

Table S1 QC details in PA medical records

| Serial number | Diagnostic classification | Defect type | Defect detail   |
|---------------|---------------------------|-------------|---|
| 1             | CPA                       | Examination | Chest CT not done   |
| 2             | CPA                       | Diagnosis   | History of less than 3 months   |
| 3             | CPA                       | Treatment   | No antifungal therapy   |
| 4             | CPA                       | Treatment   | Itraconazole was not used as the antifungal drug of first choice  |
| 5             | ABPA                      | Treatment   | Unreasonable treatment of choice, no oral corticosteroids   |
| 6             | ABPA                      | Treatment   | No antifungal prescribed  |
| 7             | ABPA                      | Treatment   | Unreasonable treatment of choice, without itraconazole as antifungal drug of first choice   |
| 8             | CCPA                      | Examination | Chest CT not done   |
| 9             | CCPA                      | Treatment   | No antifungal prescribed  |
| 10            | CCPA                      | Treatment   | Itraconazole and Voriconazole were not used as antifungal drugs of first choice   |
| 11            | IPA                       | Treatment   | No antifungal prescribed  |
| 12            | IPA                       | Treatment   | Voriconazole not used as antifungal drug of Itraconazole was not used as the antifungal drug of first choice  |
| 13            | IPA                       | Treatment   | Echinocandins cannot be used as the first choice of treatment   |
| 14            | IA                        | Treatment   | When there is no contraindication, voriconazole is not selected as the drug of choice in patients with acquired immunodeficiency (HIV) and IA                   |
| 15            | IA                        | Treatment   | Did not switch to caspofungin when resistance to voriconazole developed in patients with parenchymal organ transplantation and IA                               |
| 16            | IA                        | Treatment   | In patients with IA treated with voriconazole, trough serum concentrations were not measured after 2 to 5 days of treatment                                     |
| 17            | IA                        | Treatment   | Patients with parenchymal organ transplantation and IA do not discontinue voriconazole and switch to caspofungin when they experience liver function impairment |
| 18            | CFPA                      | Examination | Chest CT not done   |
| 19            | CFPA                      | Diagnosis   | Lack of diagnostic evidence, severe fibrosis in at least two lobes  |
| 20            | SA                        | Examination | Chest CT not done   |
| 21            | AN                        | Examination | Chest CT not done   |
| 22            | AN                        | Diagnosis   | CT chest without visible nodule   |
| 23            | SAIA                      | Examination | Chest CT not done   |
| 24            | SAIA                      | Examination | Tissue microbiological test was not performed   |
| 25            | CNPA                      | Treatment   | No antifungal prescribed  |
| 26            | CNPA                      | Treatment   | voriconazole was not used as the antifungal drug of first choice  |

QC, quality control; PA, pulmonary aspergillosis; CPA, chronic pulmonary aspergillosis; ABPA, allergic bronchopulmonary aspergillosis; CCPA, chronic cavitary pulmonary aspergillosis; IPA, invasive pulmonary aspergillosis; IA, invasive aspergillosis; CFPA, chronic fiberoptic pulmonary aspergillosis; SA, simple pulmonary aspergillosis; AN, Aspergillus nodule; SAIA, subacute invasive aspergillosis; CNPA, chronic necrotizing pulmonary aspergillosis; CT, computed tomography.

**Table S2** Reference for quality control points

| Serial number | Guide details   | Reference guide                    |
|---------------|---|------------------------------------|
| 1             | The diagnosis of CPA requires a combination of characteristics: a consistent appearance in thoracic imaging (preferably by CT)  | 2015 ERS and ESCMID guideline [32] |
| 2             | The diagnosis of CPA requires a combination of characteristics: one or more cavities with or without a fungal ball present or nodules on thoracic imaging, either direct evidence of <i>Aspergillus</i> infection (culture or microscopy from biopsy) or an IgG antibody response to <i>Aspergillus</i> spp. and exclusion of alternative diagnoses (especially mycobacterial infection), all present for at least 3 months   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 3             | <i>Table 38</i>   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 4             | <i>Table 38</i>   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 5             | Corticosteroids are a cornerstone of therapy for exacerbations ( <i>Table 1</i> )   | 2016 IDSA guideline [5]            |
| 6             | <i>Table 1</i>  | 2016 IDSA guideline [5]            |
| 7             | <i>Table 1</i>  | 2016 IDSA guideline [5]            |
| 8             | 84. Oral itraconazole and Voriconazole are the preferred oral antifungal agents (strong recommendation; high-quality evidence); posaconazole is a useful third-line agent for those with adverse events or clinical failure (strong recommendation; moderate-quality evidence)  | 2016 IDSA guideline [5]            |
| 9             | 84. Oral itraconazole and Voriconazole are the preferred oral antifungal agents (strong recommendation; high-quality evidence); posaconazole is a useful third-line agent for those with adverse events or clinical failure (strong recommendation; moderate-quality evidence)  | 2016 IDSA guideline [5]            |
| 10            | 81. The diagnosis of CCPA requires: (i) 3 months of chronic pulmonary symptoms or chronic illness or progressive radiologic radiographic abnormalities, with cavitation, pleural thickening, pericavitary infiltrates, and sometimes a fungal ball; (ii) <i>Aspergillus</i> IgG antibody elevated or other microbiological data; and (iii) no or minimal immunocompromise, usually with one or more underlying pulmonary disorders. The <i>Aspergillus</i> IgG antibody test is the most sensitive microbiological test (strong recommendation; moderate-quality evidence). Sputum <i>Aspergillus</i> PCR testing is more sensitive than culture (weak recommendation; moderate-quality evidence) | 2016 IDSA guideline [5]            |
| 11            | 25. We recommend primary treatment with Voriconazole (strong recommendation; high-quality evidence)   | 2016 IDSA guideline [5]            |
| 12            | 25. We recommend primary treatment with Voriconazole (strong recommendation; high-quality evidence)   | 2016 IDSA guideline [5]            |
| 13            | 28. Combination antifungal therapy with Voriconazole and an echinocandin may be considered in select patients with documented IPA (weak recommendation; moderate-quality evidence)<br><br>29. Primary therapy with an echinocandin is not recommended (strong recommendation; moderate-quality evidence). Echinocandins (micafungin or caspofungin) can be used in settings in which azole and polyene antifungals are contraindicated (weak recommendation; moderate-quality evidence)   | 2016 IDSA guideline [5]            |
| 14            | <i>Table 32</i>   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 15            | <i>Table 32</i>   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 16            | All patients receiving Voriconazole prophylaxis for IA, Measure serum trough level after 2–5 days of therapy or soon after, and 4 days after change of dose   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 17            | <i>Table 32</i>   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 18            | Severe fibrotic destruction of at least two lobes of lung complicating CCPA leading to a major loss of lung function. Severe fibrotic destruction of one lobe with a cavity is simply referred to as CCPA affecting that lobe. Usually the fibrosis is manifest as consolidation, but large cavities with surrounding fibrosis may be seen  | 2016 IDSA guideline [5]            |
| 19            | Severe fibrotic destruction of at least two lobes of lung complicating CCPA leading to a major loss of lung function. Severe fibrotic destruction of one lobe with a cavity is simply referred to as CCPA affecting that lobe. Usually the fibrosis is manifest as consolidation, but large cavities with surrounding fibrosis may be seen  | 2016 IDSA guideline [5]            |
| 20            | Single pulmonary cavity containing a fungal ball, with serological or microbiological evidence implicating <i>Aspergillus</i> spp. in a non-immunocompromised patient with minor or no symptoms and no radiological progression over at least 3 months of observation   | 2016 IDSA guideline [5]            |
| 21            | <i>Aspergillus</i> nodules, which may be single or multiple, may mimic malignancy as well as nodules seen in rheumatoid arthritis, coccidioidomycosis, tuberculosis, non-tuberculous mycobacterial infection and, rarely, actinomycosis or rheumatoid arthritis. Typically, <i>Aspergillus</i> nodules appear rounded, some with low attenuation or cavitation within. Some are spiculated, a common feature of carcinoma   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 22            | <i>Aspergillus</i> nodules, which may be single or multiple, may mimic malignancy as well as nodules seen in rheumatoid arthritis, coccidioidomycosis, tuberculosis, non-tuberculous mycobacterial infection and, rarely, actinomycosis or rheumatoid arthritis. Typically, <i>Aspergillus</i> nodules appear rounded, some with low attenuation or cavitation within. Some are spiculated, a common feature of carcinoma   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 23            | SAIA should be diagnosed according to established definitions of invasive aspergillosis in immunocompromised patients (or highly debilitated patients), with a slower course than acute invasive aspergillosis (1–3 months), and commonly with both detectable <i>Aspergillus</i> antibody and antigen in the serum. Histological confirmation derives from seeing hyphae invading lung parenchyma  | 2016 IDSA guideline [5]            |
| 24            | SAIA should be diagnosed according to established definitions of invasive aspergillosis in immunocompromised patients (or highly debilitated patients), with a slower course than acute invasive aspergillosis (1–3 months), and commonly with both detectable <i>Aspergillus</i> antibody and antigen in the serum. Histological confirmation derives from seeing hyphae invading lung parenchyma  | 2015 ERS and ESCMID guideline [32] |
| 25            | Voriconazole preferred for CNPA and patients with fungal balls to minimize risk of resistance; Voriconazole Start 150–200 mg bid, adjust with TDM   | 2017 ESCMID-ECMM-ERS guideline [6] |
| 26            | Voriconazole preferred for CNPA and patients with fungal balls to minimize risk of resistance; Voriconazole Start 150–200 mg bid, adjust with TDM   | 2017 ESCMID-ECMM-ERS guideline [6] |

CPA, chronic pulmonary aspergillosis; CT, computed tomography; CCPA, chronic cavity pulmonary aspergillosis; PCR, polymerase chain reaction; IPA, invasive pulmonary aspergillosis; IA, invasive aspergillosis; SAIA, subacute invasive aspergillosis; CNPA, chronic necrotizing pulmonary aspergillosis; TDM, therapeutic drug monitoring.

**Table S3** PA medical records diagnostic coding reference

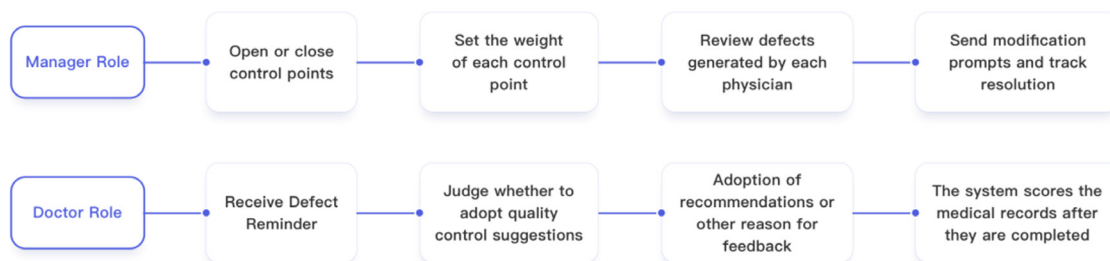
| Diagnostic classification | Term coding                              | Code source                |
|---------------------------|--|----------------------------|
| PA                        | B44                                      | ICD10                      |
| CPA                       | 733171006                                | SNOMED CT V20190131        |
| ABPA                      | B44.101+                                 | ICD10                      |
| CCPA                      | 733171006&2483006                        | SNOMED CT V20190131        |
| IPA                       | 3214003&2704003, 3214003&89187006, B44.0 | SNOMED CT V20190131, ICD10 |
| IA                        | 721798004                                | SNOMED CT V20190131        |
| CFPA                      | 733171006&112674009                      | SNOMED CT V20190131        |
| SA                        | 6042001&13673007                         | SNOMED CT V20190131        |
| AN                        | 6042001&27925004                         | SNOMED CT V20190131        |
| SAIA                      | 782761005                                | SNOMED CT V20190131        |
| CNPA                      | 782761005                                | SNOMED CT V20190131        |

PA, pulmonary aspergillosis; CPA, chronic pulmonary aspergillosis; ABPA, allergic bronchopulmonary aspergillosis; CCPA, chronic cavitary pulmonary aspergillosis; IPA, invasive pulmonary aspergillosis; IA, invasive aspergillosis; CFPA, chronic fiberoptic pulmonary aspergillosis; SA, simple pulmonary aspergillosis; AN, Aspergillus nodule; SAIA, subacute invasive aspergillosis; CNPA, chronic necrotizing pulmonary aspergillosis.

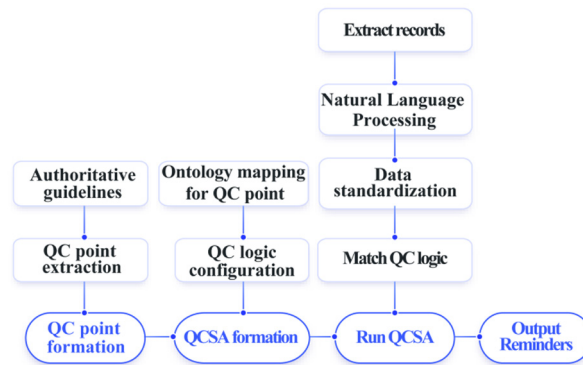
**Table S4** Results of manual verification of 200 medical records from QCSA

| Classification of PA | Number of QC points to be verified <sup>§</sup> | Number of medical records to be verified | Total number of QC points verification* |
|----------------------|---|--|---|
| ABPA                 | 3   | 37                                       | 111                                     |
| SA                   | 1   | 17                                       | 17                                      |
| IPA                  | 7   | 64                                       | 448                                     |
| CCPA                 | 3   | 19                                       | 57                                      |
| CFPA                 | 2   | 4  | 8                                       |
| CPA                  | 4   | 59                                       | 236                                     |
| Overall calculation  | 20  | 200                                      | 877                                     |

<sup>§</sup>, the number of quality control points to be verified included in QCSA for each diagnostic classification; \*, the result of multiplying the number of quality control points for each classification by the number of medical records that fit that classification. QCSA, quality control system for pulmonary aspergillosis; PA, pulmonary aspergillosis; QC, quality control; ABPA, allergic bronchopulmonary aspergillosis; SA, simple pulmonary aspergillosis; IPA, invasive pulmonary aspergillosis; CCPA, chronic cavitary pulmonary aspergillosis; CFPA, chronic fiberoptic pulmonary aspergillosis; CPA, chronic pulmonary aspergillosis.



**Figure S1** QCSA multi-role workflow. QCSA, quality control system for pulmonary aspergillosis.



**Figure S2** Approach to forming QCSA using guidelines. There are four steps in the construction of the QCSA. Step 1: PA clinical experts sort out the guidelines and select key diagnosis and treatment suggestions to form quality control points. Step 2: extract the nouns of diagnosis, treatment and examination that appear in the quality control points, map them to the ontology library for standardization, and then form a standardized quality control logic. Step 3: connect the QCSA with the hospital business system, extract the information from the electronic medical records, carry out entity identification and standardization mapping, and then match the quality control logic in QCSA to judge whether there is a defect. Step 4: if a defect is found, transfer this information to the page end and give the corresponding prompt. QCSA, quality control system for pulmonary aspergillosis.

**Table S5** Characteristics of PA medical records from 2015 to 2020 in the First Affiliated Hospital of Guangzhou Medical University

| Characteristics of PA medical records | Total PA medical records | Defective PA medical records |
|---------------------------------------|--------------------------|------------------------------|
| Number                                | 699                      | 162                          |
| Sex (M/F)                             | 460 (65.8%)/239 (34.2%)  | 112 (69.1%)/50 (30.9%)       |
| Median age                            | 56                       | 56                           |
| Median hospital stay                  | 8                        | 7                            |
| PA (unspecified)                      | 284                      | 0                            |
| IPA                                   | 132                      | 29                           |
| CPA                                   | 121                      | 84                           |
| ABPA                                  | 78                       | 34                           |
| CCPA                                  | 44                       | 9                            |
| SA                                    | 36                       | 10                           |
| CFPA                                  | 2                        | 2                            |
| Others*                               | 0                        | 0                            |

\*, others include AN, SAIA and CNPA. PA, pulmonary aspergillosis; IPA, invasive pulmonary aspergillosis; CPA, chronic pulmonary aspergillosis; ABPA, allergic bronchopulmonary aspergillosis; CCPA, chronic cavitary pulmonary aspergillosis; SA, simple pulmonary aspergillosis; CFPA, chronic fiberoptic pulmonary aspergillosis; AN, Aspergillus nodule; SAIA, subacute invasive aspergillosis; CNPA, chronic necrotizing pulmonary aspergillosis.

**Table S6** QCSA evaluation results of each classification

| Catalogue            | True positive | False positive | True negative | False negative | Precision | Recall | F1   |
|----------------------|---------------|----------------|---------------|----------------|-----------|--------|------|
| Classification of PA |               |                |               |                |           |        |      |
| ABPA                 | 19            | 0              | 90            | 2              | 1.00      | 0.90   | 0.95 |
| SA                   | 5             | 0              | 12            | 0              | 1.00      | 1.00   | 1.00 |
| IPA                  | 13            | 0              | 434           | 1              | 1.00      | 0.92   | 0.96 |
| CCPA                 | 5             | 0              | 35            | 17             | 1.00      | 0.23   | 0.37 |
| CFPA                 | 1             | 0              | 6             | 1              | 1.00      | 0.50   | 0.67 |
| CPA                  | 33            | 3              | 198           | 2              | 0.92      | 0.94   | 0.93 |
| Overall calculation  | 76            | 3              | 775           | 23             | 0.96      | 0.77   | 0.85 |
| QC Type              |               |                |               |                |           |        |      |
| Diagnosis            | 4             | 2              | 55            | 2              | 0.67      | 0.67   | 0.67 |
| Treatment            | 38            | 0              | 659           | 18             | 1.00      | 0.68   | 0.81 |
| Examination          | 34            | 1              | 61            | 3              | 0.97      | 0.92   | 0.94 |

QCSA, quality control system for pulmonary aspergillosis; PA, pulmonary aspergillosis; ABPA, allergic bronchopulmonary aspergillosis; SA, simple pulmonary aspergillosis; IPA, invasive pulmonary aspergillosis; CCPA, chronic cavitary pulmonary aspergillosis; CFPA, chronic fiberoptic pulmonary aspergillosis; CPA, chronic pulmonary aspergillosis; QC, quality control.

**Table S7** The overall evaluation results of QCSA

| Test indicators           | Values |
|---------------------------|--------|
| Specificity               | 0.77   |
| Sensitivity               | 0.99   |
| Positive predictive value | 0.96   |
| Negative predictive value | 0.97   |
| Precision                 | 0.96   |
| Recall                    | 0.77   |
| F1                        | 0.85   |

According to the results of confusion matrix in *Table 1*, we calculated the results of evaluation indicators. QCSA, quality control system for pulmonary aspergillosis.