research

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Telesurgery 2.0

ORIGINAL RESEARCH Multicentre randomised controlled trial

Reliability of urological telesurgery compared with local surgery

Wang Y, Xia D, Xu W, et al, on behalf of the TeleS Research Group

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Study question Is the reliability of telesurgery non-inferior to that of standard local surgery in patients undergoing urological robotic operations?

Methods This multicentre non-inferiority randomised controlled trial enrolled 72 patients scheduled for radical prostatectomy or partial nephrectomy across five Chinese hospitals between December 2023 and June 2024. Participants were randomly assigned (1:1) to telesurgery or local surgery. The primary outcome was probability of surgical success, assessed by the medical team using predefined criteria. Secondary outcomes included 13 clinical indicators related

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to surgery and early recovery, one metric evaluating medical team workload, and four technical parameters of the telesurgery system (network latency, display latency, frame loss, and system malfunction). Follow-up was conducted at four and six weeks postoperatively.

Study answer and limitations Telesurgery showed non-inferiority to local surgery, with a difference in the probability of success of 0.02 (95% credible interval −0.03 to 0.15) and a bayesian posterior probability of 0.99. The telesurgery system remained stable over distances of 1000-2800 km, with mean round trip network latency of 20.1-47.5 ms and minimal frame loss (0-1.5 per procedure). No significant differences were observed in secondary outcomes. Limitations include the moderate sample size and lack of long term outcome assessment.

What this study adds This randomised controlled trial in telesurgery provides evidence that telesurgery is non-inferior to local surgery in terms of reliability, supporting the expanded clinical adoption of telesurgical systems.

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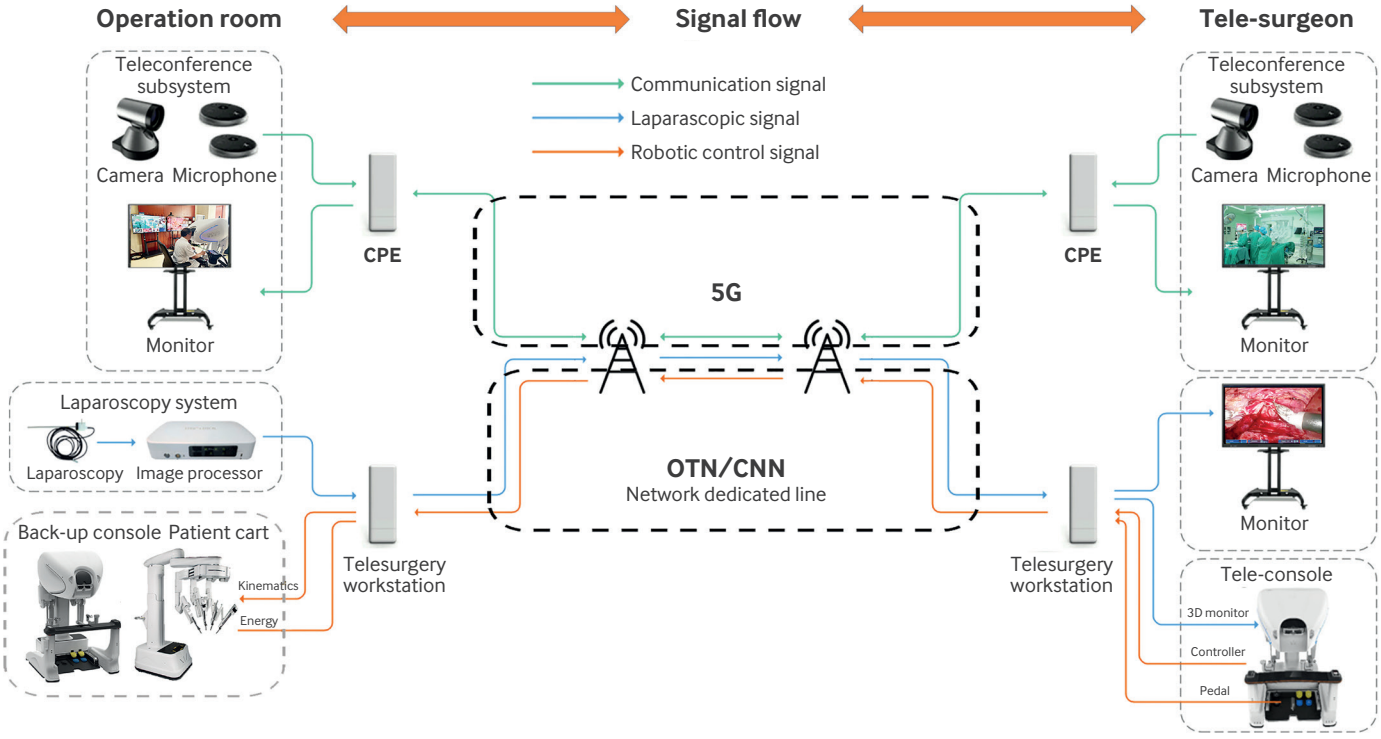
Study registration ChiCTR.org ChiCTR2300077721.



Structure and instrument arrangement of telesurgery system. CNN=cloud connect network; CPE=customer premises equipment; OTN=optical transport network

Interest in telesurgery has been renewed around 20 years after it first came into use. With telesurgery, a remote surgeon is able to operate with a tool on a patient over a distance between two hospitals. The tool in question is usually a surgical robot, and the connection between the remote surgeon and the patient is through a secure telecommunication link.

The first clinical telesurgery was a robotic cholecystectomy in 2001 between New York and Strasbourg,[1] using a robot called Zeus (Computer Motion, USA). This was followed by the first randomised controlled trial of telesurgery between Guy's Hospital, UK, and Johns Hopkins Hospital, USA, using a percutaneous access to the kidney robot,[2] showing that although the robot was slower than a human hand it was more accurate at inserting a needle into the kidney. Thereafter the da Vinci robotic system (Intuitive Surgical, USA) became the main surgical robot in the market for 20 years. Although it revolutionised surgery, it was not built with telesurgery in mind. As a result, the concept of telesurgery gradually faded and traditional robotic surgery with the surgeon and patient in one room became the norm, until recently.

The rise of telesurgery

In 2018 we demonstrated 5G ultra-low latency telesurgery with a headset for vision and a haptic glove to control a 3D printed robotic tool, with minimal time lag.[4] Colleagues from China performed 5G telerobotic procedures soon after, and since then China has largely dominated the re-emergence of telesurgery.[5 6] Several reasons for this exist. The new robotic systems are telesurgery compatible. This means improved 3D computer vision and a reduced time delay within the robots themselves. The telecommunication links have vastly improved with fibreoptic lines, 5G/6G cloud architecture, high speed internet, and satellite. The connections are now an astonishing 99.9999% secure. And as China has a single law across the nation, overcoming the legal obstacles is easier than in other countries such as the US, where the laws are different across different states.

Multiple reports of telesurgery within nations, as well as transcontinentally, have been published.[7-10] The national reports have come from China, Japan, India, and Belgium, with transcontinental telesurgery between North and South America, Europe/UK and China, China and Africa, and the first US Food and Drug Administration approved procedure from the US to Africa.[11]

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Newer robots will reduce the cost, connectivity across nations will improve, and artificial intelligence will personalise surgery

Around 300 telesurgery procedures have been reported with no technical failures. What was lacking in these reports was the scientific rigour needed to show that telesurgery was safe and here to stay. Wang and colleagues' multicentre randomised controlled trial compared telesurgery in China with local robotic surgery for robotic assisted radical prostatectomy and robotic partial nephrectomy for small renal masses.[12] The authors accept that deciding on the numbers needed to treat to show non-inferiority of telesurgery was difficult, as no such previous trials had been conducted. A large number of patients were invited, but many decided against participation. The main reason for patients not joining the trial or withdrawing after randomisation was the desire to have traditional robotic surgery with the da Vinci system, which already has an established track record in China. The robot used in the trial was the MP1000 (Edge Medical Co., China), which is telesurgery compatible.

The trial showed telesurgery to be non-inferior to local robotic surgery with minimal time delay (latency 20.1-47.5 ms) from 1000 to 2800 km and no cybersecurity problems. The only failure of the robot happened on a single occasion in the local robotic surgery arm. Although having had patients randomised to either prostate or kidney surgery in the two arms would have been preferable, this would have led to longer recruitment. The positive margin rates for robotic assisted radical prostatectomy were significantly lower in the telesurgery arm, and one possible explanation for this may be that the most experienced surgeon was in the telesurgery arm.

In 2024, the Society for Robotic Surgery began consensus meetings of telesurgery involving surgeons, ethicists, patients' groups, device manufacturers, telecommunication experts, policymakers, regulators, legal experts, and hospital administrators. This led to a Delphi consensus and 10 guiding principles for telesurgery.[13 14] These are informed consent, patient autonomy, surgeon-patient relationship, surgeon's discretion, clear roles and responsibilities, comprehensive data review, guaranteed system safety, reliable communication network, approved equipment, and emergency protocols.

Clinical implications

The return of telesurgery has wider considerations. Newer robots will reduce the cost, connectivity across nations will improve, and artificial intelligence (AI) will personalise surgery while making it more efficient.[16] Standardisation of evaluation with frameworks such as IDEAL (stages 1-4) for investigating surgical innovations will be vital.[17] Sceptics argue that if a team capable of performing surgery locally was essential in case the telecommunications link should go down, then why have a remote surgeon in the first place? Does it make financial sense? Or perhaps we accept that this is purely about bringing the best surgeon to a remote location without the surgeon, the patient, or their family having to travel long distances.

Most crucially, the authors of this trial accept that patient and public involvement was not an important part of the trial design. Most grant funding bodies now insist on this. Although robotic surgery may eventually become more automated, when asked recently at the Royal Academy for Engineering People's AI Stewardship Summit the public were willing to be part of trials but said "not yet" to fully autonomous surgery.[18] Initiatives such as the Responsible AI UK ecosystem will ensure that public trust remains the highest priority as surgery becomes more digital and the role of telesurgery becomes more established across health systems and nations and even in space.[19]

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Towards the equal recognition of autism in girls and women

ORIGINAL RESEARCH Population based, prospectively collected, birth cohort study

Time trends in the male to female ratio for autism incidence

Fyfe C, Winell H, Dougherty J, et al

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Study question How does age at diagnosis, calendar period, and birth cohort influence the male to female ratio for autism incidence in Sweden?

Methods This register based, prospectively collected, birth cohort study included all liveborn children recorded in the Swedish medical birth register between 1985 and 2020. The study investigated the interaction between age at diagnosis, calendar period, and birth cohort and the male to female ratio for a diagnosis of autism spectrum disorder (ASD).

Study answer and limitations Among 2 756 779 individuals born in Sweden between 1985 and 2020, 78 522 (2.8%) had a diagnosis of ASD at the end of follow-up in 2022. The incidence rate of the condition increased with each five year age interval throughout childhood, peaking at 645.5 (per 100 000 person years) for males at age 10-14 years and 602.6 for females at age 15-19 years in 2020-22, and then decreased. A pattern for incidence in the female cohort catching up with that in the male cohort was observed, with increasing age at diagnosis and, for ages older than 10 years, by calendar period. For the final year of follow-up, the cumulative male to female ratio for ASD incidence was 1.2 by age 20 years; further projection of these trends suggested that the cumulative male to female ratio would reach parity when participants reached age 20 years by 2024. The study had some limitations. Using register data restricted the assessment of ASD type to specific ICD-10 (international classification of disease, 10th revision) coded categories. In addition, measuring time dependent effects limited the study's ability to control for within cohort confounders.

What this study adds The male to female ratio for ASD may be substantially lower than previously thought—to the extent that, in Sweden, it may no longer be distinguishable by adulthood.

Funding, competing interests, and data sharing
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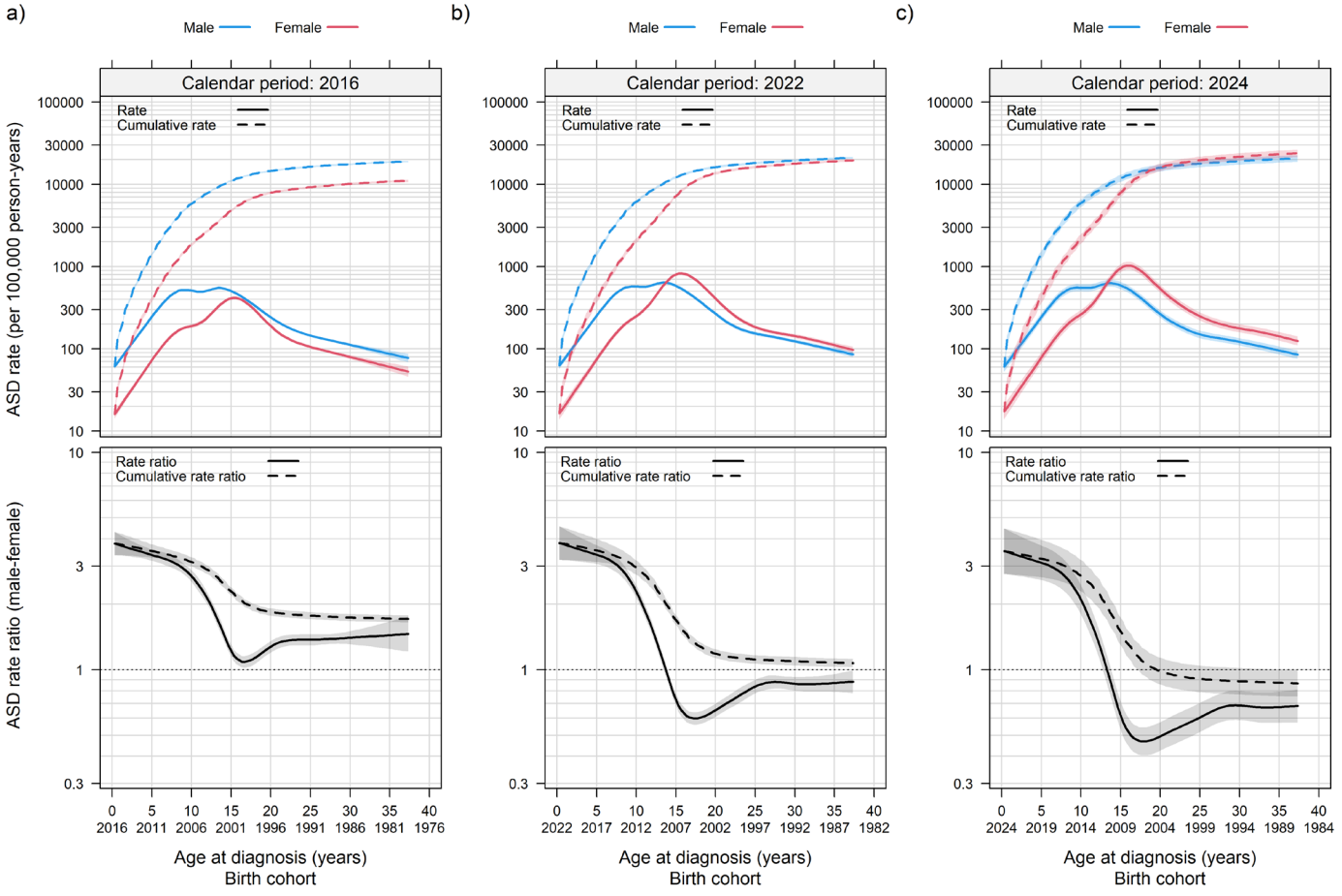

Population averaged, age-cohort specific rates of autism spectrum disorder and male to female ratios for calendar periods 2016, 2022, and 2024. Figure presents estimates from the model best supported by the Akaike information criterion, which included terms for age, period, cohort, and their interactions with sex, using diagnoses of autism spectrum disorder between 1987 and 2022 and projected diagnoses in 2024

Autism has long been regarded as a condition that predominantly affects the male sex, with even the DSM-5 (*Diagnostic and Statistical Manual of Mental Disorders*, fifth edition) stating a male to female ratio of 4:1 for diagnoses. More recent research, as well as common self-reported experiences of autistic women,[1] suggest that the true ratio is less skewed and that current practices are failing to recognise autism in many women until later in life, if at all. A 2017 meta-analysis of research before 2011 suggests a lower but still skewed ratio of 3:1.[2] This is an area of active research with multiple competing and complementary hypotheses.[2-6]

The harms of underdiagnosis and misdiagnosis of autism in women—harms that are infrequently reported in medical research but are often discussed in the autistic community—extend beyond barriers to appropriate interventions, supports, and accommodations afforded to correctly diagnosed autism in women.

Main findings

Fyfe and colleagues' study suggests that autism may actually occur at comparable rates among male and female cohorts.[7] The authors examined diagnosis rates of autism in Sweden for all people born between 1985 and 2000. They found that although the male cohort was more likely to have a diagnosis of autism before adolescence, the female cohort then caught up, giving a male to female ratio approaching 1:1. The authors attempted to disentangle three overlapping potential phenomena: that societal variables affecting the likelihood of autism (eg, parental age) are changing over time (a birth cohort effect), that the rates at which autism are recognised by screening and diagnostic procedures is changing over time (a period effect), and that the likelihood of an individual being newly diagnosed as autistic varies with that person's age (an age effect).

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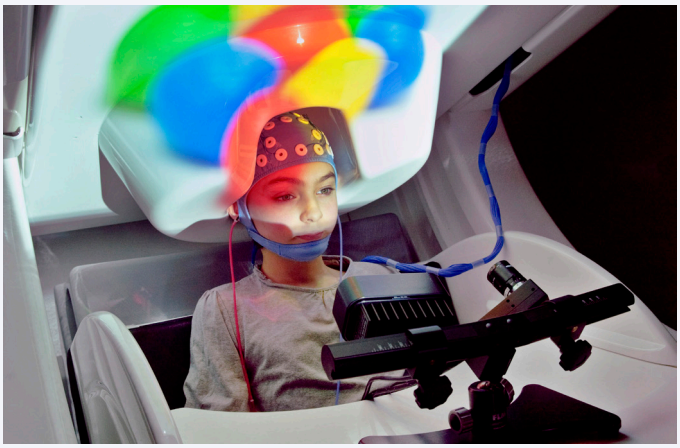

JAMES KING-HOLMES/SPL

Autism may actually occur at comparable rates among male and female cohorts

At least two findings are notable about the most recent screening data in the study. Firstly, screenings are resulting in more even rates of diagnosis between the sexes over time. This is evident when the DSM-5's 4:1 male to female ratio is compared with figure 2 (2022 screenings) in the paper, in which the cumulative rates for both sexes are essentially indistinguishable by age 35 years. Secondly, the age effect remains striking even with these recent diagnoses. The same figure shows that at age 5 years, the male to female ratio is greater than 3:1, and that it does not reach 1:1 until age 14 or 15 years.

This evidence seems to support the argument that systemic biases in diagnosis, rather than a true gap in incidence, underlie the commonly accepted 4:1 male to female ratio.[2] These biases have meant that a girl who would ultimately have a diagnosis of autism would have a less than third of a chance of receiving a diagnosis before the age of 10 years.

The skew in male to female ratio in childhood may or may not be misleading. It could be that the onset of autistic traits is delayed in females; if that is the case, it may be unreasonable to assume that autism is being missed in young girls. It might, however, suggest that the assessment tools contain sex biases and need reworking. Might it be possible to capture autism earlier in girls with refined measurement tools? Or are girls, out of instinct or necessity, more convincingly masking their autistic traits from an early age, with greater pressure to act neurotypical or fit in with their peers?

The reasoning behind sex differences

The explanation for why autism is diagnosed later in girls and women compared with boys and men is possibly twofold. Firstly, sex differences are likely in the presentation of autistic traits, especially in childhood. Secondly, informers (eg, parents, teachers) and diagnosticians might expect females to be less likely to be autistic and develop a bias against recognising autistic traits in girls.[8] With current common assessment tools, autistic girls perform at more typical levels than autistic boys in all three diagnostic domains of autism: socialisation, restricted and repetitive behaviours and interests, and communication.[9] Research has suggested that among autistic children aged 7-13 years, girls perform at higher levels than boys in assessments of social adaptive functioning.[9] However, autistic girls experience a surge of social difficulty from late childhood through adolescence.[10] Furthermore, among autistic people without intellectual disability, females across the lifespan show lower levels of restricted and repetitive behaviours and interests—at least according to common assessment tools, which may themselves include sex related biases (eg, questions about trains but not about dolls).[11 12] Finally, just as with the non-autistic population, autistic girls outperform autistic boys in the area of linguistic abilities.[13]

Studies like that of Fyfe and colleagues are essential to changing the assumption that autism is more prevalent in the male sex than in the female sex. As autistic girls and women await proper diagnosis, they are likely to be (mis)diagnosed with psychiatric conditions,[14] especially mood and personality disorders,[15] and they are forced to self-advocate to be seen and treated appropriately: as autistic patients, just as autistic as their male counterparts.

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Testing menstrual blood for human papillomavirus during cervical cancer screening in China

Tian X, Cao C, Wang L, et al

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Study question Does minipad collected menstrual blood show comparable diagnostic accuracy to clinician collected cervical samples for HPV testing and detection of cervical intraepithelial neoplasia (CIN) grade 2 or worse (CIN2+) or grade 3 or worse (CIN3+)?

Methods This population based study took place in four urban communities and three rural communities in Hubei Province, China from September 2021 to January 2025. Participants underwent HPV testing of minipad collected menstrual blood, clinician collected cervical samples, and ThinPrep cytology. Women who tested positive for HPV by either collection method or by cytology (atypical squamous cells of undetermined significance or worse) were referred for colposcopy directed biopsy sampling. This study evaluated the diagnostic accuracy of minipad based HPV testing compared with clinician based HPV testing for detecting cervical CIN2+ and CIN3+.

Study answer and limitations Among 3068 participants, minipad based HPV testing showed a sensitivity of 94.7% (95% confidence interval 80.9% to 99.1%) for CIN2+ detection, comparable to clinician based HPV testing (92.1%, 77.5% to 97.9%; P=1.00). Although minipad based HPV testing showed a lower specificity than clinician based HPV testing (89.1%, 88.0% to 90.2% *v* 90.0%, 88.9% to 91.1%; P=0.001), the negative predictive value matched that of clinician based HPV testing (99.9%, 99.7% to 100.0% *v* 99.9%, 99.7% to 100.0%; P=1.00). Positive predictive value (9.9%, 7.1% to 13.5% *v* 10.4%, 7.4% to 14.3%; P=0.82) and screening efficiency (10.1 *v* 9.6 referrals per CIN2+ detected; P=0.82) were equivalent between the two collection methods. Limitations of this study are that as menstrual blood flows through the genital tract, HPV can infect sites beyond the reach of conventional sampling methods, including the endocervical canal, vagina, and vulvar areas. Also, as the screening sample size limited the diagnostic accuracy estimates, future studies should include women with higher grade diagnoses.

What this study adds Minipad collected menstrual blood showed comparable diagnostic accuracy to clinician collected cervical samples for HPV testing in the detection of CIN2+ and CIN3+.

Funding, competing interests, and data sharing
This study was supported by the Key Technology R&D Program of Hubei and Academician Expert Workstation of the Central Hospital of Wuhan in China. No competing interests declared. Deidentified data, statistical analysis codes, and study protocols are available as supplementary materials.

Study registration ClinicalTrials.gov NCT06082765.

Diagnostic accuracies of cervical screening methods for detection of CIN2+ and CIN3+. Values are number/total number (percentage, 95% CI) unless stated otherwise

	Sample type for HPV testing				
	Minipad collected menstrual blood	Clinician collected cervical cells	Cytology ≥ASC-US	P value*	P value†
CIN2+					
Sensitivity	36/38 (94.7, 80.9 to 99.1)	35/38 (92.1, 77.5 to 97.9)	30/38 (78.9, 62.2 to 89.9)	1.00	0.11
Specificity	2701/3030 (89.1, 88.0 to 90.2)	2728/3030 (90.0, 88.9 to 91.1)	2915/3030 (96.2, 95.4 to 96.8)	0.001	<0.001
Positive predictive value	36/365 (9.9, 7.1 to 13.5)	35/337 (10.4, 7.4 to 14.3)	30/145 (20.7, 14.6 to 28.4)	0.82	0.001
Negative predictive value	2701/2703 (99.9, 99.7 to 100.0)	2728/2731 (99.9, 99.7 to 100.0)	2915/2923 (99.7, 99.4 to 99.9)	1.00	0.14
Screening efficiency‡	365/36 (10.1)	337/35 (9.6)	145/30 (4.8)	0.82	0.001
CIN3+					
Sensitivity	13/14 (92.9, 64.2 to 99.6)	12/14 (85.7, 56.2 to 97.5)	12/14 (85.7, 56.2 to 97.5)	1.00	1.00
Specificity	2702/3054 (88.5, 87.3 to 89.6)	2729/3054 (89.4, 88.2 to 90.4)	2921/3054 (95.6, 94.9 to 96.3)	0.001	<0.001
Positive predictive value	13/365 (3.6, 2.0 to 6.2)	12/337 (3.6, 1.9 to 6.3)	12/145 (8.3, 4.5 to 14.3)	1.00	0.03
Negative predictive value	2702/2703 (100.0, 99.8 to100.0)	2729/2731 (99.9, 99.7 to 100.0)	2921/2923 (99.9, 99.7 to 100.0)	1.00	1.00
Screening efficiency‡	365/13 (28.1)	337/12 (28.1)	145/12 (12.1)	1.00	0.03

≥ASC-US=atypical squamous cells of undetermined significance or higher grade; CI=confidence interval; CIN2+=cervical intraepithelial neoplasia grade 2 or worse; CIN3+=cervical intraepithelial neoplasia grade 3 or worse; HPV=human papillomavirus.
The 95% CIs for proportions were computed using the Wilson method.
*Differences in diagnostic accuracy between minipad HPV testing and clinician HPV testing were assessed using a McNemar test for sensitivity and specificity or a x^2 test for predictive values and screening efficiency.
†Differences in diagnostic accuracy between minipad HPV testing and cytology.
‡Screening efficiency: number of colposcopies required to diagnose CIN in one woman.

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