**SUPPLEMENTARY TABLES**

**Ultrasensitive detection of minimal residual disease: methods and application to patients treated for early-stage breast cancer**

Supplementary Tables: 3

**Supplementary Table 1.** Patient-level clinicopathologic data.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Study ID** | **Age at Diagnosis** | **Tumor Grade** | **Stage** | **ER Status** | **HER2 Status** | **Distant Recurrence** | **Time from Surgery to Relapse (days)** | **Visceral** | **Non-visceral** |
| 05055\_2 | 58 | 3 | 3 | + | - | Yes | 3570 | Yes |   |
| 05055\_3 | 40 | 2 | 3 | - | - | No | NA |   |   |
| 05055\_4 | 41 | 1 | 3 | + | - | No | NA |   |   |
| 05055\_5 | 30 | 1 | 2 | + | - | Yes | 824 | Yes |   |
| 05055\_9 | 63 | NA | 2 | + | - | No | NA |   |   |
| 05055\_11 | 35 | 2 | 2 | + | - | Yes | 2877 | Yes |   |
| 05055\_17 | 64 | NA | 3 | + | - | No | NA |   |   |
| 05055\_18 | 50 | 1 | 3 | + | - | No | NA |   |   |
| 05055\_19 | 54 | 3 | 2 | - | - | No | NA |   |   |
| 05055\_22 | 49 | NA | 2 | + | - | No | NA |   |   |
| 05055\_23 | 52 | 3 | 3 | - | - | No | NA |   |   |
| 05055\_26 | 67 | NA | 2 | + | - | No | NA |   |   |
| 05055\_31 | 51 | NA | 2 | + | - | No | NA |   |   |
| 05055\_32 | 55 | 1 | 3 | + | - | No | NA |   |   |
| 05055\_33 | 34 | NA | 3 | + | - | Yes | 777 |   | Yes |
| 05055\_46 | 44 | 3 | 3 | - | - | No | NA |   |   |
| 05055\_48 | 50 | NA | 2 | + | - | No | NA |   |   |
| 05055\_49 | 47 | 3 | 2 | - | - | No | NA |   |   |
| 05055\_52 | 67 | NA | 3 | + | - | No | NA |   |   |
| 05055\_54 | 59 | 3 | 2 | - | - | No | NA |   |   |
| 05055\_57 | 44 | 3 | 2 | - | - | No | NA |   |   |
| 05055\_69 | 52 | NA | 3 | + | - | No | NA |   |   |
| 05055\_70 | 55 | 2 | 3 | + | - | No | NA |   |   |
| 05055\_73 | 48 | NA | 3 | - | + | Yes | 624 |   | Yes |
| 05055\_78 | 39 | NA | 3 | + | + | Yes | 637 |   |   |
| 05055\_81 | 32 | NA | 2 | + | - | Yes | NA |   | Yes |
| 05055\_88 | 48 | 3 | 3 | + | - | No | NA |   |   |
| 05055\_92 | 57 | NA | 2 | + | - | No | NA |   |   |
| 05055\_93 | 45 | 2 | 3 | - | - | Yes | 633 |   | Yes |
| 05055\_94 | 68 | NA | 3 | + | - | No | NA |   |   |
| 05055\_95 | 48 | NA | 3 | + | - | Yes | 907 |   | Yes |
| 05055\_106 | 53 | 3 | 2 | + | - | Yes | 690 |   |   |
| 05055\_109 | 31 | NA | 3 | + | - | Yes | 456 |   | Yes |
| 05055\_110 | 66 | NA | 2 | + | - | No | NA |   |   |
| 05055\_119 | 71 | NA | 2 | + | - | No | NA |   |   |
| 05055\_121 | 53 | NA | 2 | + | - | No | NA |   |   |
| 05055\_123 | 41 | 3 | 3 | + | - | No | NA |   |   |
| 05055\_124 | 52 | 3 | 3 | + | - | No | NA |   |   |
| 05055\_126 | 58 | 2 | 3 | + | - | Yes | 959 |   | Yes |
| 05055\_129 | 50 | 2 | 3 | + | - | Yes | 2001 |   |   |
| 05055\_131 | 45 | NA | 2 | + | - | No | NA |   |   |
| 05055\_135 | 46 | 2 | 3 | + | - | No | NA |   |   |
| 05055\_136 | 25 | NA | 3 | + | - | Yes | 1298 |   | Yes |
| 05055\_138 | 50 | 3 | 3 | - | - | Yes | 715 |   |   |
| 05055\_141 | 47 | 2 | 2 | + | - | Yes | 947 |   | Yes |
| 05055\_143 | 50 | 2 | 2 | + | - | Yes | 2645 | Yes |   |
| 05055\_144 | 51 | 3 | 2 | + | - | Yes | 1562 | Yes |   |
| 05055\_148 | 50 | NA | 2 | + | - | No | NA |   |   |
| 05055\_150 | 40 | NA | 2 | - | - | No | NA |   |   |
| 05055\_156 | 39 | 2 | 3 | + | - | Yes | 3971 |   |   |
| 05055\_157 | 46 | NA | 3 | - | - | No | NA |   |   |
| YWBC\_102 | 31 | 2 | 3 | + | - | No | NA |   |   |
| YWBC\_1033 | 25 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_1063 | 33 |   | 2 | - | - | No | NA |   |   |
| YWBC\_1074 | 29 | 3 | 1 | + | + | No | NA |   |   |
| YWBC\_1083 | 33 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_1114 | 36 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_1149 | 31 | 3 | 3 | + | - | Yes | 1790 | Yes |   |
| YWBC\_115 | 34 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_117 | 34 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_119 | 35 | 2 | 1 | + | - | Yes | 2797 | Yes |   |
| YWBC\_124 | 38 | 2 | 1 | + | + | No | NA |   |   |
| YWBC\_14 | 33 | 2 | 2 | + | + | Yes | 1575 |   |   |
| YWBC\_167 | 36 | 3 | 1 | + | - | Yes | 535 | Yes |   |
| YWBC\_189 | 34 | 3 | 2 | + | + | Yes | 1203 |   | Yes |
| YWBC\_202 | 34 | 3 | 1 | + | + | Yes | NA | Yes |   |
| YWBC\_208 | 27 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_21 | 29 | 3 | 2 | - | + | No | NA |   |   |
| YWBC\_213 | 32 | 2 | 2 | + | + | No | NA |   |   |
| YWBC\_228 | 33 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_23 | 36 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_244 | 35 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_253 | 33 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_26 | 34 | 3 | 1 | - | - | No | NA |   |   |
| YWBC\_260 | 31 | 3 | 1 | - | - | No | NA |   |   |
| YWBC\_27 | 36 | 3 | 1 | + | - | Yes | 1995 |   |   |
| YWBC\_29 | 34 | 3 | 1 | + | - | Yes | 981 |   |   |
| YWBC\_293 | 35 | 3 | 2 | + | + | No | NA |   |   |
| YWBC\_300 | 34 | 3 | 3 | - | - | No | NA |   |   |
| YWBC\_303 | 33 | 2 | 1 | + | + | No | NA |   |   |
| YWBC\_309 | 31 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_315 | 30 | 3 | 2 | - | - | Yes | 630 | Yes |   |
| YWBC\_342 | 31 | 3 | 1 | + | - | Yes | 1125 | Yes |   |
| YWBC\_359 | 35 | 3 | 1 | + | + | No | NA |   |   |
| YWBC\_36 | 30 | 2 | 1 | + | - | Yes | 813 | Yes |   |
| YWBC\_372 | 30 | 3 | 1 | - | - | No | NA |   |   |
| YWBC\_38 | 36 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_402 | 30 | 1 | 1 | + | - | No | NA |   |   |
| YWBC\_406 | 33 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_407 | 28 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_412 | 35 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_418 | 33 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_453 | 34 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_468 | 33 | 2 | 3 | + | - | No | NA |   |   |
| YWBC\_475 | 27 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_480 | 35 | 3 | 2 | + | + | Yes | 2932 | Yes |   |
| YWBC\_481 | 35 | 3 | 3 | + | + | No | NA |   |   |
| YWBC\_491 | 28 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_493 | 30 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_497 | 35 | 3 | 2 | + | + | No | NA |   |   |
| YWBC\_527 | 31 | 3 | 2 | + | + | No | NA |   |   |
| YWBC\_566 | 23 | 3 | 3 | + | - | No | NA |   |   |
| YWBC\_578 | 33 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_591 | 33 | 1 | 2 | + | - | No | NA |   |   |
| YWBC\_61 | 36 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_614 | 30 | 1 | 0 | + | - | No | NA |   |   |
| YWBC\_64 | 33 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_640 | 35 | 3 | 2 | + | + | No | NA |   |   |
| YWBC\_642 | 35 | 3 | 1 | + | - | No | NA |   |   |
| YWBC\_646 | 31 | 3 | 2 | + | + | No | NA |   |   |
| YWBC\_653 | 31 | 3 | 3 | + | + | Yes | 477 | Yes |   |
| YWBC\_663 | 35 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_667 | 35 | 3 | 3 | + | + | No | NA |   |   |
| YWBC\_669 | 35 | 3 | 2 | - | - | Yes | 602 |   |   |
| YWBC\_686 | 34 | 2 | 3 | + | - | Yes | 2503 |   |   |
| YWBC\_7 | 31 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_710 | 30 | 2 | 2 | + | + | No | NA |   |   |
| YWBC\_73 | 36 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_749 | 32 | 3 | 3 | + | + | No | NA |   |   |
| YWBC\_750 | 33 | 3 | 1 | + | + | No | NA |   |   |
| YWBC\_760 | 31 | 3 | 1 | + | - | No | NA |   |   |
| YWBC\_761 | 29 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_774 | 35 | 3 | 2 | + | - | No | NA |   |   |
| YWBC\_779 | 33 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_786 | 34 | 3 | 1 | + | - | No | NA |   |   |
| YWBC\_803 | 24 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_807 | 37 | 2 | 2 | + | + | No | NA |   |   |
| YWBC\_808 | 35 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_809 | 34 | 3 | 3 | - | - | Yes | 308 |   |   |
| YWBC\_813 | 31 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_844 | 30 | 3 | 1 | - | - | No | NA |   |   |
| YWBC\_857 | 27 | 3 | 1 | + | - | No | NA |   |   |
| YWBC\_879 | 24 | 3 | 2 | - | - | Yes | 197 |   |   |
| YWBC\_882 | 33 | 3 | 1 | + | - | No | NA |   |   |
| YWBC\_883 | 25 | 3 | 1 | - | - | No | NA |   |   |
| YWBC\_915 | 31 | 2 | 1 | + | - | No | NA |   |   |
| YWBC\_928 | 35 | 3 | 2 | + | - | Yes | 1413 | Yes |   |
| YWBC\_934 | 35 | 3 | 2 | - | - | No | NA |   |   |
| YWBC\_94 | 32 | 2 | 2 | + | - | No | NA |   |   |
| YWBC\_944 | 31 | 3 | 0 | - | + | No | NA |   |   |
| YWBC\_950 | 35 | 3 | 0 | + | indeterminate | No | NA |   |   |
| YWBC\_953 | 29 | 3 | 2 | - | - | No | NA |   |   |

**Supplementary Table 2.** Characteristics of the patients at baseline by MRD status. MRD-positive status indicates patients with at least one MRD-positive test.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristic** | **Total (n=142)** | **MRD-negative (n=129)** | **MRD-positive (n=13)** | **p-value** |
| **Age at diagnosis**median(range) | 35 (23-71) | 35 (25-71) | 34 (24-53) | 0.1480 |
| **Subtype n(%)**ER+ER+/HER2+HER2+TNBC | 86 (61)22 (15.49)3(2.11)31 (21.83) | 79(61.24)21(16.28)3(2.33)26 (20.16) | 7(53.85)1(7.69)0(0)5 (38.46) | 0.4262 |
| **Stage at diagnosis n(%)**0IIIIII | 3(2.11)32(22.54)68(47.89)39(27.46) | 3(2.33)28(21.71)63(48.84)35(27.13) | 0(0)4(30.77)5(38.46)4(30.77) | 0.7879 |
| **Grade at diagnosis n(%)****1****2****3****NA** | 7 (4.93)40(28.17)70 (49.29)24 (16.90) | 7 (5.4)37 (28.7)61 (47.3)23 (17.8) | 0 (0)3 (23.1)9 (69.2)1 (7.7) | 0.44 |
| **Adjuvant or Neo-adjuvant therapy n(%)****No****Yes****NE** | 11 (7.7)130 (91.6)1 (0.7) | 11 (8.5)117 (90.7)1 (0.8) | 0 (0)13 (100)0 (0) | 0.52 |
| **Endocrine Therapy n (%)****No****Yes** | 33 (23.4)108 (76.6) | 28 (21.7)100 (77.5) | 5 (38.5)8 (61.5) | 0.18 |
| **Radiation n(%)****No****Yes** | 38 (26.8)104 (73.2) | 36 (27.9)93 (72.1) | 2 (15.4)11 (84.6) | 0.33 |

**SupplementaryTable 3.** Lead Time. Time from a positive MRD test to clinical metastatic recurrence

|  |  |  |
| --- | --- | --- |
| **Patient ID** | **Lead Time (Days)** | **Lead Time (Months)** |
| **05055\_106** | 228 | 7.6 |
| 05055\_136 | 1177 | 39.2 |
| **05055\_141** | 833 | 27.8 |
| **05055\_93** | 524 | 17.5 |
| **YWBC\_27** | 567 | 18.9 |
| **YWBC\_29** | 918 | 30.6 |
| **YWBC\_315** | 568 | 18.9 |
| **YWBC\_342** | 1036 | 34.5 |
| **YWBC\_809** | 102 | 3.4 |
| **YWBC\_879** | 161 | 5.4 |

.