

Review

East meets West: ethnic differences in prostate cancer epidemiology between East Asians and Caucasians

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Abstract

Prostate cancer is the most prevalent cancer in males in Western countries. The reported incidence in Asia is much lower than that in African Americans and European Caucasians. Although the lack of systematic prostate cancer screening system in Asian countries explains part of the difference, this alone cannot fully explain the lower incidence in Asian immigrants in the United States and west-European countries compared to the black and non-Hispanic white in those countries, nor the somewhat better prognosis in Asian immigrants with prostate cancer in the United States. Soy food consumption, more popular in Asian populations, is associated with a 25% to 30% reduced risk of prostate cancer. Prostate-specific antigen (PSA) is the only established and routinely implemented clinical biomarker for prostate cancer detection and disease status. Other biomarkers, such as urinary prostate cancer antigen 3 RNA, may increase accuracy of prostate cancer screening compared to PSA alone. Several susceptible loci have been identified in genetic linkage analyses in populations of countries in the West, and approximately 30 genetic polymorphisms have been reported to modestly increase the prostate cancer risk in genome-wide association studies. Most of the identified polymorphisms are reproducible regardless of ethnicity. Somatic mutations in the genomes of prostate tumors have been repeatedly reported to include deletion and gain of the 8p and 8q chromosomal regions, respectively; epigenetic gene silencing of glutathione S-transferase Pi (GSTP1); as well as mutations in androgen receptor gene. However, the molecular mechanisms underlying carcinogenesis, aggressiveness, and prognosis of prostate cancer remain largely unknown. Gene-gene and/or gene-environment interactions still need to be learned. In this review, the differences in PSA screening practice, reported incidence and prognosis of prostate cancer, and genetic factors between the populations in East and West factors are discussed.

Key words Prostate cancer, epidemiology, Asia, ethnic difference

Prostate cancer is the most frequent cancer among males in economically developed countries^[1]. A total of 903 500 prostate cancer patients were diagnosed in 2008, accounting for 14% of the total new cancer cases in the world. Prostate cancer was also the 6th leading cause of cancer deaths in males in 2008. The disease is well known to be more prevalent in Western countries, including Oceanian, North American, and European countries, than in Asian countries (Figure 1). However, there are many factors to consider when comparing the

incidence and mortality of prostate cancer across countries. In this review, the factors that impact cross-country comparisons include prostate-specific antigen (PSA) screening practice and genetic background.

Reported Incidence and Prostate-Specific Antigen Screening

Despite the limited specificity on detecting true cancer cases, prostate-specific antigen (PSA) is the only established and routinely implemented clinical biomarker. PSA level and its change from the baseline can be a signal of prostate cancer development, progression, recurrence, and efficacy measure of medical treatments. PSA-based cancer screening, however, still varies in practice by country. The European Randomized Study of

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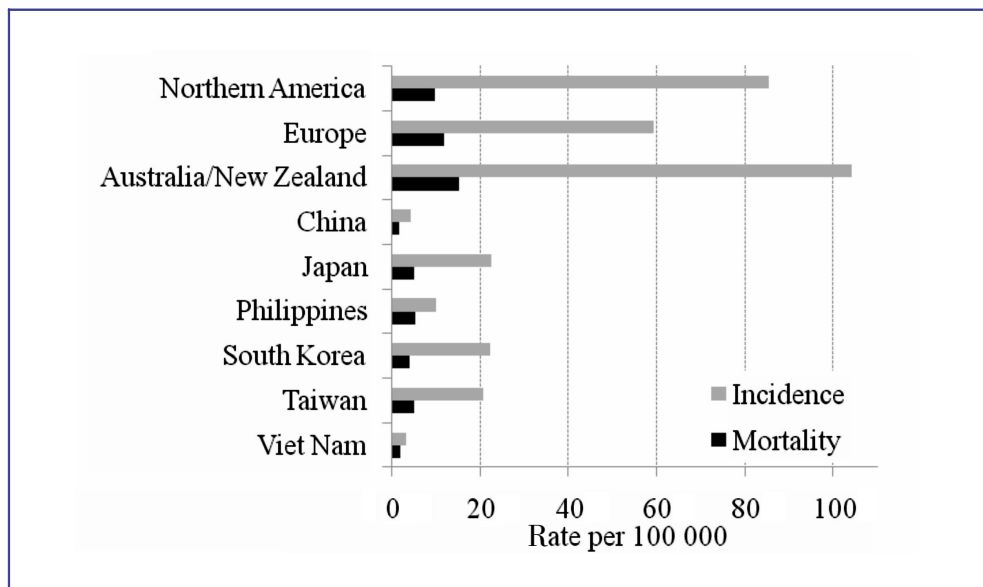


Figure 1. Age-standardized incidence and mortality of prostate cancer in selected countries. Data were obtained from GLOBOCAN 2008 [<http://globocan.iarc.fr/>]. Incidence and mortality in all ages (0 to 75 years) were standardized using the world standard population.

Screening for Prostate Cancer (ERSPC) reported that PSA-based screening significantly reduced prostate cancer mortality^[2-4]. Also, population-based studies in Tyrol showed PSA-based screening can reduce prostate cancer mortality^[5,6]. However, the results are still controversial^[7]. In the future, cancer screening programs with better accuracy and cost-efficiency may be implemented more widely by combining PSA with urinary biomarker(s), e.g. prostate cancer antigen 3 (PCA3)^[8,9], but is currently not officially recommended and the cost of the test is not always reimbursed to all men worldwide.

The reported incidence would be lower in those countries without a systematic prostate cancer screening program. Knowledge and access to the PSA-based cancer screening would impact the detection rate of prostate cancer that might have otherwise not been diagnosed, resulting in an earlier stage at diagnosis^[10-14]. Here, the relationship between the PSA screening practice and reported incidence in populations in mainland China, Japan, and Korea is discussed. In these representative Asian countries, prostate cancer and its screening were off the radar probably because of the relatively low reported incidence and slower progress compared to the other cancers. However, Asian immigrants in the United States, Canada, Australia, and west-European countries, where they could have better access to PSA screening, still show a lower incidence compared to the black and European Caucasian living in the same regions.

In China and Japan, the nationwide prostate cancer screening rate is unknown. Tianjin, the third largest

city in China, is a member of the International Agency for Research on Cancer. The incidence of prostate cancer in Tianjin is significantly increasing^[15] but is still low at 2.84 per 100 000 in 2004^[16]. Considering the high mortality/incidence (M/I) ratio (0.68 in Qidong, Jiangsu province, China in 1978–2002^[17] and 0.42 in GLOBOCAN 2008, each higher than the rate of 0.12 in Northern America, Figure 1), Chinese patients with prostate cancer in mainland China may still be diagnosed in relatively advanced stage^[18]. In Japan, the estimated age-standardized incidence rates increased until 2003, when the National Cancer Center changed the estimation methods, after which rates became stable^[19] (age-standardized rate using world population was 27.3 per 100 000 in 2003 and 27.1 per 100 000 in 2006^[20,21]). In regional cancer registries, the stage at diagnosis was not reported in 35% to 40% of prostate cancer cases, but distant metastasis at diagnosis was reported in 15% to 17% of the remaining cases^[20,22-24]. In Korea, Park *et al.*^[25] mentioned as “unpublished data” that PSA screening is not common in Korea, and a telephone survey of 700 men older than 50 years in a small city revealed that approximately 15% had been screened for prostate cancer during the previous two years. However, the age-standardized incidence of prostate cancer in Korea has dramatically increased from 8.5 per 100 000 in 1999 to 23.1 per 100 000 in 2008^[26].

Several studies reported that the incidence of prostate cancer in Asian immigrants living in North America^[27-30] and European countries^[31-35] was much higher than that in their countries of birth. Could this be because of the better access to the PSA screening in

the Western countries?

Many European countries do not offer routine PSA screening; however, the incidence is much higher than that in Asian countries (Figure 1). In United Kingdom, all men are enabled to make an informed choice about PSA screening. In 2007, the screening rate and age-standardized incidence was estimated as 6.2% in men aged 45 to 89^[36] and 100.5 per 100 000, respectively. It is estimated that if population-based PSA screening were introduced, prostate cancer diagnosis rates in men aged 50 to 69 years would increase more than 20-fold compared to the current rates^[11].

On the other hand, there are countries which have higher PSA screening rate as well as higher prostate cancer incidence rate. In the United States, all men over 50 years are recommended to have an annual PSA test. The Behavioral Risk Factor Surveillance System of 2008 showed that 54.8% (median of states' statistics) of men aged 40 years or older underwent PSA screening in the previous two years^[37]. In Canada, 24.7% of men aged 40 years or older and 34.1% of men aged 50 years or older received PSA screening less than 1 year prior to the Canadian Community Health Survey of 2000–2001 despite PSA testing not being generally recommended. In Australia, the PSA screening rate was 21% to 25% in men aged 50–79 years in 2008–2009^[38]. In these

countries, the incidence of prostate cancer peaked before 1995 and then decreased, followed by a relatively stable incidence^[39]. However, screening rates for visible minorities did not follow the same trend in these countries. In Canada, visible minorities (three largest groups are Chinese, South Asian, and black) had lower lifetime PSA screening rates compared to whites (30.4% vs. 44.7%)^[40]. Australian immigrants from East Asia had significantly lower PSA screening rates than Australian-born men (odds ratio, 0.4; 95% confidence interval, 0.3–0.6)^[41]. According to the California Health Interview Survey^[28], the PSA screening rate within the past year in men aged 50 years or older was higher in non-Hispanic whites (57.7%) but not too different from the rates in Asian Americans: Chinese (51.6%), Filipino (46.1%), and Japanese (48.0%). However, the incidence and mortality of prostate cancer in Chinese, Filipino, and Japanese living in the US was 1/2 to 3/4 compared to those in non-Hispanic white based on Surveillance, Epidemiology, and End Results (SEER) data from 1998–2002^[27] (Figure 2). Rates in Koreans (32.7%) and Vietnamese (27.3%) were low, as was the incidence in these populations. In the military-based Center for Prostate Disease Research (CPDR), where all men underwent mandatory annual screening with an equal access healthcare system, 5% of patients registered

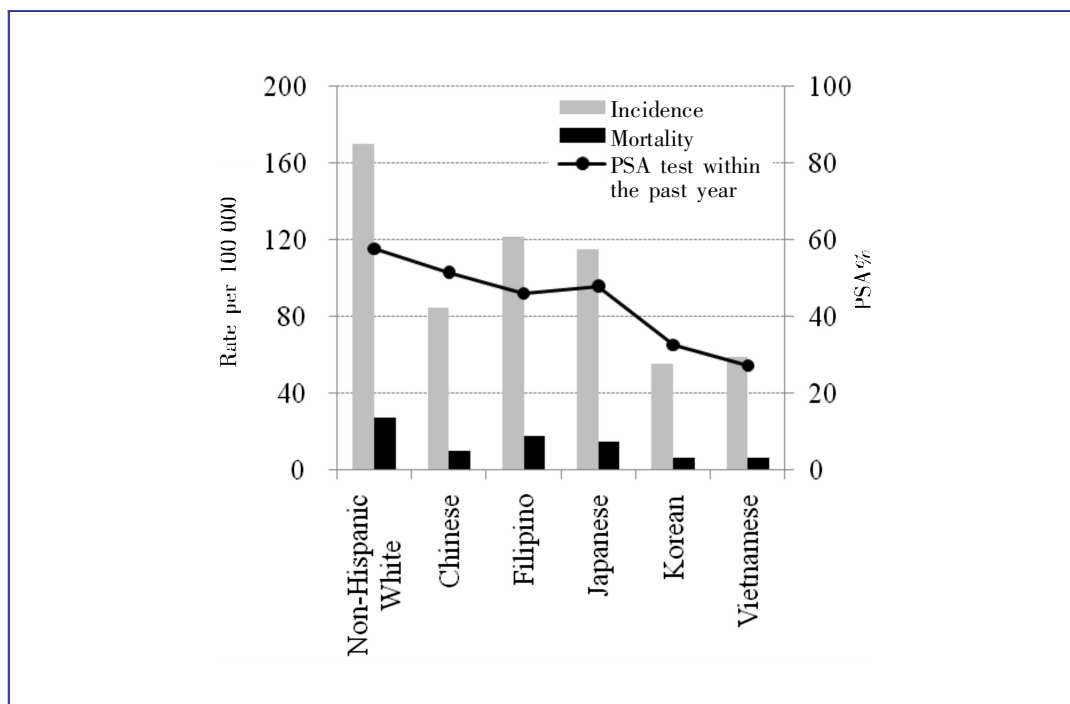


Figure 2. Age-standardized incidence and mortality of prostate cancer and PSA screening rates in Asians in the United States. Incidence and mortality in the US population (non-Hispanic whites and Asian Americans) standardized by using the 2000 US Standard Population and 95% confidence interval were obtained from Miller *et al.*^[27] based on Surveillance, Epidemiology, and End Results data from 1998–2002. The PSA screening rates in men aged 50 years and older who had heard of and underwent the PSA test was obtained from California Health Interview Survey of 2003^[28].

database were Asian despite the fact that only 3.4% of the military population is Asian^[30], indicating American men of Asian descent might not have lower incidence of prostate cancer compared to Caucasians.

In summary, as illustrated in Figure 1, the reported incidence and mortality is much lower in Asian countries compared to the countries in North America, Europe, and Oceania. Also, the incidence in Asian immigrants in Western countries had higher incidence of prostate cancer compared to those in their countries of birth. The PSA screening rate seems to be low in Asian countries and some of the Asian populations in Western countries, which may partially explain the low incidence in Asian populations. However, as illustrated in Figure 2, American Asians in California with comparable PSA screening rate still had a lower incidence compared to non-Hispanic white. Therefore, the low PSA screening rate is not the only reason of lower incidence in Asian. It is also possible that elderly migrants might leave to their countries of birth, which may lead to a relatively smaller proportion of elderly population in these countries^[42], and/or patients with cancer might be more prone to leave on diagnosis of cancer. Therefore, it is challenging to generalize the relationship between the PSA screening rate and reported incidence and underlying reasons of the difference in populations between East and West.

Survival and Prognostic Differences between Asian and US Prostate Cancer Patients

The differences between East and West are not only in the PSA screening rate and the reported incidence of prostate cancer but also in clinical conditions at diagnosis and survival. Several studies suggested that Asian prostate cancer patients are prone to present with higher stages/worse grades at diagnosis but had similar or even better prognosis^[43-49] (Table 1). Several background factors impact the outcomes, including age at diagnosis, clinical stage at diagnosis, Gleason scores, choice of therapy, and comorbidities. For example, Huang *et al.*^[50] compared the clinical outcomes of Taiwanese men with localized prostate cancer who underwent radical prostatectomy in Taiwan with similar studies in the United States and the European Union and reported inferior outcomes for Taiwanese patients, largely because of delayed surgery at higher PSA level. The 5-year survival in Japanese prostate cancer patients diagnosed between 1993 and 1996 (observed and relative survival of 50.2% and 67.6%, respectively)^[51] was much worse than that in Japanese Americans diagnosed between 1988 and 1994 (91.1%)^[47]. Notably, the relative survival in Japanese patients with distant metastasis was low (35.2% and 39.6% in patients diagnosed between 1993 and 1996

and between 1997 and 1999, respectively)^[52]. On the other hand, under an equal access healthcare system, Asian Americans were diagnosed at significantly younger age (mean of 66.4 years in Caucasians vs. 62.4 years in Asians), had lower clinical stage (but worse biopsy grade), and experienced improved overall survival rates (hazard ratio for Caucasians was 2.9, 95% CI 1.8–4.8, compared to Asians)^[30].

Nutrition Factors and Genetic Susceptibility of Prostate Cancer in Asians and Caucasians

As indicated previously, the Asian immigrants in the Western countries had higher incidence of prostate cancer compared to those in their countries of birth. It might be because of the different medical systems, but diet could also be attributable. Generally, it is speculated that the westernized diet in Asian countries may be related to the elevated risk of prostate cancer, but it is challenging to separately discuss the impact of diet from the improvement of medical practice and detection methods. Soy foods are popular among Asian culture and it is interesting that the soy foods, especially nonfermented soy foods, have been consistently reported to be associated with a 25%–30% reduced risk of prostate cancer^[53-55].

The etiology of prostate cancer remains largely unknown, but considering that the family history is one of the established risk factors for prostate cancer^[56], and that gene and/or environmental factor should be involved in its etiology. An individual with a positive family history has a 2–3 times higher risk of having prostate cancer^[57-59], and 10%–20% of prostate cancer cases are estimated to be such non-sporadic prostate cancer. Lee *et al.*^[60] reported that 11.5% (25/218) of Korean patients with prostate cancer diagnosed and/or treated in a large hospital during a three-month study period had a positive family history. The International Consortium for Prostate Cancer Genetics conducted combined linkage analyses on a large number of families (mainly white) with prostate cancer^[61,62]. These studies showed a significant linkage at 22q12 and several other regions with “suggestive” linkage. There are few linkage studies in Asian populations. Matsui *et al.*^[63] reported a nominal linkage at chromosome 8p23 and 1p36 in Japanese.

Considering the relatively late onset of the disease and low reported incidence rate 20–30 years ago in Asia, collecting familial genomic samples may be challenging. Case-control studies on candidate genes may have greater power compared to linkage analysis, but the results have been largely controversial^[64]. One candidate gene is 2'-5'-oligoadenylate-dependent RNase L (*RNASEL*), which is located in the hereditary prostate cancer (HPC) 1 region (1q24–25). A meta-analysis

Table 1. Racial/ethnic difference in outcomes of prostate cancer patients

Author (country)	Year of diagnosis	Patient population	Baseline difference (Asian vs. white)	Follow-up	Outcomes (Asian vs. white)
Man ^[43] (Canada)	1994–	Radical radiotherapy, 63 Asian and 1,804 non-Asian	Greater % of Asian patients present with high risk CaP	Median 33 mo	No significant difference in time to first biochemical failure ($P = 0.7$ for log-rank test) and cause specific survival ($P = 0.4$ for log-rank test) after radiotherapy
Oakley-Girvan ^[44] (US, Canada)	1987–1991	Population-based cancer registry < 85 years: 484 White, 396 North America-born Asian, 157 Foreign-born Asian	Foreign-born Asian were more likely to be diagnosed with advance cancer	Till end of 1998	95% CI for death rate ratio crosses 1 with or without adjustment for age, SES, and comorbidity.
Robbins ^[45] (US, California)	1995–2004	Population-based cancer registry: 108 076 White, 8 840 Asian (Chinese, Filipino, Japanese, Korean, South Asian, Vietnamese)	Asian had risk profile at diagnosis for survival disadvantage	Till end of 2004	Multivariate hazard ratios for death (and 95% CI) referent to white were: Chinese, 0.51 (0.43–0.62) Japanese, 0.59 (0.51–0.70) Filipino, 0.49 (0.37–0.65) Korean, 0.60 (0.37–0.98)
Cohen ^[46] (US)	1986–1996	SEER/Medicare, localized CaP aged 65–84; 23 353 white and 566 Asian	Asian presented with higher grade disease	Till end of 1998	Multivariate hazard ratio for disease recurrence in Asian was 0.97 (95% CI, 0.68–1.38)
Holmes ^[48] (US)	1992–1999	SEER/Medicare, locoregional CaP \geq 65 years: 53 764 Caucasians, 1 830 Asians	Higher % of Asian presented with worse biopsy grades	Till end of 2003	Multivariable hazard ratio for overall survival was 37% lower in Asian
Lin ^[47] (US)	1988–1994	SEER; 93 767 white, 978 Chinese, 1 872 Japanese, and 1 417 Filipino	Filipino were more likely to be diagnosed with advanced stage	Till end of 1997	Cause-specific 5-year survival and 95% CI were: White, 89.3% (89.1%–89.6%) Chinese, 91.4% (89.3%–93.4%) Japanese, 91.1% (89.6%–92.5%) Filipino, 85.8% (83.8%–87.9%)
Raymundo ^[50] (US)	1989–2007	Military-based cancer registry; 8 335 Caucasians and 583 Asians	Asian American had lower clinical stage but worse biopsy grade	Till Nov 2008	Multivariate hazard ratio for overall survival in white referent to Asian was 2.92 (1.78–4.79)
Fukagai ^[49] (US, Hawaii)	1992–2001	59 Caucasian and 105 Japanese American CaP with hormonal therapy at one center	No statistical difference but tended to higher PSA level and Gleason Scores in Japanese American	Till end of 2001	Japanese American had significantly better overall ($P = 0.001$ for log-rank test) and cause-specific survival ($P = 0.036$ for log-rank test).

CaP, prostate cancer patients; 95% CI, 95% confidence interval; SES, socioeconomic status defined as census education and census poverty; SEER, surveillance, epidemiology, and end results program; RP, radical prostatectomy.

showed that the Glu allele for the Asp541Glu polymorphism was associated with an increased risk in Caucasians^[65], whereas a small Japanese study suggested a protective effect for Gln/Gln genotype^[66]. Another meta-analysis on *elaC* homolog-2 (*ELAC2*) gene/HPC2 at 17p11 indicated that the Ser allele of Ser217Leu and the Ala allele of the Ala541Thr polymorphisms significantly increased prostate cancer risk in Asians but had only marginal impact in Caucasians^[67]. The Gln allele of the Arg399Gln polymorphism of the X-ray repair cross-complementing

group 1 (*XRCC1*) gene may be associated with a higher prostate cancer risk in Asians but not in Caucasians^[68,69]. A meta-analysis quantified (CAG)_n and (GGN)_n repeat polymorphisms in androgen receptor (*AR*) gene and concluded that although shorter repeats modestly associated with prostate cancer risk, the absolute difference was less than one repeat between cases and controls^[70]. The polymorphisms on vitamin D receptor (*VDR*) gene^[71], steroid 5- α -reductase type 2 (*SRD5A2*) gene^[72,73], and genes on folate-pathway (e.g. *MTHFR*)^[74] were not significantly associated with prostate cancer

risk in meta-analyses in Caucasians or in Asians. Interestingly, patients with diabetes mellitus have lower risk of prostate cancer compared with those without diabetes mellitus in European Americans (relative risk, 0.65; 95% CI, 0.50–0.84), as well as in Japanese Americans (RR, 0.80; 95% CI, 0.69–0.96)^[75], probably based on somewhat protective effects of diabetes-susceptible SNPs^[76].

Although a study of twins from Sweden, Denmark, and Finland suggested that an estimated 42% of prostate cancer risk can be explained by heritable factors^[77], risk alleles may be rather common and weakly penetrant^[78]. In order to differentiate high-risk men, several but not single candidate genetic polymorphisms may need to be combined with family history^[79].

Many genome-wide association studies (GWAS) have been conducted, mainly in Caucasians. A meta-analysis of 21 studies found significant association between 31 single nucleotide polymorphisms (SNP) and prostate cancer^[80]. Among 71 subgroups of studied population, only two were executed in Asians (Chinese Americans and Japanese Americans)^[81,82], and associations with some of the 31 SNPs disappeared in Asian subgroup analysis. However, a large Japanese GWAS study, which was not included in this meta-analysis, showed significant relationships between prostate cancer risk and most of those SNPs^[83], including the ones on chromosome 8q24, an established prostate cancer susceptibility locus^[84]. These genetic polymorphisms can work interactively with each other as well as with environmental factors; however, Lindstrom *et al.*^[85] reported that based on the US National Cancer Institute Breast and Prostate Cancer cohort consortium data, these SNPs were, rather, independent risk factors and that there is little evidence of such interaction.

According to a combined analysis of comparative genomic hybridization (CGH) studies, chromosome 8p

and 8q were the most commonly deleted and gained regions in the genome of prostate tumors, respectively^[86]. Ethnic difference in CGH between Asians and Caucasians remains to be learned^[87]. Gene silencing by CpG island hypermethylation in the *GSTP1* promoter region occurs in over 90% of prostate cancers^[88]. Also, other somatic mutations, including *AR* “activating” mutations^[89], have been reported. However, none of these markers have yet been employed routinely in clinical practice. Ethnic sensitivities on mutation sites, frequencies, and clinical implications remain unclear.

Conclusions

The epidemiology of prostate cancer has changed dramatically since implementation of PSA-based screening in some Western countries^[10]. The reported incidence of prostate cancer in Asian men is currently much lower than that in Asian immigrants, African Americans, and European Caucasians in Western countries, but it is increasing probably along with the change of medical practice, diet, and awareness of the disease. Many susceptible loci and genetic polymorphisms have been reported to modestly increase the risk of prostate cancer. No genetic and somatic biomarkers other than PSA have been established for segregating patient population according to disease aggressiveness, recurrence rate, responsiveness to treatments, or survival. Several observational studies suggested better prognosis and survival in Asian patients with prostate cancer for unknown reasons. This finding should be considered when planning multi-regional clinical trials including Asian countries.

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Meeting Description

The Sino-French 2012 Conference in Thoracic Oncology is hosted by the Department of Thoracic Surgery in Sun Yat-sen University Cancer Center, a leading comprehensive institution for cancer care, research, education and prevention in South China.

The meeting is also organized in collaboration with two renowned French hospitals, namely, Institut Gustave Roussy (IGR) and Centre Chirurgical Marie Lannelongue (CCML). IGR is the leading European anticancer centre, and bases its uniqueness on therapeutic innovation and development of personalized medicine. CCML is a non-profit organization, with a status of university teaching hospital CCML is specialized in thoracic surgery and interventions (heart, lungs, major vessels, etc.) and has been historically at the cutting edge of medical practice (1956: 1st CPB (cardio-pulmonary bypass) and in 1985: 1st successful Heart-Lung transplantation). The conference will convene international specialists, from both France and China and aims to address various topics in thoracic

oncology with a multi-disciplinary approach: surgery, radiation oncology and medical oncology. It will be divided in 3 plenary sessions:

1. Lung Cancer Surgery
2. Innovation in Surgical Techniques
3. Multi-Disciplinary Treatment in Lung Cancer

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