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# Effect of a Knowledge-Based and Skills-Based Programme for Physicians on Risk of Sexually Transmitted Reinfections Among High-Risk Patients in China: a Cluster Randomised Trial

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# Effect of a knowledge-based and skills-based programme for physicians on risk of sexually transmitted reinfections among high-risk patients in China: a cluster randomised trial



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## Summary

**Background** China is experiencing growing epidemics of HIV and sexually transmitted infections (STIs). Programmes to train physicians in China on HIV and STI knowledge, diagnosis, treatment, and risk reduction counselling can potentially reduce HIV and STI risk among high-risk patients. We aimed to assess a knowledge-based and skills-based programme for physicians in China to reduce patients' STI risk.

**Methods** In this cluster randomised trial, we block randomised counties in two provinces in eastern China to intervention or control groups. In the intervention group, physicians from county general hospitals participated in a structured HIV and STI training programme and received opportunities to enhance their clinical and counselling skills, whereas in the control group, physicians from county hospitals received the training after the intervention group completed final assessments. We recruited STI patients from physicians in both groups, treated baseline gonorrhoea and chlamydia infections, and assessed 9-month gonorrhoea and chlamydia reinfection as the primary outcome. Statistical comparisons between intervention and delayed-control patients used multilevel analyses to account for cluster effects at county and physician levels. Analysis was by intention to treat. This study is registered with ClinicalTrials.gov, NCT00644150.

**Findings** Between April 1, 2007, and Sept 1, 2008, 51 counties were randomly assigned; 27 to receive immediate intervention and 24 to receive delayed intervention. 249 physicians from the 51 county-level hospitals were enrolled, 121 physicians in the intervention group and 128 in the control group. From these physicians, we enrolled 633 and 491 patients, respectively, of whom 508 (80%) and 402 (82%) were available for reassessment at 9 months. Intervention patients at follow-up had significantly lower odds of combined gonorrhoea or chlamydia reinfection than did control patients (58/508 [11%] vs 123/402 [31%]; adjusted odds ratio 0.62 [95% CI 0.46–0.84]).

**Interpretation** Integrating HIV and STI training into medical education in China could be an effective strategy to reduce the country's growing HIV risk and STI epidemics.

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## Introduction

HIV in China has evolved from an epidemic mainly associated with contaminated red-cell infusion after blood donation and injection drug use to an epidemic increasingly characterised by sexual transmission.<sup>1–4</sup> Although early HIV cases in China were geographically concentrated, during the previous decade the epidemic has spread throughout all of China's 31 provinces, autonomous regions, and municipalities (excluding Hong Kong, Macau, and Taiwan). The Chinese Government has responded to the growing epidemic with assertive public health policies, such as the 2006 AIDS Prevention and Control Regulations, which include initiatives to provide free antiretroviral treatment and HIV testing, support syringe distribution and drug treatment programmes, promote condom use, and reduce AIDS stigma.<sup>5–8</sup>

Implementation of China's national AIDS policies relies on physicians to deliver prevention and treatment

of HIV and sexually transmitted infections (STIs) in routine practice, including HIV testing, symptom diagnosis, treatment recommendations, and risk reduction counselling.<sup>9–11</sup> However, there are serious gaps in physicians' knowledge and skills in diagnosing and treating HIV and STIs.<sup>12–17</sup> Interventions to increase the ability of Chinese physicians to counsel and to treat patients at risk of HIV and STIs have shown improvements in physicians' HIV/STI knowledge and clinical skills at follow-up.<sup>18–20</sup> These studies have not, however, been tested using controlled designs or corroborated with patient-level outcomes. A recent randomised trial done in China showed the efficacy of an intervention to reduce physicians' stigmatising attitudes and behaviours towards people living with HIV,<sup>21</sup> suggesting that HIV/AIDS interventions targeting physicians can improve interactions with patients.

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See [Online](#) for a podcast interview with Thomas Coates

We assessed a knowledge and skills-based programme for physicians in China to reduce patients' HIV and STI risk. Physicians were trained in HIV and STI transmission, diagnosis, treatment, and patient-centred risk reduction counselling. The programme, entitled Ai Shi Zi (meaning "AIDS Plus" in Mandarin) views physicians as important agents of change to reduce HIV and STI transmission and risk behaviours among high-risk patients in China. The training curriculum is based on social learning theory, which emphasises interactive learning, modelling of behavioural skills, self-efficacy, goal setting, and knowledge as determinants of behaviour change.<sup>22</sup> We conducted the intervention in Anhui and Jiangsu, geographically contiguous provinces in eastern China. Both provinces have expanding HIV and STI epidemics, with unprotected sexual behaviour as a primary risk factor of transmission.<sup>23–25</sup> Our primary hypothesis was a reduction in STI reinfection (gonorrhoea and chlamydia) among patients of physicians who received the intervention compared with patients of physicians in a control group who received the intervention after a delay. We also hypothesised improvements in knowledge about HIV and STI transmission, attitudes, satisfaction with physicians, and condom use among patients in the intervention group compared with those in the control group.

## Methods

### Study design and participants

In this cluster-randomised trial, counties were assigned to intervention or control groups. Cluster randomisation was used to account for interaction, and potential contamination, among physicians within hospital settings. We contacted administrators of county-level general hospitals in Anhui and Jiangsu provinces to inform them about the study and to solicit their interest in allowing hospital physicians to participate. There was one general hospital per county. We randomly assigned counties to either the intervention group, in which groups of county-level general hospital physicians received the training immediately, or to the control group in which physicians received the training after physicians in the intervention counties completed the study; a delayed control group was deemed appropriate to ensure that all physicians enrolled in the study had access to the information provided in the training. The Ethical Review Boards of Anhui Medical University and UCLA approved the study, and we obtained written informed consent from all participants.

To recruit physicians, we enlisted the provincial health bureaus to issue a formal invitation to participating county general hospitals. The announcement specified the purposes of the project, physician eligibility criteria, the fact that participation was entirely voluntary, and that some counties would receive training immediately and that training for other counties would be delayed. Hospitals were not paid to participate. County-level physicians were eligible if they were employed at a

county-level general hospital; specialised in STIs, obstetrics, gynaecology, or HIV care; had a minimum 3 years of clinical experience; had ever treated patients with HIV or STIs; and were willing to complete the intervention training programme. All costs associated with transportation and lodging were paid for, but participating physicians were not given financial compensation for taking part in the intervention.

Research assistants recruited patients from waiting rooms of participating physicians. Between three and ten patients were recruited from each physician. Patients were informed about the study and those who expressed interest were asked to provide a urine sample to test for gonorrhoea and chlamydia and to return to the county hospital in 2 weeks for test results. All patients who tested positive received treatment free of charge regardless of enrolment, and those expressing continued interest were referred to a study intake coordinator. Patients were eligible if they tested baseline-positive for gonorrhoea or chlamydia, received treatment, were at least 18 years old, received patient services from a physician who participated in the training programme, and were not planning to relocate in the next 9 months.

Patients in the intervention group were recruited after their physicians had completed the final 9-month training assessment. Patients in the control group were recruited and completed their 9-month follow-up before their physicians started the training. Based on this design, patient group differences at 9-months' follow-up would reflect comparative effects between patients of physicians who received the training immediately (intervention group) versus patients of physicians who had not yet received the training (control group).

### Randomisation and masking

To minimise uneven distribution of STI prevalence between study groups, counties were rank-ordered within province by HIV and STI cases and stratified into four blocks, and we randomised counties within each block to immediate intervention or control. Randomisation was conducted by the project data coordinator based in Hefei, the capital of Anhui province, with a computer-generated randomisation sequence. Allocation of county to treatment group remained concealed until site investigators were ready to implement the training.

### Procedures

The Ai Shi Zi curriculum was developed by Chinese and international collaborators based on comprehensive literature reviews and consultation activities with local and national experts, in both the USA and China. The consultation meetings included discussions about Chinese national guidelines for HIV and STI treatment and infectious disease control, behavioural risk reduction strategies, and Chinese cultural issues that can affect communication with patients. The curriculum took into consideration the Chinese medical system by

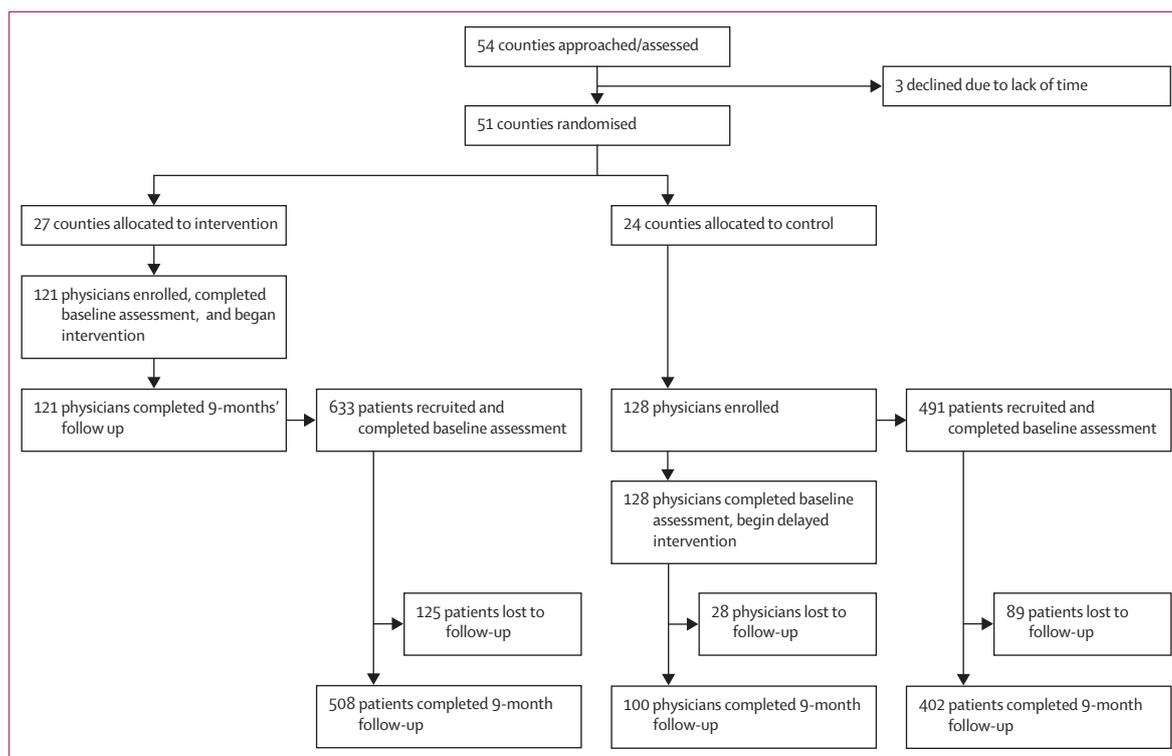


Figure: Trial profile

incorporating information related to the provincial health-care structures (eg, the organisation of local Centers for Disease Control and Prevention, county-level and township-level hospitals) and national AIDS policies such as access to testing and treatment.

The structure of Ai Shi Zi consisted of three major components: (1) an initial 1-week group training held in Hefei, Anhui Province, followed by (2) return to clinical practice for 2 months to implement new knowledge and skills, and (3) two additional two-day group “booster” training sessions (at about 3 months and 6 months after enrolment) held in Hefei. The initial group training covered: HIV and STI biology, pathology, and epidemiology; host immune response; opportunistic infection and syndrome management; antiretroviral therapy; STI treatments; behavioural risk reduction counselling; and stigma reduction. Training methods incorporated lectures, case studies, small group discussions, problem-solving exercises, and role plays. Patients with AIDS also gave presentations about their experiences living with the disease. After the 1-week session, participating physicians returned to their hospital-based clinic for 2 months to practise what they had learned, and were encouraged to maintain a journal describing the most difficult or instructive cases encountered during clinical practice, which they would discuss during follow-up intervention sessions. They then reconvened in Hefei for a 2-day workshop and practice booster session that focused on individual

presentations and case studies of difficult cases described in their journals, group problem solving, and feedback. Participant physicians returned again to their clinic for 2 months, maintaining a journal of difficult cases, and reconvened for a final 2-day workshop and practice booster session. Participant physicians completed a so-called closing ceremony, which acknowledged their participation and encouraged the integration of their knowledge and skills in clinical practice.

Participating physicians completed survey assessments at baseline, immediately before every booster session (3 months and 6 months, respectively), and at 9 months' follow-up. Survey assessments included self-report measures, previously validated with Chinese physicians,<sup>19</sup> of the following: knowledge of HIV biology, testing, and epidemiology (48 items); syndromic management (48 items); management of opportunistic infections (41 items); antiretroviral treatment (25 items), and behavioural risk reduction counselling (36 items).

Patients completed baseline and 9-month assessments. Baseline patient assessments included survey measures of HIV and STI knowledge (25-point scale with higher scores reflecting greater knowledge), attitudes towards people with HIV (12-point scale with higher scores reflecting more positive and less stigmatising attitudes), satisfaction with their physician (7-point scale with higher scores reflecting greater satisfaction), and whether they had unprotected sex during the past 6 months. Patient survey measures were previously validated with

patient samples in China.<sup>19</sup> At 9 months' follow-up, patients completed identical surveys and provided urine samples to retest for gonorrhoea and chlamydia. Urine samples were transferred to the central laboratory of Anhui Medical University. Biospecimen testing used the ligase chain reaction test (Abbott LCx assay; Abbott Laboratories, Abbot Park, IL, USA). Those testing positive were contacted and offered free treatment. A random sample of 10% of specimens was retested to check reliability.

### Outcomes

The primary outcomes were combined STI (gonorrhoea and chlamydia) reinfection rate at 9 months' follow-up and improvements in physician HIV/STI knowledge during follow-up. Secondary outcomes were patients' self-reported measures of STI knowledge, attitudes toward people with HIV, satisfaction with physician, and condom use during the past 6 months.

	Intervention (n=121)	Delayed control (n=128)
<b>Domain 1: HIV/STI biology, testing, and epidemiology (48 items)</b>		
Baseline	48.7% (23.4; 0.09)	48.4% (23.2; 0.09)
3 months	63.9% (30.7; 0.10)	61.3% (29.4; 0.10)
6 months	71.5% (34.3; 0.11)	74.9% (36.0; 0.11)
9 months	72.9% (35.0; 0.12)	79.5% (38.2; 0.12)
One-way ANOVA	F(3,360)=208.5; p=0.01	F(3,299)=527.0; p=0.01
<b>Domain 2: STI syndromic management (48 items)</b>		
Baseline	49.4% (23.7; 0.13)	50.2% (24.1; 0.14)
3 months	58.7% (28.2; 0.12)	66.3% (31.8; 0.15)
6 months	67.1% (32.2; 0.16)	79.1% (38.0; 0.17)
9 months	66.6% (32.0; 0.18)	80.5% (38.6; 0.16)
One-way ANOVA	F(3,360)=88.8; p=0.01	F(3,299)=515.9; p=0.01
<b>Domain 3: Management of opportunistic infections (41 items)</b>		
Baseline	38.1% (15.6; 0.11)	39.1% (16.0; 0.09)
3 months	60.3% (24.7; 0.18)	48.3% (19.8; 0.12)
6 months	64.4% (26.4; 0.16)	57.2% (23.4; 0.15)
9 months	64.3% (26.4; 0.17)	62.8% (25.8; 0.15)
One-way ANOVA	F(3,360)=118.8; p=0.01	F(3,299)=231.6; p=0.01
<b>Domain 4: Antiretroviral treatment (25 items)</b>		
Baseline	33.6% (8.40; 0.11)	34.8% (8.70; 0.10)
3 months	51.3% (12.8; 0.12)	42.7% (10.7; 0.15)
6 months	53.4% (13.3; 0.15)	48.2% (12.1; 0.17)
9 months	55.1% (13.8; 0.15)	52.2% (13.1; 0.18)
One-way ANOVA	F(3,360)=113.00; p=0.01	F(3,299)=81.2; p=0.01
<b>Domain 5: Risk reduction counselling (36 items)</b>		
Baseline	42.9% (15.5; 0.15)	40.9% (14.7; 0.14)
3-months	64.3% (23.4; 0.16)	66.1% (23.8; 0.17)
6-months	74.5% (26.8; 0.17)	83.3% (30.0; 0.14)
9-months	76.7% (27.6; 0.17)	90.4% (32.6; 0.09)
One-way ANOVA	F(3,360)=469.5; p=0.01	F(3,299)=785.8; p=0.01
Data are % correct (M items correct; SD). STI=sexually transmitted infection.		
<b>Table 1: Physician HIV/STI knowledge domains at baseline, 3 months', 6 months', and 9 months' follow-up by intervention (n=249)</b>		

### Statistical analysis

The sample size calculation was based on our primary hypothesis concerning patient outcomes. From preliminary data derived from our Ai Shi Zi pilot study, conducted in different Anhui counties from those included in this trial,<sup>19</sup> we hypothesised that patients in the intervention group would have a 30% reduction in combined STI reinfection compared with patients in the control group. With an estimated interclass correlation coefficient of 0.01 based on our pilot, this trial required a sample size of 480 patients per group to provide power of 0.80 at a significance of 0.05 to test our primary hypothesis. We planned to recruit four patients per physician, requiring 120 physicians per group.

To assess whether the intervention led to improvements in physicians' knowledge, we conducted one-way repeated measures ANOVAs to assess the number of items answered correctly for each physician knowledge domain (HIV/AIDS biology, testing, epidemiology; STI syndromic management; management of opportunistic infections; antiretroviral treatment; risk reduction counselling). We expected physicians in both intervention and control groups to show improvements at follow-up on all five knowledge domains.

Due to the hierarchical structure of the design (patients nested within physicians nested within counties), we used mixed effects multilevel logistic regression models for binary outcomes and ordinary least squares regression models for continuous outcomes to account for county-level and physician-level clustering. All regressions also adjusted for basic patient sociodemographic characteristics (sex, marital status, employment status). We calculated variance across county and physician levels according to the specified outcomes, and we undertook regression diagnostics, including calculating intraclass correlation values, to assess goodness of fit. We undertook regression analyses with an intention-to-treat approach and used the last observation carried forward technique to account for the 20% missing follow-up data on study outcomes. Data were analysed with Stata (version 11.1).

This study is registered with ClinicalTrials.gov, NCT00644150.

### Role of the funding source

The funder had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

### Results

Between April 1, 2007, and Sept 1, 2008, we approached 54 administrators of county-level general hospitals, of whom 51 (39 from Anhui province and 12 from Jiangsu province) expressed interest; three declined due to lack of time. 27 were randomly assigned to the intervention group and 24 to control. 249 physicians from the 51 county-level hospitals were enrolled. Of these, 121 physicians were in the intervention group, all of whom were reassessed at 9 months, and 128 physicians

	Combined STI		Gonorrhoea		Chlamydia	
	n/N (%)	AOR (95% CI)	n/N (%)	AOR (95% CI)	n/N (%)	AOR (95% CI)
Intervention	58/508 (11%)	0.62 (0.46–0.84)	44/508 (9%)	0.68 (0.49–0.60)	39/508 (8%)	0.79 (0.56–1.12)
Control	123/402 (31%)	1.00	92/402 (23%)	1.00	75/402 (19%)	1.00

Multilevel models adjusted for county and physician levels. STI=sexually transmitted infection.

**Table 2: Effects of intervention on STI (gonorrhoea or chlamydia) reinfection at 9 months' follow-up**

	Unprotected sex, past 6 months*	HIV knowledge	Attitudes towards people with HIV	Physician communication
<b>Study group</b>				
Intervention	0.10 (0.12 to 0.42)	2.13 (1.52 to 2.73)	1.51 (0.97 to 2.05)	0.22 (0.15 to 0.30)
Delayed control	1.00	1.00	1.00	1.00
<b>Sex</b>				
Male	1.32 (0.77 to 2.25)	0.07 (–0.46 to 0.59)	0.25 (–0.24 to 0.75)	0.03 (–0.01 to 0.07)
Female	1.00	1.00	1.00	1.00
<b>Marital status</b>				
Never married	1.00	1.00	1.00	1.00
Married	2.23 (1.36 to 3.65)	–1.04 (–1.58 to –0.50)	–0.79 (–1.31 to –0.28)	0.001 (–0.04 to 0.04)
Divorced or separated	0.48 (0.20 to 1.19)	–1.50 (–2.72 to –0.29)	–2.09 (–3.24 to –0.94)	–0.03 (–0.12 to 0.07)
Widowed	..	–3.45 (–6.23 to –0.67)	–0.14 (–2.78 to 2.48)	–0.07 (–0.25 to 0.12)
<b>Employment</b>				
Yes	0.85 (0.51 to 1.41)	0.64 (0.13 to 1.14)	–0.14 (–0.62 to 0.34)	0.01 (–0.02 to 0.05)
No	1.00	1.00	1.00	1.00

Data are \*AOR (95% CI) or adjusted  $\beta$  (95% CI). Multilevel models adjusted for county and physician levels. AOR=adjusted odds ratio.

**Table 3: Intervention effects on patient unprotected sex, HIV knowledge, attitudes towards people with HIV, and communication with physician**

were in the control group, of whom 100 (78%) were reassessed at 9 months (figure). No differences were noted in baseline measures between physicians who completed the 9-month assessment versus those who did not complete the 9-month assessment.

Table 1 shows descriptive physician scores on the five assessed HIV knowledge domains. Baseline knowledge scores did not differ between intervention and control groups. As expected, we noted improvements in both intervention group and control groups for all domains: HIV/STI biology, testing, and epidemiology ( $p=0.01$ ); STI syndromic management ( $p=0.01$ ); management of opportunistic infections ( $p=0.01$ ); antiretroviral treatment ( $p=0.01$ ); and risk reduction counselling ( $p=0.01$ ; table 1).

1124 patients were recruited from participating physicians. Of these, 862 (77%) were men, 1072 (95%) were of Han ethnicity, 878 (78%) were from Anhui province, 785 (70%) were educated below the high school level, 842 (75%) were currently employed, and 850 (76%) were married. No significant baseline differences in sociodemographic characteristics were noted between the intervention and control patients. Of 633 patients in the intervention group at baseline, 508 (80%) were reassessed at 9 months; of 491 patients in the control group at baseline, 402 (82%) were reassessed at 9 months. No significant sociodemographic differences

were noted between patients who completed versus those who did not complete the 9-month assessment.

At baseline, 910 (81%) of 1124 patients tested positive for gonorrhoea or chlamydia (or both): 508 (77%) of 663 in the intervention group and 402 (82%) of 491 in the control group. 838 (75%) of 1124 patients tested positive for gonorrhoea (475 [75%] of 633 patients in the intervention group vs 363 (74%) of 491 patients in the control group) and 598 (53%) of 1124 tested positive for chlamydia (356 [56%] of 633 patients in the intervention group vs 242 [49%] of 491 patients in the control group. Baseline group differences in patient gonorrhoea and chlamydia were not statistically significant; all patients who were infected with gonorrhoea and chlamydia at baseline were treated. At 9-month follow-up, after adjustment for county and physician levels, patients in the intervention group had significantly lower odds of combined STI (gonorrhoea or chlamydia) and gonorrhoea reinfection only at 9 months' follow-up (table 2). Group differences in 9-month chlamydia reinfection were not statistically significant (table 2).

Table 3 shows the effects of the intervention on patients' follow-up levels of unprotected sex during the past 6 months, HIV knowledge, attitudes towards people living with HIV, and physician communication. In multilevel regression, which adjusted for county and physician levels, we noted that patients in the intervention

group at follow-up were significantly less likely to report unprotected sex during the past 6 months than were control patients (426/508 vs 382/402; table 3). Intervention patients also had significantly higher HIV/STI knowledge scores (M=16.8 [SD 3.10]) compared with control patients (M=14.91 [SD 3.19]; table 3); and higher physician satisfaction (M=2.43 [SD 0.22]) compared with control patients (M=2.29 [SD 0.54]; table 3). Although not statistically significant, attitudes towards people living with HIV tended to be moderately more positive among intervention patients (M=8.50 [SD 3.43]) compared with control patients (M=7.15 [SD 3.10]; table 3). In these multilevel mixed-effects logistic models, which included county and physician levels, county level accounted for 19–26% of the total variance and physician level accounted for 17–20% of the total variance, depending on the choice of outcome. On the basis of these regression diagnostics and the ICC values, these models show reasonable goodness of fit.

No harms were reported during the conduct of this trial.

## Discussion

Training physicians in China on HIV and STI knowledge, treatment, and risk reduction counselling, and motivating them to integrate prevention and treatment into routine care resulted in lower reinfection with gonorrhoea and chlamydia in patients at 9 months (panel). Patients of physicians who received the training had 38% lower odds of combined gonorrhoea and chlamydia reinfection and 32% lower odds of gonorrhoea reinfection alone compared with patients of physicians in the delayed control. The protective intervention effect trend for chlamydia reinfection alone was not statistically significant, suggesting either that the non-significant effect was due to chance or that our sample size was inadequate to determine a definitive benefit. We suspect the latter, in view of the significant effect of the intervention on the combined STI and gonorrhoea-alone endpoints. Effects on HIV incidence were not assessed owing to the prohibitive sample size needed to determine such an effect. Patients of physicians who received the training also reported 78% lower odds of unprotected sex during the past 6 months as well as significantly improved HIV and STI knowledge, attitudes towards people living with HIV, and satisfaction with physicians. To our knowledge, this is the first study in China that uses a randomised trial to assess the effects of physician HIV and STI training on indicators of patient-level biological, behavioural, and sociocognitive risk.

There were several unique features of the Ai Shi Zi programme that could have contributed to the observed effects. First, the programme recognised and included up-to-date information about national AIDS policies and local health infrastructure, including availability and guidelines for HIV medications and STI treatment, which can affect service provision for patients. Second, the programme included culturally sensitive information

about risk reduction counselling, stigma towards people living with HIV, and traditional norms and beliefs that can influence physicians' interactions with patients. Presentations by local patients with AIDS about their perspectives on health care, stigma, and living with the disease could have been particularly relevant to this programme. Third, the programme incorporated several strategies to train physicians and model new skills. For example, interactive learning strategies complemented didactic lectures, which tend to be the dominant mode of instruction in China. Fourth, booster sessions provided additional opportunities for problem solving, feedback, and professional support.

Findings from the Ai Shi Zi project are consistent with studies done in the USA showing the role of physician training to reduce HIV transmission risk among patient populations. For example, a randomised trial of a brief 4-h training for medical providers on behavioural risk counselling with HIV-positive patients noted significantly increased provider-patient discussions of safer sex and reduced number of sex partners among patients compared with patients of physicians who were not trained.<sup>26</sup> Similar studies have shown the effects of provider-initiated safer sex counselling to HIV-positive or at-risk patients on behavioural risk reduction outcomes compared with patients in control groups without provider-initiated counselling.<sup>27,28</sup> These studies align with recommendations by the US CDC for the integration of routine HIV and STI assessment and risk reduction counselling in clinical settings serving HIV-infected populations.<sup>29</sup> Based on findings from Ai Shi Zi, integration of HIV and STI prevention into routine care for risk populations in China could be warranted.

Due to stigma, traditional cultural beliefs, and inadequate institutional support, physicians in China might experience challenges to HIV and STI-related service provision.<sup>30</sup> Results from Ai Shi Zi, and a related intervention shown to reduce HIV stigma in Chinese physicians entitled "White Coat, Warm Heart",<sup>21</sup> indicate that these challenges can be overcome by programmatic efforts to engage physicians, provide educational training and support, and shift norms around services for HIV-risk patient populations. Questions remain, however, regarding the specific strategies needed to broadly disseminate and implement these programmes. "White Coat, Warm Heart" involved four group training sessions over a 1-month period and three additional booster sessions, whereas Ai Shi Zi involved a 1-week group training and two additional booster sessions. Specific training components that contributed to intervention effects have not been identified in either study. Because of programme length and complexity, institutional support, and training resources will be needed to scale up these training programmes. In addition to efforts to improve physician training, public health strategies such as partner tracing, partner notification, and partner treatment might enhance

identification and prevention of HIV and STI cases in China, and warrant further study.

Limitations to this research must be considered. The study used a brief 9-month follow-up, and we cannot comment on longer-term effects. There might be limitations in representativeness and generalisability of study findings owing to selection biases and non-monetary incentives (eg, paid trip to Hefei for professional training) among physicians who agreed to participate; we also do not have information about the size of the full sampling frame of physicians, and cannot determine the proportion of physicians represented in this study. We undertook the training in county hospitals that allowed for recruitment and physician participation; findings might not generalise to hospital settings where physicians do not have institutional support to participate. Patients were recruited from waiting areas of participating physicians, and these patients might not represent those who do not seek health services. Patient attrition levels were high and study findings might be less reliable due to the amount of missing data (20%); challenges in patient retention might possibly reflect high levels of internal migration. We did not observe or collect data about the clinical encounters between trained physicians and patients, and so we cannot specify the exact physician-level factors that influenced improvements in patient outcomes. We did not collect detailed information about physician demographic backgrounds and thus are unable to examine physician background characteristics that might moderate the intervention effects. There might have been contamination such that control participants later in the trial might have been exposed to intervention content. We sampled only 10% of biospecimens for reliability. Biological results might not be generalisable to other STIs, including HIV or syphilis.

In summary, this research provides empirical support for the efficacy of physician training on HIV and STI knowledge, treatment, and risk reduction counselling as a strategy to prevent HIV risk and STI reinfection in China. Future analyses based on this trial should provide greater understanding of the behavioural mechanisms, psychosocial factors, and patient characteristics that contributed to the intervention effects. For example, the intervention is likely to have led to improved patient-physician communication, higher levels of patient self-efficacy, and greater levels of patient awareness about HIV risk. Intervention effect moderators will also be examined, including patient characteristics such as sex, marital status, and socioeconomic status, to identify whether the intervention has greater effect on specific subgroups. A report on the implementation processes, content, and curricula is also planned.

As HIV and STI epidemics in China continue to expand, strategic interventions are needed to reach those populations at highest risk.<sup>31</sup> Improvement in HIV and STI expertise in the next generation of health providers

### Research in context

#### Systematic review

In September, 2004, at the time of planning this trial, we searched the published literature indexed in PubMed with the terms “HIV AND intervention AND physician AND China” and found no randomised controlled trials evaluating an intervention to train physicians in China on HIV and STI prevention. We searched PubMed again in July, 2015, to identify relevant research at the time of final analysis. Although we were unable to identify published clinical trials in this area of research, we identified three studies<sup>18–20</sup> that have shown feasibility and preliminary effects of programmes to train Chinese physicians on HIV knowledge. However, these studies did not have control groups or patient-level biological outcomes. Another identified study<sup>21</sup> used a randomised control trial to test an HIV stigma reduction intervention for physicians in China, and noted significant reductions in stigmatising attitudes and behaviours among physicians. However, this study did not examine patient-level HIV or STI behavioural or biological outcomes. Conclusions from a recently published systematic review of HIV interventions in China further highlight an absence of evidence on the effectiveness of physician training on HIV and STI behavioural or biological outcomes.<sup>31</sup>

#### Interpretation

This study provides the first evidence, to our knowledge, for the effectiveness of training physicians on HIV and STI prevention in China. Findings showed promising effects of physician intervention training on patient STI reinfection and self-reported HIV risk behaviours. Specifically, findings showed that patients of physicians who received the training had lower STI reinfection, lower unprotected sex, and greater physician satisfaction compared with patients of physicians who had not received the training. These findings indicate the importance of incorporating education on HIV and STI prevention and treatment in medical education in China.

in China is one such strategy, yet requires institutional and political commitment, in terms of human resources, educational investments, and motivation for engagement in training. In view of the sheer size and reach of the HIV and STI epidemics in China, such investments are likely to have considerable public health and population-level benefits.

#### Contributors

DO and DW are co-first authors. DO, DW, JChe, QH, HZ, JCha, JG, GS, and TJC took part in the design, implementation, analysis, and writing of this study. M-FY, KB, and NZ took part in the analysis and writing. All authors saw and approved the final version.

#### Declaration of interests

We declare no competing interests.

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