT the null hypothesis.

Similary, we could obtain the same result by calculating the p-value
$F_{9,490(p)} = 0.9219 \quad \rightarrow \quad p = 50.56.$
Since $50.56\% > 5\%$, we reject the null hypothesis.

**Results indicate that all programs have a response rate that is statistically the same.**



Calculate yearly average cost of each outreach method:

LETTERS

Assumptions:

- 1 letter costs $0.05
- 1 stamp costs $0.47

235 letters sent, 117 successful, 118 unsuccessful

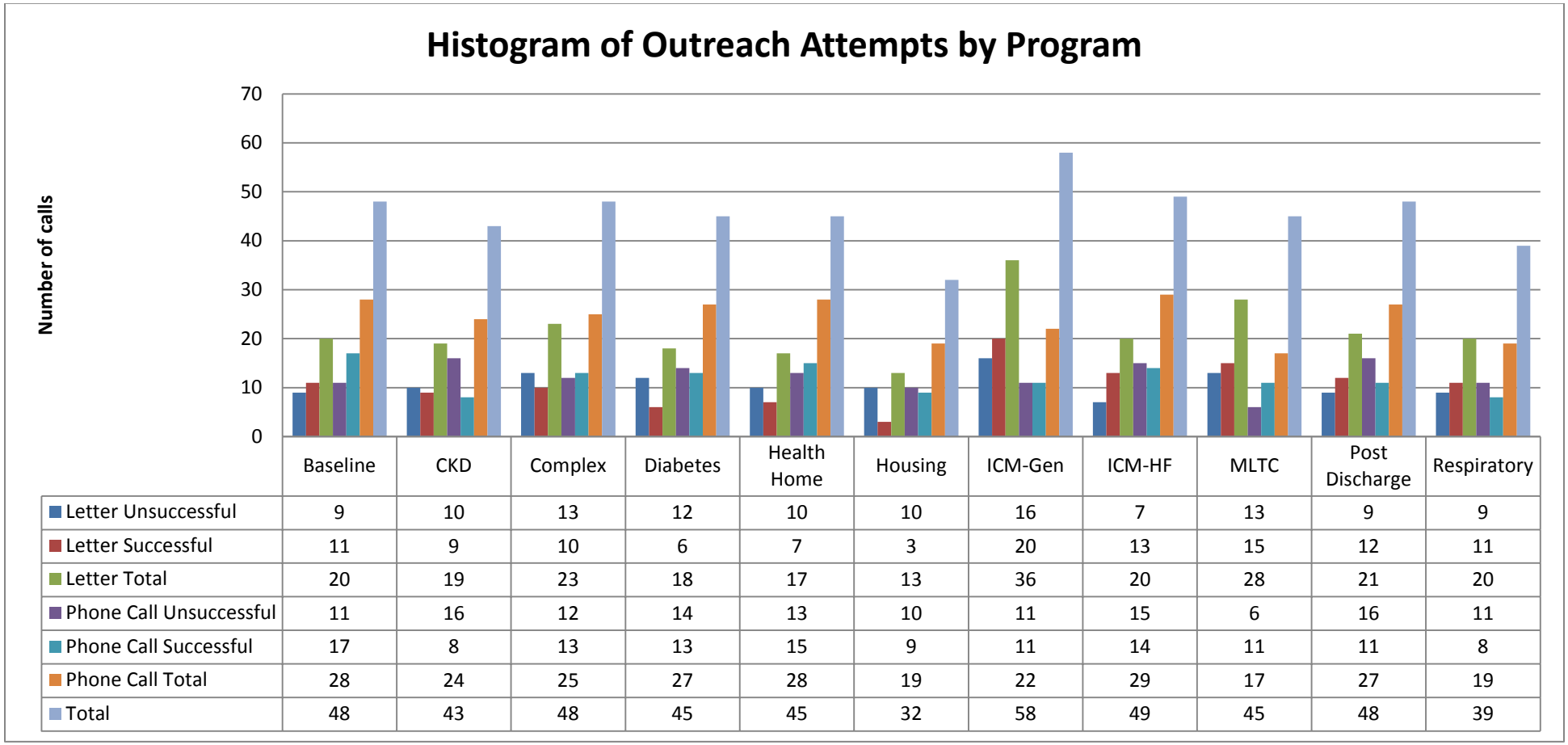
0.05(235) + 0.47(235) = $122.20

0.05(118) + 0.47(118) = $61.36 spent in just 2 months on members who did not respond

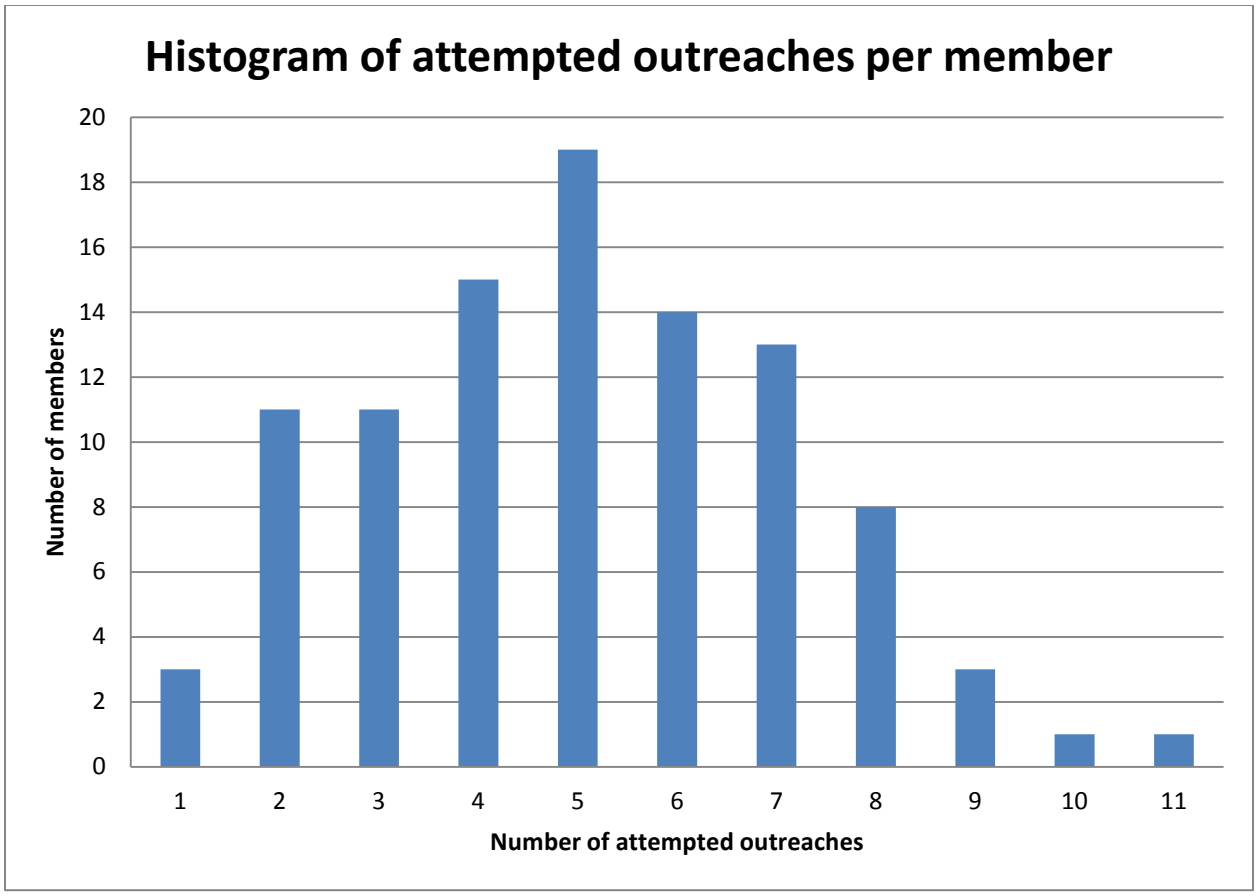
**Tools used**

- **Histogram(s)**
- **Statistic(s)**
- **Hypothesis testing (ANOVA)**
- **Time series graph**
- **Cause and effect diagram**

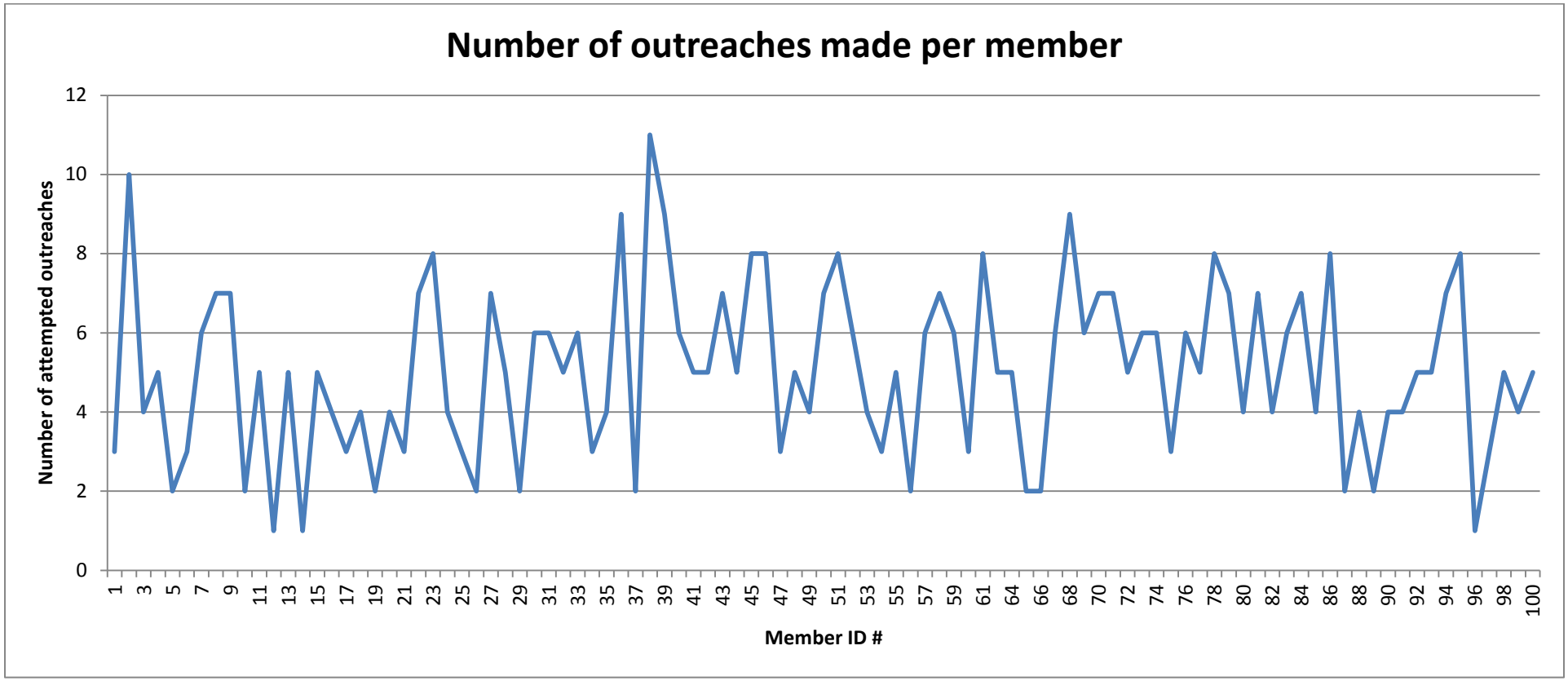
ICM-General outreached the most members, with 58 attempted outreaches over the 2 months considered. Housing outreached the least number of members, with 32 attempted outreaches over the 2 months. ICM-General also sent the most letters of any program. ICM-HF made the largest amount of phone calls of any program. The Baseline team had the highest number of successful phone calls made, while CKD and Respiratory tied for the least number of successful phone calls made. CKD and Post Discharge tied for highest number of unsuccessful phone calls made, and MTLC had the lowest number of unsuccessful phone calls made. ICM-Gen had the highest number of successful letters sent, while Housing had the lowest number of successful letters mailed. ICM-Gen had the highest number of unsuccessful letters sent, while ICM-HF had the lowest number of unsuccessful letters sent.




| | Baseline | CKD | Complex | Diabetes | Health Home | Housing | ICM-Gen | ICM-HF | MLTC | Post Discharge | Respiratory |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Letter Unsuccessful | 9 | 10 | 13 | 12 | 10 | 10 | 16 | 7 | 13 | 9 | 9 |
| Letter Successful | 11 | 9 | 10 | 6 | 7 | 3 | 20 | 13 | 15 | 12 | 11 |
| Letter Total | 20 | 19 | 23 | 18 | 17 | 13 | 36 | 20 | 28 | 21 | 20 |
| Phone Call Unsuccessful | 11 | 16 | 12 | 14 | 13 | 10 | 11 | 15 | 6 | 16 | 11 |
| Phone Call Successful | 17 | 8 | 13 | 13 | 15 | 9 | 11 | 14 | 11 | 11 | 8 |
| Phone Call Total | 28 | 24 | 25 | 27 | 28 | 19 | 22 | 29 | 17 | 27 | 19 |
| Total | 48 | 43 | 48 | 45 | 45 | 32 | 58 | 49 | 45 | 48 | 39 |

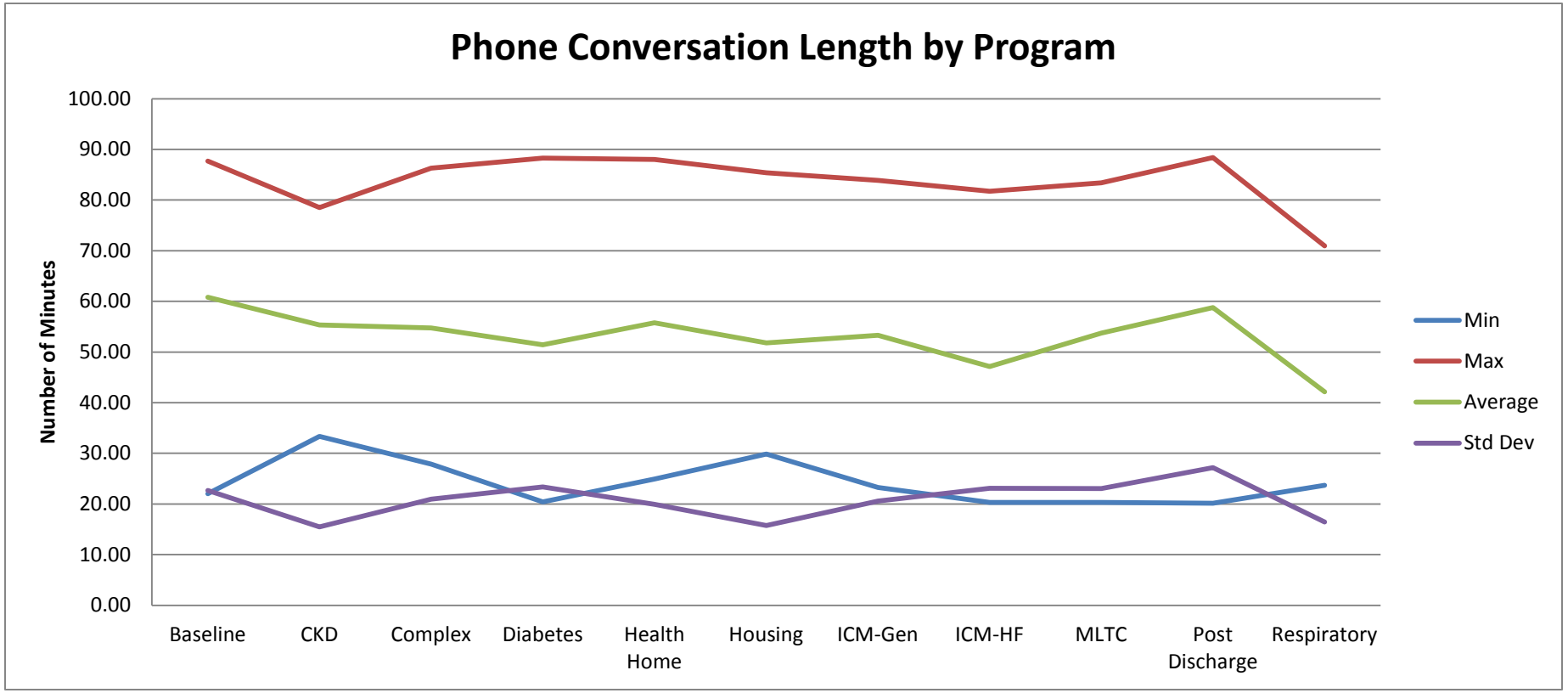

Histogram of attempted outreaches per member
Number of members
20
18
16
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
Number of attempted outreaches

Out of the 100 members we tracked for January and February 2015, Member #38 was outreached the most (11 times total). Members #12, #14, and #96t tied for the fewest number of outreaches (1 time each). The average member was outreached 5 times. The median number of outreaches per member is also 5.



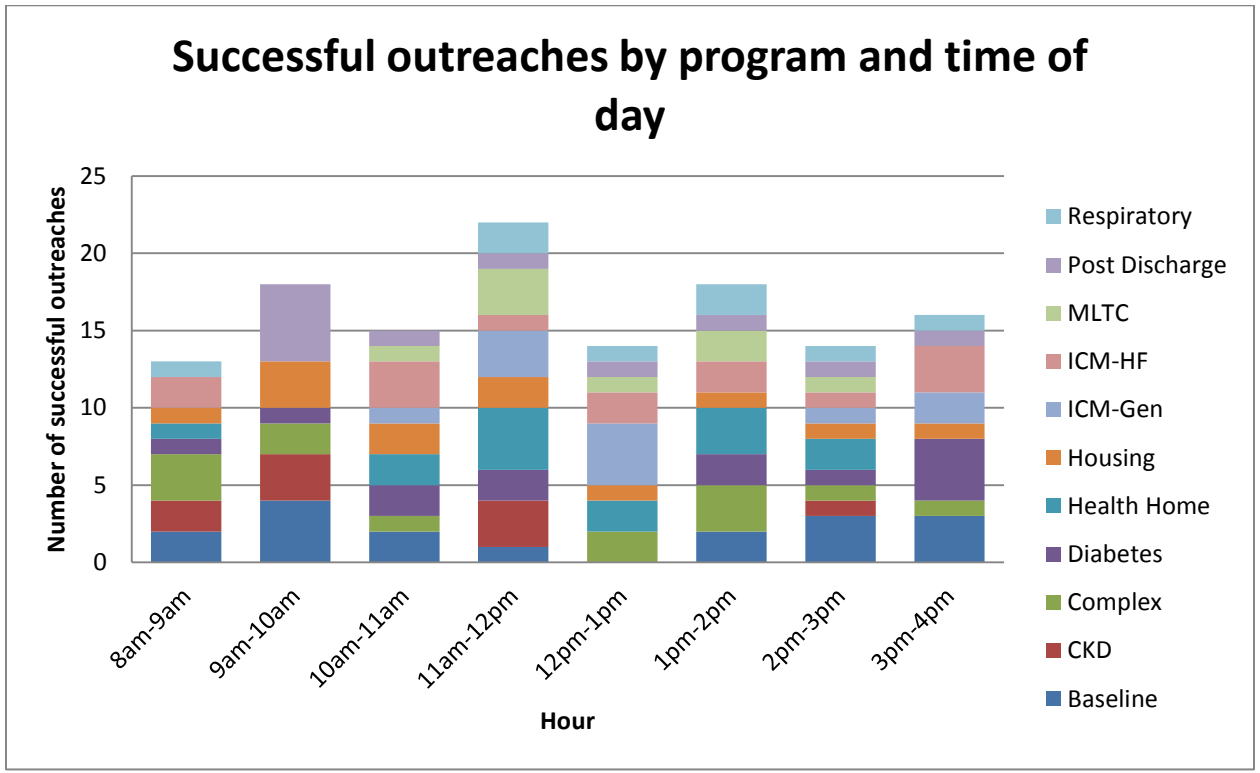
| | Phone Convo Length by Program | | | |
|---|---|---|---|---|
| | **Min** | **Max** | **Average** | **Std Dev** |
| Baseline | 22.02 | 87.70 | 60.81 | 22.68 |
| CKD | 33.37 | 78.54 | 55.34 | 15.48 |
| Complex | 27.88 | 86.31 | 54.76 | 20.93 |
| Diabetes | 20.42 | 88.30 | 51.41 | 23.35 |
| Health Home | 24.93 | 88.02 | 55.76 | 19.95 |
| Housing | 29.88 | 85.37 | 51.82 | 15.77 |
| ICM-Gen | 23.24 | 83.91 | 53.31 | 20.59 |
| ICM-HF | 20.32 | 81.76 | 47.12 | 23.11 |
| MLTC | 20.32 | 83.42 | 53.76 | 23.06 |
| Post Discharge | 20.14 | 88.41 | 58.78 | 27.16 |
| Respiratory | 23.71 | 70.96 | 42.14 | 16.43 |

The minimum phone call across all programs lasted 20.14 minutes and was from the Post Discharge team. The maximum phone conversation across all programs lasted 88.41 minutes and was also from the Post Discharge team. The average phone call for all programs is 53.18 minutes long. The average standard deviation in phone conversation length for all programs is 20.77.

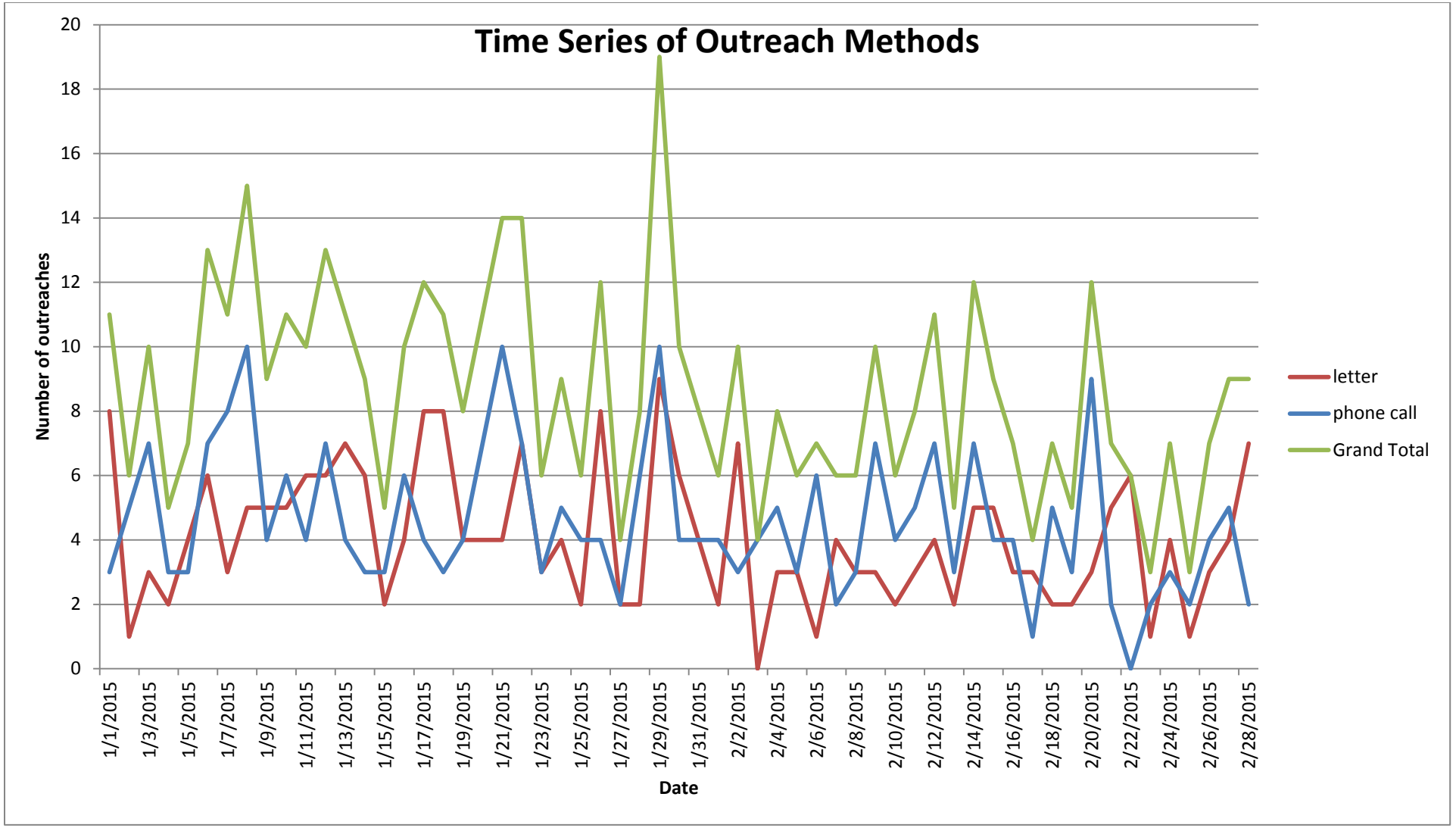


## Time Distribution Histogram

| | Baseline | CKD | Complex | Diabetes | Health Home | Housing | ICM-Gen | ICM-HF | MLTC | Post Discharge | Respiratory | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **8am-9am** | 2 | 2 | 3 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | **14** |
| **9am-10am** | 4 | 3 | 2 | 1 | 0 | 3 | 0 | 0 | 0 | 5 | 0 | **18** |
| **10am-11am** | 2 | 0 | 1 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 0 | **15** |
| **11am-12pm** | 1 | 3 | 0 | 2 | 4 | 2 | 3 | 1 | 3 | 1 | 2 | **22** |
| **12pm-1pm** | 0 | 0 | 2 | 0 | 2 | 1 | 4 | 2 | 1 | 1 | 1 | **14** |
| **1pm-2pm** | 2 | 0 | 3 | 2 | 3 | 1 | 0 | 2 | 2 | 1 | 2 | **18** |
| **2pm-3pm** | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | **14** |
| **3pm-4pm** | 3 | 0 | 1 | 4 | 0 | 1 | 2 | 3 | 0 | 1 | 1 | **16** |




The most successful hour for outreach is 11am-12pm. During this hour, Health Home made the highest number of successful outreaches. The least most successful hour for outreach is 8am-9am.


Time Series of Outreach Methods
Number of outreaches
Date
letter
phone call
Grand Total
0
2
4
6
8
10
12
14
16
18
20
1/1/2015
1/3/2015
1/5/2015
1/7/2015
1/9/2015
1/11/2015
1/13/2015
1/15/2015
1/17/2015
1/19/2015
1/21/2015
1/23/2015
1/25/2015
1/27/2015
1/29/2015
1/31/2015
2/2/2015
2/4/2015
2/6/2015
2/8/2015
2/10/2015
2/12/2015
2/14/2015
2/16/2015
2/18/2015
2/20/2015
2/22/2015
2/24/2015
2/26/2015
2/28/2015

# Low Patient Response Rates

## Cause & Effects Diagram