Supplementary Table 1: Patterns of Medication use prior to and during hospitalization

|  |  |  |
| --- | --- | --- |
|   | **Angiotensin Converting Enzyme Inhibitor/Angiotensin Receptor Blocker Therapy Group** |   |
|  | **Continued ACEI/ARB Therapy** | **New Initiation of ACEI/ARB** | **Discontinue ACEI/ARB** | **No Therapy** | **p** |
| **Home Heart Failure Medical Therapy** |
| Beta-Blocker |  1491 (86.9)  |  220 (37.0)  | 642 (89.5)  | 405 (64.7)  | <0.001 |
| Mineralocorticoid receptor Antagonist |  515 (30.0)  |  43 (7.2)  | 205 (28.6)  | 107 (17.1)  | <0.001 |
| Loop Diuretic |  1701 (99.2)  |  584 (98.3)  | 633 (88.3)  | 570 (91.1)  | <0.001 |
| Thiazide-type Diuretic |  291 (17.0)  |  73 (12.3)  | 174 (24.3)  | 129 (20.6)  | <0.001 |
| Angiotensin Converting Enzyme Inhibitor |  1332 (77.7)  | NA | 536 (74.8)  | NA | <0.001 |
| Outpatient ACEI Equivalent Dose mg (mean (SD)) |  19.89 (14.61) | NA |  17.22 (13.85) | NA | <0.001 |
| Angiotensin Receptor Blocker |  429 (25.0)  | NA | 200 (27.9)  | NA | <0.001 |
| Outpatient ARB Equivalent Dose mg (mean (SD)) |  62.65 (36.68) | NA |  52.38 (32.35) | NA | 0.001 |
|  |
| **HF Medical Therapy prescribed during inpatient Stay** |
| Beta Blocker |  404 (23.6) |  144 (24.2) | 182 (25.4)  | 165 (26.4) | 0.509 |
| Mineralocorticoid Receptor Antagonist |  140 (8.2)  |  25 (4.2)  |  34 (4.7)  |  39 (6.2)  | 0.001 |
| Loop Diuretic |  1701 (99.2)  |  584 (98.3)  | 633 (88.3)  | 570 (91.1)  | <0.001 |
| Thiazide-type Diuretic |  291 (17.0)  |  73 (12.3)  | 174 (24.3)  | 129 (20.6)  | <0.001 |
|  |
| **Inpatient ACEI/ARB use** |
| First ACEI/ARB used N (%) |   |   |  |  |  NA |
| ACEI To ARB |  15 (0.9)  |  11 (1.9)  | NA | NA |  |
| ACEI |  1268 (73.9)  |  506 (85.2)  | NA | NA |  |
| ARB |  432 (25.2)  |  77 (13.0)  | NA | NA |  |
|   |  |  |  |  |  |
| First Inpatient ACEI Equivalent Dose mg (mean (SD)) | 13.32 (12.75) | 7.50 (7.26) | NA | NA | <0.001 |
| Maximum Inpatient ACEI Equivalent Dose mg (mean (SD)) | 14.39 (13.14) | 9.18 (8.68) | NA | NA | <0.001 |
| Last Inpatient ACEI Equivalent Dose mg (mean (SD)) | 13.07 (12.53) | 7.98 (8.39) | NA | NA | <0.001 |
| First Inpatient ARB Equivalent Dose mg (mean (SD)) | 43.04 (30.98) | 36.84 (24.11) | NA | NA | 0.408 |
| Maximum Inpatient ARB Equivalent Dose mg (mean (SD)) | 46.52 (32.26) | 40.79 (27.90) | NA | NA | 0.467 |
| Last Inpatient ARB Equivalent Dose mg (mean (SD)) | 44.13 (30.59) | 36.84 (24.11) | NA | NA | 0.325 |
|   |  |  |  |  |  |
| ***Inpatient to Outpatient Dose Relationship*** |  |  |  |  | NA |
|  No Change | 486 (36) | NA | NA | NA |  |
|  Decrease | 194 (14.4) | NA | NA | NA |  |
|  Increase | 670 (49.6) | NA | NA | NA |  |
| Days to First ACEI/ARB (mean (SD)) | 1.57 (2.18) | 2.42 (2.83) | NA | NA | <0.001 |
| Number of days on first dose before first change in dose (mean (SD)) | 1.28 (2.2) | 1.09 (1.78) | NA | NA | 0.273 |
| Days from last dose to Discharge (mean (SD)) | 1.06 (3.20) | 1.28 (4.54) | NA | NA | 0.196 |
| Total Number of inpatient Days on ACEI/ARB (mean (SD)) | 4.93 (3.62) | 5.12 (4.43) | NA | NA | 0.298 |
| Average Change in ACEI/ARB Dose during inpatient stay (mean (SD)) | -1.38 (9.79) | -1.41 (11.12) | NA | NA | 0.874 |
|   |
| **Discharge GDMT Use** |
| Any ACEI/ARB/ARNI outpatient prescription within 7d of discharge | 691 (40.3) | 353 (59.4) | 92 (12.8) | 46 ( 7.3) | <0.001 |
| Alternate definition of discharge – including those who were on it on last day despite no outpatient Rx found.  | 1487 (86.7) | 518 (87.2) | 92 (12.8) | 46 (7.3) | <0.001 |
| Beta-blocker | 1505 (87.8) | 482 (81.1) | 548 (76.4) | 439 (70.1) | <0.001 |
| Mineralocorticoid Receptor Antagonist | 663 (38.7) | 180 (30.3) | 209 (29.1) | 125 (20.0) | <0.001 |
|   |
| **Logistic regression Predicting Continuation or Initiation of ACEI/ARB therapy** |
| Admission parameters | OR | 2.50% | 97.50% |  |
| Creatinine (per unit increase) | 0.51 | 0.46 | 0.57 |  |
| Systolic BP (per unit increase) | 1.01 | 1.00 | 1.02 |  |
| Diastolic BP (per unit increase) | 0.99 | 0.98 | 1.01 |  |
| Potassium (per unit increase) | 0.97 | 0.90 | 1.05 |  |
| Age at admission (per year increase) | 0.98 | 0.97 | 0.99 |  |
|   |
| **Contraindications and Patterns of ACEI/ARB use** |
| ACEI/ARB use status |
| Contraindication to ACEI/ARB on admission | Continued ACEI/ARB | Initiated ACEI/ARB | Discontinued ACEI/ARB | No Therapy |  |
| No contraindication |  1545 (90.1)  |  542 (91.2)  |  493 (68.8)  |  464 (74.1)  | <0.001 |
|   |  |  |  |  |  |
| contraindication to ACEI/ARB on discharge | no ACEI/ARB/ARNI on discharge | discharged on ACEI/ARB/ARNI |  |  | <0.001 |
| with contraindication | 337 (72.9) | 168 (27.1) |  |  |  |
| No contraindication | 992 (36.3) | 2155 (63.7) |  |  |  |
|   |  |  |  |  |  |
| 1Contraindications (any): Potassium > 5 meq/L; Systolic Blood Pressure < 90 mmHg; Serum creatinine > 2.5mg/dl (at admission) or estimated glomerular filtration rate < 25 ml/min/1.73m2 (at discharge). |

ACEI-angiotensin converting enzyme inhibitor, ARB-angiotensin receptor blocker, ARNI-angiotensin receptor neprilysin inhibitor, BP-blood pressure, SD-standard deviation

Supplementary Table 2. Inpatient laboratory and clinical parameters

|  |  |  |
| --- | --- | --- |
|   | **Angiotensin Converting Enzyme Inhibitor/Angiotensin Receptor Blocker Therapy Group** |   |
|  | **Continue ACEI/ARB**  |  **Initiate ACEI/ARB** | **Discontinue ACEI/ARB** | **No Therapy** | **p value** |
| **N** | 1715 | 594 | 717 | 626 |   |
| **Blood Pressure (mmHg)**  |
| ***Systolic Blood Pressure, mean (SD)*** |
|  First Inpatient Value | 130.56(21.33) | 131.34(18.40) | 128.89(21.85) | 130.53(21.79) | 0.113 |
|  Value at First  ACEI/ARB during  Admission | 125.47(19.35) | 124.38(19.57) | NA | NA | 0.272 |
|  Value at First Change  of ACEI/ARB dose | 125.66(21.39) | 123.48(20.33) | NA | NA | 0.236 |
|  Last Inpatient Value | 119.12(17.73) | 117.21(17.9) | 118.76(17.9) | 119.05(19.05) | 0.659 |
|  Minimum Inpatient  value | 109.95(17.28) | 108.74(17.42) | 109.57(17.12) | 109.78(18.16) | 0.875 |
|    |
| ***Diastolic Blood Pressure, mean (SD)*** |
|  First Inpatient Value | 77.18(13.37) | 79.68(13.31) | 77.08(13.31) | 77.28(14.12) | 0.141 |
|  Value at First  ACEI/ARB during  Admission | 74.54 (11.33) | 74.03 (11.99) | NA | NA | 0.389 |
|  Value at First Change  of ACEI/ARB dose | 74.60 (12.27) | 74.28 (12.60) | NA | NA | 0.762 |
|  Last Inpatient Value | 70.24 (10.44) | 69.08 (10.82) | 70.15 (10.36) | 69.63 (10.95) | 0.356 |
|  Minimum Inpatient  value | 64.66 (9.58) | 64.49 (10.13) | 64.58 (9.91) | 64.04 (10.11) | 0.484 |
|  |
| **Laboratory Values**  |
| ***Creatinine (mg/dl)*** |   |   |   |   |   |
|  First Inpatient Value | 1.38 (0.56) | 1.27 (0.55) | 1.93 (0.82) | 1.83 (0.92) | <0.001 |
|  Value at First  ACEI/ARB during  Admission | 1.34 (0.53) | 1.24 (0.51) | NA | NA | <0.001 |
|  Value at First Change  of ACEI/ARB dose | 1.31 (0.46) | 1.20 (0.45) | NA | NA | 0.004 |
|  Last Inpatient Value | 1.36 (0.51) | 1.23 (0.57) | 1.56 (0.75) | 1.61 (0.90) | <0.001 |
|  Minimum Inpatient  value | 1.65 (0.74) | 1.51 (0.69) | 2.27 (0.99) | 2.19 (1.15) | <0.001 |
| ***Renal Changes prior to and during hospitalization*** |   |  <0.001 |
|  WRF-A | 66 (3.8) | 38 (6.4) | 106 (14.8) | 56 (8.9) |  |
|  WRF-H   | 624 (36.4) | 190 (32.0) | 349 (48.7) | 284 (45.4) |  |
|  Stable Renal Function | 1025 (59.8) | 366 (61.6) | 262 (36.5) | 286 (45.7) |  |
|  |
| ***Potassium (meq/L)*** |   |   |   |   |   |
|  First Inpatient Value | 4.11 (0.75) | 4.11 (0.73) | 4.17 (0.85) | 4.12 (0.95) | 0.402 |
|  Value at First  ACEI/ARB during  Admission | 4.00 (0.49) | 3.98 (0.48) | NA | NA | 0.451 |
|  Value at First Change  of ACEI/ARB dose | 4.00 (0.53) | 3.96 (0.57) | NA | NA | 0.294 |
|  Last Inpatient Value | 4.11 (0.55) | 4.10 (0.61) | 4.11 (0.55) | 4.11 (0.61) | 0.958 |
|  Minimum Inpatient  value | 4.62 (0.51) | 4.66 (0.49) | 4.72 (0.61) | 4.73 (0.60) | 0.003 |
|  |
| ***Natriuretic peptide monitoring during inpatient Stay*** |
|  Any | 1583 (92.3) | 551(92.8) | 631 (88) | 556 (88.8) | <0.001 |
|   |  |  |  |  | 0.004 |
|  With BNP | 939 (59.3) | 322 (58.4) | 420 (66.6) | 322 (58.0) |   |
|  With NT-pro BNP  | 644 (40.7) | 229 (41.6) | 211 (33.4) | 234 (42.1) |   |
|   |   |   |   |   |   |
| ***NT-proBNP (pg/ml): mean (SD)*** |
|  First Value | 10407.30 (11789.50) | 9590.84 (9499.85) | 12119.57 (14984.77) | 12779.96 (15280.45) | 0.015 |
|  Last Value | 9277.68 (10902.56) | 8783.02 (9099.79) | 11954.31 (14956.30) | 12926.01 (18993.89) | <0.001 |
|  Percent Change During Admission (Median (25th, 75thpercentile) | --35.03 (-58.74, -4.06) | -29.21 (-68.20, 0.00) | 0.00 (-26.27, 11.11) | -7.92 (-37.64, 16.32) | <0.001 |
|   |   |   |   |   |   |
| ***BNP (pg/ml): mean (SD)***  |   |   |   |   |
|  First Value |  1930.86 (4535.37) | 1964.01 (4727.27) |  2571.40 (7154.67) |  2199.44 (5106.87) | 0.206 |
|  Last Value |  1893.30 (4564.22) | 1799.87 (4733.02) |  2611.02 (7305.38) |  2283.11 (5650.06) | 0.095 |
|  % change during admission (median (25th, 755th percentiles)) |  -20.46 (-50.01, 5.59) | -31.65 (-58.25, 8.94) | -7.87 (-39.03, 25.66) | -15.84 (-42.57, 11.42) | 0.023 |
|   |   |   |   |   |   |
|  % change of any BNP  during admission  (mean (SD)) |  -18.61 (55.69) |  -21.26 (47.49) |  7.77 (97.66) |  -5.65 (70.71) | <0.001 |
|  Any BNP % Δ category  |   |   |   |   | <0.001 |
|  Decrease <50% |  127 (29.3)  |  51 (32.5)  |  29 (15.3)  |  28 (17.3)  |  |
|  Decrease >50% |  195 (45.0)  |  64 (40.8)  |  80 (42.3)  |  74 (45.7)  |  |
|  Increase/No-Change |  111 (25.6)  |  42 (26.8)  |  80 (42.3)  |  60 (37.0)  |  |
|   |   |   |   |   |   |
| **Weight Changes during Admission (Pounds)** |
|  First (mean (SD)) |  219.59 (59.63) |  205.46 (55.04) | 209.52 (54.69) |  197.67 (50.81) | <0.001 |
|  Change in Weight during admission (mean (SD)) |  -9.06 (13.04) |  -10.62 (15.13) | -8.07 (12.35) |  -7.86 (12.10) | 0.001 |
| **Categorical Weight Change During Admission (N (%))** |  0.002  |
|  Increase in Weight or No Change |  853 (51.0)  |  256 (44.2)  |  333 (47.9)  |  297 (49.0)  |  |
|  Decrease 0-13 lbs |  467 (27.9)  |  186 (32.1)  |  176 (25.3)  |  150 (24.8)  |  |
|  Decrease >13lb |  353 (21.1)  |  137 (23.7)  |  186 (26.8)  |  159 (26.2)  |  |
|   |
| **Decongestion and renal function changes combined categories** | <0.001 |
|  Reduction in weight +  No WRF | 889 (53.1)  | 320 (55.3)  | 310 (44.6)  | 288 (47.5)  |   |
|  Reduction in weight +  WRF | 431 (25.8)  | 122 (21.1)  | 199 (28.6)  | 159 (26.2)  |   |
|  No Reduction/Gain in weight + No WRF | 246 (14.7)  |  98 (16.9)  | 126 (18.1)  |  96 (15.8)  |   |
|  No Reduction/Gain in  weight + WRF | 107 (6.4)  |  39 (6.7)  |  60 (8.6)  |  63 (10.4)  |   |
|  |
| **Among Patients who continued or started ACEI/ARB in inpatient stay: Physiologic Parameters based on direction of first dose change during inpatient stay (mean (SD))** | **Creatinine (mg/dl)** | **Potassium (meq/L)** | **Systolic Blood Pressure (mmHg)** | **Diastolic Blood Pressure (mmHg)** |   |
|  Decrease in Dose | 1.28 (0.63) | 3.93 (0.69) | 122 (18.3) | 75.1 (14.2) |   |
|  Increase in Dose | 1.28 (0.52) | 4.01 (0.4) | 116 (15.8) | 70.1 (12.5) |   |

ACEI-angiotensin converting enzyme inhibitor, ARB-angiotensin receptor blocker, SD-standard deviation, NT-proBNP – N terminal pro brain natriuretic peptide, BNP-brain natriuretic peptide, WRF-A-worsening renal function on admission, WRF-H-worsening renal function hospitalization

Supplementary Figure 1: Flow diagram

\*Heart Failure. Admissions could be within the VA system or outside. Non-VA hospital admission for ADHF was captured if patient utilized VA payment for this non-VA hospitalization.

37,374 total visits for Acute HF\* in 2016 in 26091 unique patients.

8312 (31%) removed for inpatient stay < 48 hours

13938 with acute HF diagnosis in the 1st inpatient header position.

5972 Acute on chronic systolic HF, acute systolic HF.

3779 with inpatient Serum creatinine values that are not missing.

2193 (8.4%) removed due to missing creatinine values

3652 after excluding 127 with eGFR < 15 or on dialysis.

Supplementary Figure 2. Algorithm for ACEI/ARB use in hospitalization for AHF

