# SUPPLEMENTARY MATERIALS

## Table 2: List of ICD-9 CM Codes for heart failure

| ICD – 9 CM Code | Description |
|---|---|
| 402.01 | Malignant hypertensive heart disease with heart failure |
| 402.11 | Benign, hypertensive heart disease with heart failure |
| 402.91 | Unspecified, hypertensive heart disease with heart failure |
| 404.01 | Malignant hypertensive heart and kidney disease with heart failure |
| 404.03 | Malignant hypertensive heart and kidney disease with heart failure and chronic kidney disease |
| 404.11 | Benign, hypertensive heart and kidney disease with heart failure |
| 404.13 | Benign, hypertensive heart and kidney disease with heart failure and chronic kidney disease |
| 404.91 | Unspecified, hypertensive heart and kidney disease with heart failure |
| 404.93 | Unspecified hypertensive heart and kidney disease with heart failure and chronic kidney disease |
| 428.0 | Congestive heart failure, unspecified |
| 428.1 | Left heart failure |
| 428.20 | Unspecified systolic heart failure |
| 428.21 | Acute systolic heart failure |
| 428.22 | Chronic systolic heart failure |
| 428.23 | Acute on chronic systolic heart failure |
| 428.30 | Unspecified diastolic heart failure |
| 428.31 | Acute diastolic heart failure |
| 428.32 | Chronic diastolic heart failure |
| 428.33 | Acute on chronic diastolic heart failure |
| 428.40 | Unspecified combined systolic and diastolic heart failure |
| 428.41 | Acute combined systolic and diastolic heart failure |
| 428.42 | Chronic combined systolic and diastolic heart failure |
| 428.43 | Acute on chronic combined systolic and diastolic heart failure |
| 428.9 | Heart failure, unspecified |
|  |  |

**Table 3: Monthly 30 - day All-Cause Readmission rates for the clinic and MHHS cohort**

| Month | Clinic Cohort | | | MHHS Cohort | | |
|---|---|---|---|---|---|---|
| | All-cause readmissions | Total index Admissions | HF Clinic Readmission Rate | MHHS HF Readmissions | MHHS Index Admissions | MHHS Readmission Rate |
| Jan-10 | | | | 43 | 335 | 12.84% |
| Feb-10 | | | | 46 | 272 | 16.91% |
| Mar-10 | | | | 62 | 322 | 19.25% |
| Apr-10 | | | | 47 | 327 | 14.37% |
| May-10 | | | | 46 | 305 | 15.08% |
| Jun-10 | | | | 39 | 255 | 15.29% |
| Jul-10 | | | | 50 | 239 | 20.92% |
| Aug-10 | | | | 45 | 250 | 18.00% |
| Sep-10 | 0 | 3 | 0.00% | 47 | 225 | 20.89% |
| Oct-10 | 2 | 3 | 66.67% | 44 | 250 | 17.60% |
| Nov-10 | 0 | 5 | 0.00% | 44 | 246 | 19.92% |
| Dec-10 | 2 | 7 | 28.57% | 49 | 307 | 14.66% |
| Jan-11 | 1 | 7 | 14.29% | 45 | 320 | 14.38% |
| Feb-11 | 1 | 4 | 25.00% | 46 | 306 | 15.69% |
| Mar-11 | 1 | 6 | 16.67% | 48 | 325 | 9.54% |
| Apr-11 | 0 | 4 | 0.00% | 31 | 235 | 21.70% |
| May-11 | 1 | 13 | 7.69% | 51 | 268 | 13.06% |
| Jun-11 | 1 | 3 | 33.33% | 35 | 282 | 13.48% |
| Jul-11 | 0 | 9 | 0.00% | 38 | 240 | 16.67% |
| Aug-11 | 0 | 12 | 0.00% | 40 | 246 | 12.60% |
| Sep-11 | 1 | 11 | 9.09% | 31 | 239 | 15.90% |
| Oct-11 | 0 | 8 | 0.00% | 38 | 244 | 22.54% |
| Nov-11 | 4 | 10 | 40.00% | 55 | 307 | 20.20% |
| Dec-11 | 0 | 6 | 0.00% | 62 | 302 | 13.25% |
| Jan-12 | 1 | 7 | 14.29% | 40 | 301 | 14.29% |
| Feb-12 | 1 | 5 | 20.00% | 43 | 305 | 19.02% |
| Mar-12 | 2 | 4 | 50.00% | 58 | 339 | 11.80% |
| Apr-12 | 0 | 9 | 0.00% | 40 | 268 | 17.91% |
| May-12 | 0 | 8 | 0.00% | 48 | 300 | 17.67% |
| Jun-12 | 1 | 7 | 14.29% | 53 | 267 | 15.36% |
| Jul-12 | 1 | 5 | 20.00% | 41 | 247 | 14.98% |
| Aug-12 | 0 | 7 | 0.00% | 37 | 229 | 15.28% |
| Sep-12 | 0 | 1 | 0.00% | 35 | 238 | 17.23% |
| Oct-12 | 0 | 12 | 0.00% | 41 | 274 | 15.69% |
| Nov-12 | 3 | 10 | 30.00% | 43 | 288 | 22.22% |
| Dec-12 | 2 | 6 | 33.33% | 64 | 325 | 19.69% |

**Table 4: Descriptive statistics for Clinic and MHHS Cohort**

| Descriptive statistics | Clinic Cohort | MHHS Cohort |
|---|---|---|
| Total all-cause readmissions | 26 | 1625 |
| Total Index admissions | 192 | 10028 |
| Average readmission rate (Sample Mean) | 13.54% | 16.20% |
| Sample Standard deviation | 17.79% | 3.16% |
| Sample Minimum | 0% | 9.54% |
| Sample Maximum` | 66.67% | 22.54% |
| 25$^{th}$ percentile (Q1) | 0% | 14.35% |
| Median (Q2) | 11.69% | 15.80% |
| 75$^{th}$ percentile (Q3) | 25.89% | 19.18% |

**Table 5: Causes of 30 -day all-cause readmissions among clinic patients**

| DRGs | # of redmits | Percentage of redmits |
|---|---|---|
| Heart failure | 9 | 34.62% |
| Respiratory DRGs | 2 | 7.69% |
| Cardiac defib Implant | 2 | 7.69% |
| Circulatory disorders | 3 | 11.54% |
| Atherosclerosis | 1 | 3.85% |
| Cardiac Arrhythmias | 1 | 3.85% |
| Chest pain | 1 | 3.85% |
| GI Hemorrhage | 1 | 3.85% |
| Esophagitis | 1 | 3.85% |
| Nutritional | 2 | 7.69% |
| HIV related conditions | 1 | 3.85% |
| Diabetes | 1 | 3.85% |
| Renal failure | 1 | 3.85% |

**MHTMC hospital cohort**

For the MHTMC hospital cohort, data was collected from January 2010 until December 2012. There were a total of 1312 index admissions within this time period, with 231 30-day all-cause heart failure readmissions. Table 5 describes the monthly readmissions rates for the cohort.

**Table 6: MHTMC Monthly 30-day all-cause heart failure readmission rate**

| Month | MHTMC HF Readmissions | MHTMC Index Admissions | TMC Readmission Rate |
|---|---|---|---|
| Jan-10 | 3 | 46 | 6.52% |
| Feb-10 | 8 | 40 | 20.00% |
| Mar-10 | 10 | 45 | 22.22% |
| Apr-10 | 6 | 40 | 15.00% |
| May-10 | 5 | 53 | 9.43% |
| Jun-10 | 5 | 25 | 20.00% |
| Jul-10 | 7 | 25 | 28.00% |
| Aug-10 | 6 | 38 | 15.79% |
| Sep-10 | 7 | 28 | 25.00% |
| Oct-10 | 8 | 34 | 23.53% |
| Nov-10 | 6 | 22 | 27.27% |
| Dec-10 | 6 | 35 | 17.14% |
| Jan-11 | 7 | 41 | 17.07% |
| Feb-11 | 4 | 46 | 8.70% |
| Mar-11 | 7 | 34 | 20.59% |
| Apr-11 | 5 | 25 | 20.00% |
| May-11 | 9 | 35 | 25.71% |
| Jun-11 | 5 | 36 | 13.89% |
| Jul-11 | 2 | 29 | 6.90% |
| Aug-11 | 6 | 36 | 16.67% |
| Sep-11 | 6 | 26 | 23.08% |
| Oct-11 | 3 | 27 | 11.11% |
| Nov-11 | 9 | 40 | 22.50% |
| Dec-11 | 8 | 48 | 16.67% |
| Jan-12 | 6 | 31 | 19.35% |
| Feb-12 | 8 | 35 | 22.86% |
| Mar-12 | 13 | 47 | 27.66% |
| Apr-12 | 5 | 42 | 11.90% |
| May-12 | 5 | 48 | 10.42% |
| Jun-12 | 7 | 33 | 21.21% |
| Jul-12 | 6 | 30 | 20.00% |
| Aug-12 | 6 | 37 | 16.22% |

| | | | |
|---|---|---|---|
| Sep-12 | 3 | 25 | 12.00% |
| Oct-12 | 3 | 42 | 7.14% |
| Nov-12 | 9 | 46 | 19.57% |
| Dec-12 | 12 | 42 | 28.57% |

**Table 7: Descriptive statistics for the MHTMC hospital cohort**

| | |
|---|---|
| Total all-cause readmissions | 231 |
| Total Index admissions | 1312 |
| Average readmission rate (Sample Mean) | 17.61% |
| Sample Standard deviation | 6.34% |
| Sample Minimum | 6.9% |
| Sample Maximum | 28.57% |
| 25th percentile (Q1) | 13.41% |
| Median (Q2) | 19.46% |
| 75th percentile (Q3) | 22.91% |

**Figure 1: Time series representing 30-day heart failure readmission rates for the clinic, MHTMC and MHHS cohorts**
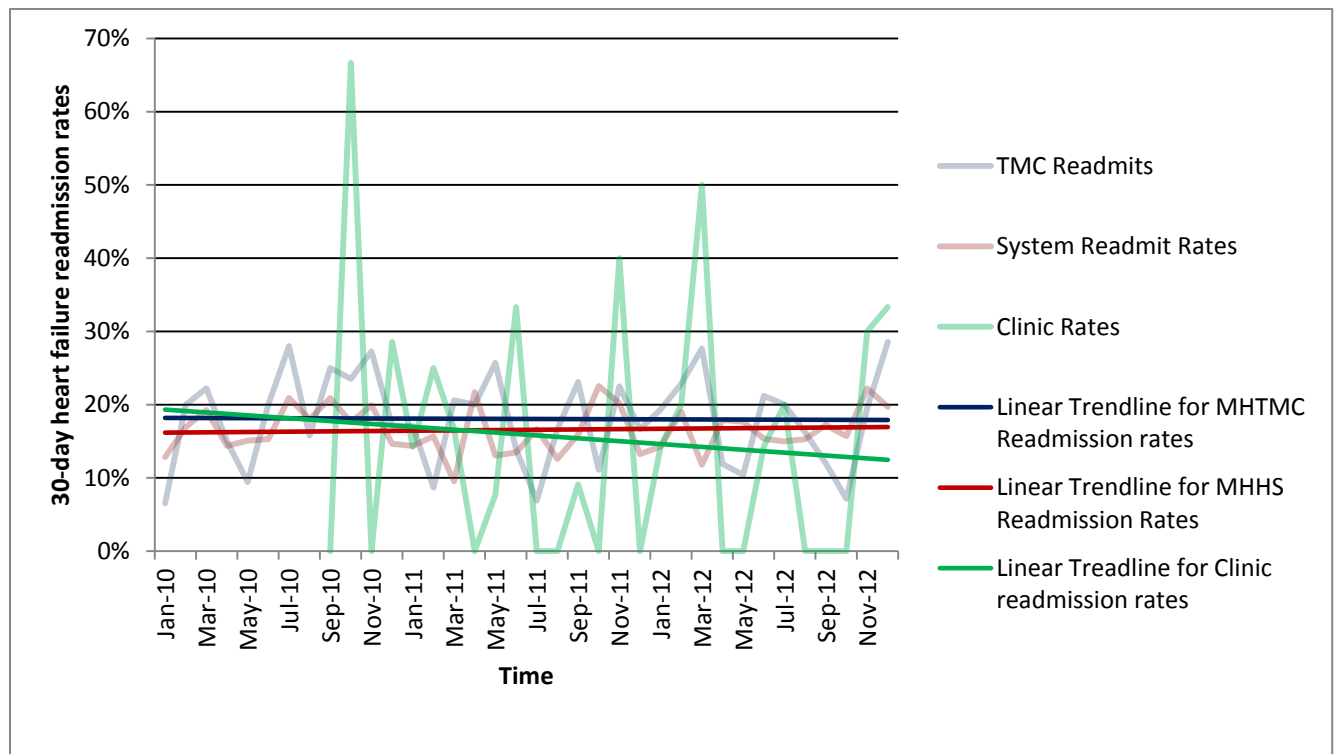
**Figure 2: Time Series representing 30-day heart failure readmission rates with the 3 month moving averages for the HF Clinic and MHHS Cohort**
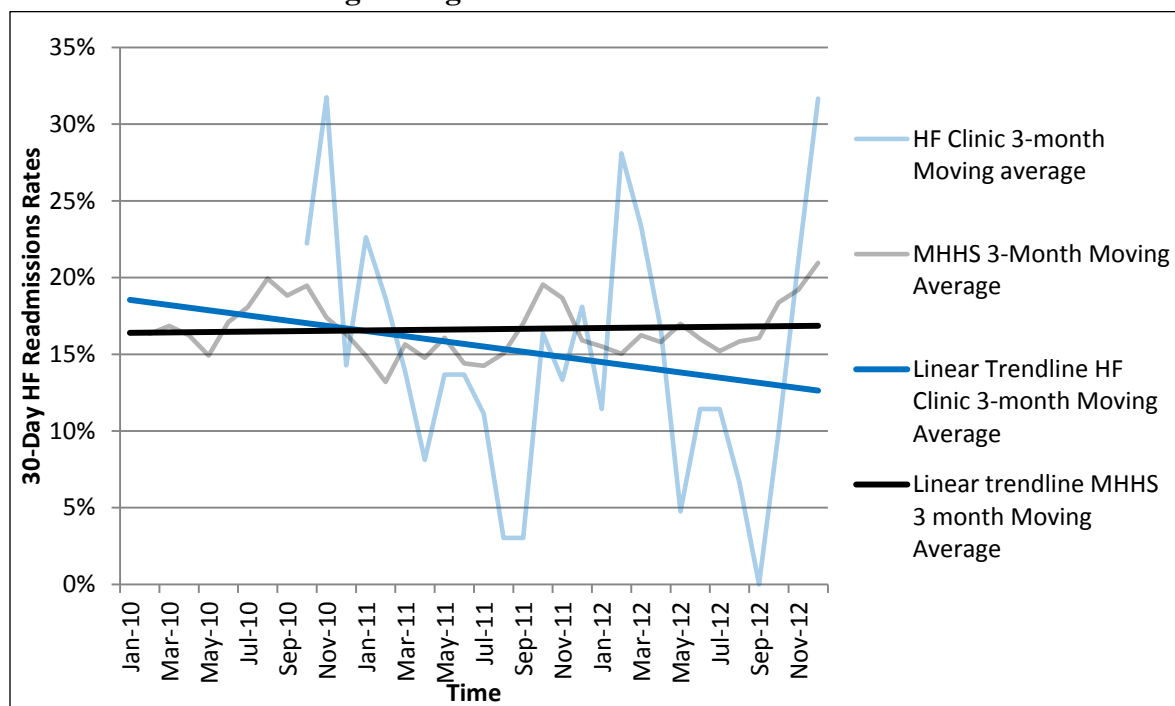
## Table 8: Base Clinic Model Assumptions

| Base Clinic Model Assumptions | |
|---|---|
| **Patient Volumes** | |
| Patients with heart failure DRGs 491, 492, 493 discharged (FY12 Data) | 420 |
| Number of patients monthly with primary diagnosis of heart failure | 35 |
| Of these patients, Medicare Discharges | 82% |
| Estimated visits/pt annually | 2 |
| Estimated percentage of referrals based on MD survey | 100% |
| Estimated compliance with recommended visit rate | 100% |
| | |
| **Revenues** | |
| Low and Medium Level Visit (CPT 99211,99212 and 99213) | $62.80 |
| High Level Visit (CPT 99214) | $94.89 |
| Estimated ratio of low/medium to high visits | 66% |
| Average revenue | $63.62 |
| Lab reimbursement for BNP | $11.63 |
| Current MC 30-Day HF readmission rate | 21.6% |
| Average direct cost per admission | $4,326 |
| Expected reduction in HF readmission rates (relative) | 16.41% |
| | |
| **Labor Costs** | |
| Average minutes spent per visit | 45 |
| # of visits that can be seen/hr by one RPh | 1.333333333 |
| # visits projected per week | 16 |
| Number of hours needed per week | 12.1 |
| Salary of Pharmacist/hr | $52.50 |
| Benefits | 25% |
| | |
| **Other Operating costs** | |
| Clinicstation software licensing | $0 |
| Cartridges - Heart Failure each/Chem8+ | $23.76 |
| | |
| **Clinic Set-Up Costs** | |
| Laptop | $1,431.50 |
| Monitor stand | $68.50 |
| Docking station | $56.75 |
| Printer | $250 |
| Data ports | $300 |
| Cables for data ports | $450 |
| iStat monitoring device | $10,000 |
| Microsoft office license | $365 |

**Table 9: Cost-Benefit Analysis of MHMC Clinic Model (Base Model)**

| MHMC HF Clinic January 2013 | Projected FY2014 | Projected FY2015 |
|---|---|---|
| Estimated Patient Visits | 840 | 840 |
| **REVENUE PROJECTIONS** | | |
| Medicare Reimbursement | | |
| Facility fees | $53,439 | $53,439 |
| Laboratory fees | $9,769 | $9,769 |
| Revenue from reimbursements | $63,209 | $63,209 |
| HF 30-day Readmissions cost savings | | |
| 30-day HF Readmissions Cost Savings | $64,402 | $64,402 |
| **Total Revenue** | **$127,611** | **$127,611** |
| **COST PROJECTIONS** | | |
| Clinic Annual Operating Costs | | |
| Total Salary (0.3 FTE) | $41,344 | $41,344 |
| ClinicStation licensing | $0 | $0 |
| Cartridges - Heart Failure | $19,958 | $19,958 |
| Additional Supplies | $1,000 | $1,000 |
| Total Operating Costs | $62,302 | $62,302 |
| Clinic Set-Up Costs | | |
| Computer - laptop | $1,557 | $0 |
| Printer | $250 | $0 |
| Data ports | $1,050 | $0 |
| iStat | $10,000 | $0 |
| Microsoft office | $365 | $0 |
| Total Set-Up Costs | $13,222 | $0 |
| **Total Costs** | **$75,524** | **$62,302** |
| **INVESTMENT RETURN** | | |
| Total Clinic Revenue | $127,611 | $127,611 |
| Total Expenses | $75,524 | $62,302 |
| **Benefit** | **$52,088** | **$65,310** |
| **Revenue/Expense Ratio** | **1.7** | **2.0** |

## Table 10: Clinic Model Scenarios

| | MHMC Base case | Scenario 1 (Volume variance) | Scenario 2 (Readmission variance) | Scenario 3 (FTE variance) | Scenario 4 (Av. Time spent variance) |
|---|---|---|---|---|---|
| Number of annual patient visits | 840 | 420 | 840 | 2774 | 840 |
| Number of FTE | 0.3 | 0.15 | 0.3 | 1.0 | 0.2 |
| Relative decrease in 30-day readmissions | 16.41% | 16.41% | 8.20% | 16.41% | 16.41% |
| Average time per visit | 45 | 45 | 45 | 45 | 30 |
| **Revenue Impact (First Year)** | **MHMC Base case** | **Scenario 1** (Volume variance) | **Scenario 2** (Readmission variance) | **Scenario 3** (FTE variance) | **Scenario 4** (Av. Time Spent variance) |
| Revenue from reimbursements | $63,209 | $31,604 | $63,209 | $208,744 | $63,209 |
| 30-day HF Readmissions Cost Savings | $64,402 | $32,201 | $32,181 | $212,679 | $64,402 |
| Total Annual Operating Costs | $62,302 | $31,651 | $62,302 | $203,443 | $48,521 |
| Total Set-Up Costs | $13,222 | $13,222 | $13,222 | $13,222 | $13,222 |
| Return on Investment | $52,088 | $18,933 | $19,868 | $204,758 | $65,869 |
| Revenue/Expense Ratio | **1.7** | **1.4** | **1.3** | **2.0** | **2.0** |

| | | | | | |
|---|---|---|---|---|---|
| ***Break-even Analysis*** | | *180 annual visits* | *3.3% relative* | | |

## Table 11: Post-Hoc Power Analysis

| | |
|---|---|
| Alpha error | 0.0500  (two-sided) |
| Beta error | 0.9000 |
| MHHS  cohort mean1 | 16.2 |
| HF Clinic mean2 | 13.54 |
| MHHS Standard deviation sd1 | 3.16 |
| HF Clinic standard deviation sd2 | 17.79 |
| n2/n1 | 1.00 |
| Estimated required sample sizes:<br>n1 =    485<br>n2 =    485 | |