Evaluating the use of telemedicine in gynaecological practice: a systematic review

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ABSTRACT

Objectives The aim of this systematic review is to examine the use of telemedicine in the delivery and teaching of gynaecological clinical practice. To our knowledge, no other systematic review has assessed this broad topic.

Design Systematic review of all studies investigating the use of telemedicine in the provision of gynaecological care and education. The search for eligible studies followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and focused on three online databases: PubMed, Science Direct and SciFinder.

Eligibility criteria Only studies within gynaecology were considered for this review. Studies covering only obstetrics and with minimal information on gynaecology, or clinical medicine in general were excluded. All English language, peer-reviewed human studies were included. Relevant studies published up to the date of final submission of this review were considered with no restrictions to the publication year.

Data extraction and synthesis Data extracted included author details, year of publication and country of the study, study aim, sample size, methodology, sample characteristics, outcome measures and a summary of findings. Data extraction and qualitative assessment were performed by the first author and crossed checked by the second author. Quality assessment for each study was assessed using the Newcastle-Ottawa scale.

Results A literature search carried out in August 2020 yielded 313 records published between 1992 and 2018. Following a rigorous selection process, only 39 studies were included for this review published between 2000 and 2018. Of these, 19 assessed gynaecological clinical practice, eight assessed gynaecological education, one both, and 11 investigated the feasibility of telemedicine within gynaecological practice. 19 studies were classified as good, 12 fair and eight poor using the Newcastle-Ottawa scale. Telecolposcopy and abortion care were two areas where telemedicine was found to be effective in potentially speeding up diagnosis as well as providing patients with a wide range of management options. Studies focusing on education demonstrated that telementoring could improve teaching in a range of scenarios such as live surgery and international teleconferencing.

Strengths and limitations of this study

► The review addresses the delivery of gynaecological clinical care and education remotely (telemedicine), a topic of immense importance as we are undergoing a period of global pandemic.
► To our knowledge, no other systematic review has assessed this broad topic.
► Large proportion of studies were observational in nature, without clear quantitative outcomes for statistical analysis.

Conclusions The results of this review are promising and demonstrate that telemedicine has a role to play in improving clinical effectiveness and education within gynaecology. Its applications have been shown to be safe and effective in providing remote care and training. In the future, randomised controlled studies involving larger numbers of patients and operators with measurable outcomes are required in order to be able to draw reliable conclusions.

INTRODUCTION

Moving into the 21st century, the exponential development of technology is driving change in the teaching and practice of gynaecology.1 The potential to reach a wider audience via targeted cost-effective innovation is almost inevitable, with an avenue opening up to improve access to healthcare and patient outcomes.2 Telemedicine (TM) can be defined as ‘the use of medical information exchanged from one site to another via electronic communications to improve a patient’s clinical health status’.3 It can be used for clinical care directly and as a method of educating trainees.

Within gynaecology, advocates of TM stress its potential role to aid diagnosis, treatment, follow-up and long-term care. Inadequate access to overall medical care has been reported as being related to a range of factors including...
METHODS

Search strategy

The systematic search followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. A bibliographic search of English language publications in three computerised databases (PubMed, Science Direct and SciFinder) was conducted. A bibliographic search of English language publications in the computerised database PubMed was conducted. PubMed was our primary database where controlled vocabulary (Medical Subject Headings (MeSH) words) was used separately and in combination. Free text words were also used on PubMed and on the supplementary databases: SciFinder and Science Direct.

The search terms, MeSH words and combinations of searches used are listed in Table 1. Various combinations of “gynaecology” or “gynecology” with other relevant MeSH words such as “telementoring”, “teledermicine”, “teleconferencing”, “mobile health”, “telehealth”, “ehealth” and “mhealth” were used for the literature search. Finally, the search was augmented by a snowball strategy, examining the references cited in primary sources and review manuscripts. The screening and selection process of the relevant studies conducted are shown on the figure 1.

Study selection

Only studies within gynaecology were considered for this review. Studies covering only obstetrics and with minimal information on gynaecology, or clinical medicine in general were excluded. All English language, peer-reviewed human studies were included. Relevant studies published up to August 2020 were considered with no restrictions to the publication year.

Study screening

The initial search for the relevant studies was performed by the first author (SM) and was independently repeated by the second author (NG). An overview of the search results and screening process is summarised in the study flow diagram (figure 1). The screening process was cross-checked by a senior author (SS). Disagreement between the reviewers was resolved by discussion until consensus was reached.

Data extraction and analysis

A data extraction spreadsheet was developed and agreed between the authors. The selected studies were...
comprehensively examined. Relevant data were extracted for each paper and inputted to the spreadsheet by the first author (SM) and subsequently crosschecked by the second author (NG). Data were then analysed qualitatively and summarised in the Results section. Because of the heterogeneity of the studies describing different modes of TM on different clinical topics within gynaecology, it was not possible to pool data together and perform a meta-analysis. The authors of the selected studies were not contacted to provide any information other than what was presented in the studies.

Quality assessment for each study was assessed using the Newcastle-Ottawa scale proforma. Using this quality assessment tool, each study is judged on eight items, categorised into three groups: the selection of the study groups; the comparability of the groups; and the ascertainment of either the exposure or outcome of interest for case-control or cohort studies, respectively. Disagreement regarding extracted data were resolved by discussion and deliberated on by a more senior author (SS).

**Patient and public involvement**
Patients were not involved in the design or required for recruitment in this systematic review.

**RESULTS**
The results are presented in the following tables: table 2 lists the topic and aim of the study, results and conclusions; table 3 contains descriptive factors related to technology such as the distance between the subjects and the tele-healthcare provider, the bandwidth and the device/technology used; table 4 consists of more study characteristics including the duration of the study, the subjects (eg, cadavers, simulation, etc) and number of operators/clinicians. The studies have also divided into four broad categories according to their topic: clinical, education, clinical and education and feasibility.

**Selected studies**
After the initial search though PubMed, a total of 313 records were screened. The publications dated from

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**Image 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses information flow chart.
| Authors (year) | Subspecialty | Study design | Aim | Results | Conclusion |
|---------------|--------------|--------------|-----|---------|------------|
| **Clinical**  |              |              |     |         |            |
| Bouwsma et al (2018) Netherlands<sup>11</sup> | Gynaecological surgery for benign disease | Stepped-wedge cluster randomised controlled trial | Randomised control trial for patients scheduled for hysterectomy and/or adnexal surgery, to assess impact of an internet-based personalised care programme on return to work (RTW) | Median time until RTW was 49 days (IQR 27–76) in the intervention group and 62 days (42–85) in the control group. In the first 85 days after surgery, patients receiving the intervention returned to work faster than patients in the control group (HR 2.66, 95% CI 1.88 to 3.77). | Implementation of an internet-based care programme has a large potential to lead to accelerated recovery and improved RTW rates following different types of gynaecological surgeries. |
| Grindlay and Grossman (2017) USA<sup>12</sup> | TM: medical abortion | Qualitative: 8 in-depth interviews with clinic providers and staff involved with the provision of medical abortion using TM | To evaluate providers’ experiences with TM provision of medical abortion in Alaska using qualitative methods | Providers reported that TM provision of medical abortion facilitated a more patient-centred approach to care where women were able to be seen sooner, have greater choice in abortion procedure type, and could be seen closer to their home. Providers felt that it was easy to integrate the new technology into clinic operations, and that a TM visit largely required the same overall processes and clinic flow as an in-person visit. | These findings indicate high acceptability among providers and the appropriateness for TM application to this healthcare service. |
| Shehata et al (2016) Canada<sup>13</sup> | General obstetrics and gynaecology | Retrospective electronic chart review study | Aim to analyse all the obstetrics and gynaecology eConsults: to estimate the effectiveness of the eConsult service by number of traditional referrals that were avoided as a result of the eConsult service and healthcare provider satisfaction | In 34.3% of eConsults, primary care providers indicated that a traditional consult was avoided. Pregnancy issues and gynaecological cancer screening issues were the most common queries. Primary care providers highly valued the eConsult and the majority of eConsults were completed within 15 min (98.8%). | Electronic consultations were effective at reducing the number of traditional consults requested over 3.5 years. This initiative has potential to reduce current waiting times for traditional consultation in Canada and to make the consultation process more effective. The service was feasible and well received by primary care providers. |

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Continued
### Table 2  Continued

| Authors                        | Subspecialty       | Study design        | Aim                                                                 | Results                                                                                                                                                                                                                                                                                                                                 | Conclusion                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------|--------------------|---------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hitt et al (2016) USA<sup>14</sup> | Telecolposcopy     | Cohort study        | To use telecolposcopy to improve patient outcomes related to cervical cancer in rural settings | Over a 15-month time period, 940 unique patients were seen using telecolposcopy. Telecolposcopy was done at 8 remote sites across Arkansas representing patients from 72 of the 75 counties. After being seen through telecolposcopy, each patient was given an impression based on the assessment by the hub-site clinician. The mean transportation cost per patient saved was US$33.25±13.15 and the mean driving distance saved was 109±43.0 miles. | Telecolposcopy should be further explored and used in rural settings as a way to reduce patient costs and improve cervical cancer outcomes.                                                                                                                                                                                                 |
| Jefferis et al (2016) UK<sup>15</sup> | Urogynaecology     | Cohort simple observational study. | To assess the use of TM follow-up after day case TVT insertion | 262 TVT cases were initially followed up via telephone, of which 10% then required review in outpatient clinic. | By using TM, 234 patients (90%) who would normally be seen in clinic were followed up remotely, saving valuable clinic time for patients with greater clinical need.                                                                                                                                                                                                                                                                 |
| Ricard-Gauthier et al (2015) Switzerland<sup>16</sup> | Gynaecology        | Cohort study        | To evaluate the feasibility and performance of smartphone digital images for the detection of CIN 2 or worse as an adjunct to a conventional visual inspection approach with acetic acid (VIA) and Lugol’s iodine (VILI), in comparison with detection by histopathological examination | 87 HPV-positive women were screened for cervical cancer. Overall, 7 cases of CIN2+ (8.0%) were diagnosed using biopsy specimens. The on-site physician obtained a sensitivity of 28.6% (95% CI 3.7% to 71%) and a specificity of 87.2% (95% CI 77.7% to 93.7%). The off-site physicians obtained a sensitivity ranging between 42.9% (95% CI 9.9% to 81.6%; p=1) and 85.7% (95% CI 42.1% to 99.6%; p=0.13) and a specificity between 48.1% (95% CI 36.5% to 59.7%; p<0.001) and 79.2% (95% CI 68.5% to 87.6%; p=0.10). Comparison between observers did not reach significance. Observers assessed 95.6% of all images as very good or acceptable for interpretation purpose. | Smartphone images may be a useful adjunct to conventional VIA and VILI for the detection of CIN2+ and improve cervical cancer screening in low-resource settings.                                                                                                                                                                                                 |

Continued
### Table 2  Continued

| Authors (year)                | Subspecialty       | Study design                        | Aim                                                               | Results                                                                                                                                                                                                 | Conclusion                                                                                                                                                                                                 |
|-------------------------------|--------------------|-------------------------------------|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Catarino et al (2015) Switzerland | Gynaecology        | Cohort study                        | To evaluate the use of a smartphone for on-site and off-site VIA diagnosis | Of the 332 women recruited, 137 (41.2%) were HPV-positive and recalled for VIA triage; compliance with this invitation was 69.3% (n=95). CIN was detected in 17.7% and 21.7% of digital images by on-site and off-site physicians, respectively. The on-site physician had a sensitivity of 66.7% (95% CI 30.0% to 90.3%) and a specificity of 85.7% (95% CI 76.7% to 91.6%); the off-site physician consensus sensitivity was 66.7% (95% CI 30.0% to 90.3%) with a specificity of 82.3% (95% CI 72.4% to 89.1%). | This pilot study supports the use of TM for off-site diagnosis of CIN, with diagnostic performance similar to those achieved on-site.                                                                                                                                 |
| Stratton et al (2015) USA      | Gynaecology        | Cohort study                        | To identify strategies and factors effective in recruitment and retention of study participants | 37 participants were enrolled. The largest proportion of participants (46%) was enrolled from the telecolposcopy network. Others were enrolled through outside institutions (43%), in-house referrals (8%), or direct advertisement (3%). Most participants were motivated to join the study to take care of their health issues. Only 2 participants joined the Facebook private page. Of 24 participants who qualified for vaccination, only 1 terminated early due to an unanticipated move. | The availability of a large number of potential participants from the telecolposcopy network increased recruitment to this clinical trial by 85% over other traditional means of recruitment. The telecolposcopy network is not only a means of providing a gynaecological service to women who otherwise would forego care, but also a novel and valuable resource in recruiting participants for a clinical trial. |
| Vonk Noordegraaf et al (2014) Netherlands | Gynaecology        | Randomised, single-blinded, controlled trial | To evaluate the effectiveness of an eHealth intervention on recovery and return to work, after gynaecological surgery | In intention-to-treat analysis, the eHealth intervention was effective on time to return to work (HR 1.43; 95% CI 1.03 to 2.04; p=0.048). The median duration of sick leave until a full sustainable return to work was 39 days (IQR 20–67 days) in the intervention group and 48 days (IQR 21–69 days) in the control group. After 26 weeks pain intensity was lower (VAS, cumulative OR 1.84; 95% CI 1.04 to 3.25; p=0.035) and quality of life was higher (Rand-36 health survey, between-group difference 30, 95% CI 4 to 57; p=0.024) in the intervention group, compared with the control group. | The use of the eHealth intervention by women after gynaecological surgery results in a faster return to work, with a higher quality of life and less pain. |
| Authors (year) | Subspecialty | Study design | Aim | Results | Conclusion |
|---------------|-------------|--------------|-----|---------|------------|
| Gomperts et al (2014) Netherlands<sup>20</sup> | Early pregnancy, medical termination | Cohort study | To evaluate the need for and outcome of self-administered medical abortion with mifepristone and misoprostol in Brazil, provided through Women on Web, a global TM abortion service | The women on website had 109,779 unique visitors from Brazil, 2,104 women contacted the helpdesk by email. Of the 1401 women who completed the online consultation, 602 women continued their request for a medical abortion. Of the 370 women who used the medicines, 307 women gave follow-up information about the outcome of the medical abortion. Of these, 207 (67.4%) women were 9 weeks or less pregnant, 71 (23.1%) were 10, 11 or 12 weeks pregnant, and 29 (9.5%) women were 13 weeks or more pregnant. There was a significant difference in surgical intervention rates after the medical abortion (19.3% at 9 weeks, 15.5% at 11–12 weeks and 44.8% at N13 weeks, p=0.06). However, 42.2% of the women who had a surgical intervention had no symptoms of a complication. | There is large need for medical abortion in Brazil. Home use of mifepristone and misoprostol provided through TM is safe and effective. However, after 13 weeks gestation, there is an increased risk of surgical intervention that may be due to the regimen used and local clinical practices in Brazil. |
| Hitt et al (2013) USA<sup>21</sup> | Gynaecology | Cohort study | To provide needed care to an at-risk population. Second, to test the validity of providing care by pairing local examiners with only limited experience in colposcopy with distant experts provided by TM, and therefore provide a model that could be duplicated in other medically underserved areas. | The programme scheduled 1812 visits involving 1504 unduplicated patient referrals from 68 of the 75 counties in Arkansas and performed 1298 colposcopic examinations. | This project provides complex specialty gynaecological services using TM technology to overcome geographical barriers while producing results comparable to traditional examinations. It is cost effective and well received by patients and can be used as a model for improving access to care among vulnerable populations. |
### Table 2 Continued

| Authors | Subspecialty | Study design          | Aim                                                                 | Results                                                                                           | Conclusion                                                                                       |
|---------|--------------|-----------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Gomperts et al (2012) Netherlands | Early pregnancy, Cohort study medical termination | Analysis of factors influencing surgical intervention rate after home medical TOP by women in countries without access to safe services using the TM service ‘Women on Web’ | Of the 2323 women who did the medical TOP and had no ongoing pregnancy, 289 (12.4%) received a surgical intervention. High rates were found in Eastern Europe (14.8%), Latin America (14.4%) and Asia/Oceania (11.0%) and low rates in Western Europe (5.8%), the Middle East (4.7%) and Africa (6.1%; p<0.001). More interventions occurred with longer gestational age (p<0.001). Women without a surgical intervention more frequently reported satisfaction with the treatment (p<0.001). | The large regional differences in the rates of reported surgical interventions after medical TOP provided by TM cannot be explained by demographic factors or differences in gestational age. It is likely that these differences reflect different clinical practice and local guidelines on (incomplete) abortion rather than complications that genuinely needed surgical intervention. Surgical interventions significantly influenced women’s views on the acceptability of the TOP. |
| Kldashvili and Schrader (2010) Georgia | Gynaecological cytology Case-control study | To evaluate the effectiveness of digital images for telecytology diagnosis and compare it with routine cytology diagnosis | There was 94% concordance in average between routine vs digital images diagnostic. Intracytologists concordance averaged 95.5%. Image sharpness and quality were rated ‘good’ and ‘excellent’ in 97% cases. With respect to image colour, 96% of the images were rated as ‘excellent’ or ‘good’. | Digital images for cytology diagnostic are of adequate quality, with diagnostic concordance rates. |
| Radley et al (2006) UK | Urogynaecology Cross-sectional study | To develop and evaluate a Web-based, electronic pelvic floor symptoms assessment questionnaire (e-PAQ) for women | In secondary care, factor analysis identified 14 domains within the four dimensions (urinary, bowel, vaginal and sexual symptoms) with internal consistency (Cronbach’s alpha) ≥ 0.7 in 11 of these. In primary care, alpha values were all ≥ 0.7 and test-retest analysis found acceptable intraclass correlations of 0.50–0.95 (p<0.001) for all domains. A measure of face validity and utility was gained using a nine-item questionnaire, which yielded strongly positive patient views on relevance and acceptability. | The e-PAQ offers a user-friendly clinical tool, which provides valid and reliable data. The system offers comprehensive symptoms and quality of life evaluation and may enhance the clinical episode as well as the quality of care for women with pelvic floor disorders. |
| Authors (year) | Subspecialty | Study design | Aim | Results | Conclusion |
|---------------|-------------|--------------|-----|---------|------------|
| Perisic, Rasic, Raznatovic (2006) Serbia and Montenegro | Gynaecology | Cohort study | To test the performance of telecolposcopy in the diagnosis of various squamous intraepithelial lesions | The findings were identical for group 1 (15 gynaecologists who were not trained in colposcopy) and group 2 (six experienced colposcopists) in 219 cases, that is, an interobserver agreement of 88%; Cohen’s kappa was 0.81. The findings were identical for group 1 and group 3 (supervising team consisting of three experts) in 208 cases, that is, an interobserver agreement of 83%; Cohen’s kappa was 0.74. The findings were identical for groups 2 and 3 in 239 cases, that is, an interobserver agreement of 96%; Cohen’s kappa was 0.93. | Beginning TM in Serbia is difficult because of the limiting factors such as insufficient computer equipment in the healthcare system and, as its consequence, the insufficient computer training of physicians, but investigations like this one show the efficacy of using new technologies for getting an accurate diagnosis, cutting travel to the specialised secondary healthcare institutions, a greater use of second opinions and continuing education of a larger circle of medical staff. The long-term goal is to transfer colposcopy screening to a lower level (eg, nurses, technicians), but to retain the same efficacy. |
| Etherington et al (2002) UK | Cervical screening | Cohort study | A pilot study to see whether the telecolposcopy system could record images of sufficient quality for diagnosis | Based on a diagnosis only of normal or abnormal, telecolposcopy had a sensitivity of 89% and a specificity of 93%, a positive predictive value of 91% and a negative predictive value of 91%. The level of agreement between the telescreener and the colposcopist was good (kappa 0.70). Furthermore, telecolposcopy screening did not erroneously grade any cases of colposcopic high grade CIN as normal. | Telecolposcopy, which is designed to be used by nurses in primary care, can be used reliably to make diagnoses. The technology is easily adaptable for real-time teleconsultation. |
| Allen-Davis et al (2002) USA | Gynaecology: vulvovaginitis | Cohort study | To examine the agreement between telephone and office management of vulvovaginal complaints and to assess the accuracy of diagnosis of vulvovaginitis | A total of 485 patients underwent telephone interviews, and 253 (52%) completed the study protocol. Values showed poor agreement between nurses and practitioners for bacterial vaginosis (0.12), candidiasis (0.22), and trichomoniasis (0.05). There was also poor agreement between telephone nurses and practitioners regarding the necessity of an office visit (0.14). | This prospective study challenges the notion that the telephone is an effective tool to diagnose and treat vulvovaginal problems. |

## Table 2 Continued
| Authors (year) | Subspecialty       | Study design | Aim                                                                 | Results                                                                 | Conclusion                                                                 |
|---------------|-------------------|--------------|----------------------------------------------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Atlas et al (2000) Israel | Gynaecology      | Case series  | To improve the care of gynaecological cancer patients and to exchange medical knowledge between multidisciplinary groups in Providence, Rhode Island, USA, and in Safed, Israel. | In the first 9 months of its operation, more than 450 patients were discussed by the International Tumour Board (ITB). During the 20 videoconferences, major technical difficulties were infrequent and easily resolved. | Collaboration via the ITB also shares expensive healthcare resources (eg, medical expertise) which are only occasionally needed for making the optimum recommendations within the vast domain of oncology. The prospective, multidisciplinary, realtime, teleconferenced ITB process could be a model for the management of other (ie, non-oncological) yet complex healthcare questions. |
| Tates et al (2016) Netherlands | Urogynaecology | Case series  | To examine the impact of a consultation medium on doctors’ and patients’ communicative behaviour in terms of information exchange, interpersonal relationship building, and shared decision-making | Satisfaction, perceived information exchange, interpersonal relationship building, and perceived shared decision-making showed no significant differences between face-to-face and screen-to-screen consultations. Patients’ attitude toward Web-based communication \( (b=-0.249, p=0.02) \) and patients’ perceived time and attention \( (b=0.271, p=0.03) \) significantly predicted patients’ perceived interpersonal relationship building. Patients’ perceived shared decision-making was positively related to their satisfaction with the consultation \( (b=0.254, p=0.005) \). Overall, patients experienced significantly greater shared decision-making with a female doctor (mean 4.21, SD 0.49) than with a male doctor (mean 3.66(SD 0.73); \( b=0.401, p=0.009) \). | The quality of doctor–patient communication did not differ significantly between web-based and face-to-face consultations. Doctors and simulated patients were equally satisfied with both types of consultation medium, and no differences were found in the manner in which participants perceived communicative behaviour during these consultations. The findings suggest that worries about a negative impact of web-based video consultation on the quality of patient–provider consultations seem unwarranted. |
| Authors (year)                  | Subspecialty       | Study design             | Aim                                                                                     | Results                                                                                                                                                                                                 | Conclusion                                                                                                                                                                               |
|--------------------------------|--------------------|--------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gambadauro and Magos (2007)    | Gynaecology surgery| Case series              | Develop a Network-Enhanced Surgical Training (NEST) system around standard hardware and free software | Successfully developed a NEST telementoring system based on two standard personal computers connected by an Ethernet cable. Technology successfully used during a range of gynaecological interventions: abdominal, vaginal and laparoscopic surgery. Also used during pelvic-trainer sessions in skills laboratory. NEST seems reliable as mentor’s instructions, both vocal and visual, always followed on time by surgeon during tests. | NEST system could be an ideal tool for studies on telementoring in safe environments, with the supervisor potentially just next door. Developed a potential new strategy to enhance rate of trainee’s supervision. NEST is affordable and reproducible with readily available and relatively inexpensive technology. |
| Katz et al (2017) Israel        | General obstetrics and gynaecology | Case-control quantitative study | Quantitative study to assess the effectiveness of a computerised interactive simulator coupled with an instructor who monitored students’ progress and provided web-based immediate feedback (WOZ training). In comparison to an automated e-learning module. | A significant advantage ($p=0.01$) was found in favour of the WOZ training approach.                                                                                                                      | Involvement of a web-based instructor in the simulation-based training process provided better learning outcomes that varied training content and trainee populations did not affect the overall learning gains. |
| Yoost et al (2017) USA          | Reproductive health | Prospective cohort Study | To evaluate the use of telehealth to teach reproductive health to rural areas with high rates of teen pregnancy | Reported condom use increased from 20% (10/50) at baseline to 40% (15/37) at 6 months ($p=0.04$). Hormonal contraception use increased from 22% (11/50) to 38% (14/37) ($p=0.12$). Report of HPV vaccination increased from 38% (10/26) to 70% (26/37) ($p=0.001$) among all subjects. At 6 months, 91.8% (34/37) reported the use of telehealth was ‘very effective’ as a means to teach the material. | Telehealth is an effective tool to teach reproductive health to rural areas. This model could be used to reach other rural counties with limited resources.                                      |
| Authors (year) | Subspecialty | Study design | Aim | Results | Conclusion |
|---------------|--------------|--------------|-----|---------|------------|
| Chekerov et al (2008) Germany¹³ | Gynaecology oncology | Qualitative study | To develop specific web-based software to organise and conduct online tumour board meetings of gynaecologists, surgeons, radiologists, oncologists and pathologists from different hospitals and gynaecological practitioners, discussing individual patient’s cases, defining therapy options and exchanging clinical experience | 84% of the participants reported to be satisfied with the information content. 72% were satisfied with the technical support. 98% of the individual therapy recommendations were accepted and implemented. 92% agreed that the tumour board conference presents an optimal possibility for extensive scientific discussions and exchange. 81% agreed that the online tumour conference improves advanced educational training. | The online tumour conference is feasible and represents a time-saving possibility for gynaecological oncologist to receive a treatment recommendation based on the best available clinical and scientific evidence. |
| Haller and Gabathuler (2003) Switzerland³⁴ | General obstetrics and gynaecology | Case study | To transmit advanced training sessions externally | Teleconferencing organised between 1997 to 2001 from Zurich to Basel and Brig. | Advantages: 1. Cost-efficient technology 2. Internationally widespread technology 3. Guaranteed bandwidth Disadvantages: 1. Limited resolution 2. Adaptation of movements dependent on the amount of ISDN lines 3. Mixed use of multipoint 128/384 kbit/s is error sensitive 4. Interactivity with use of multipoint is hardly used. |
| Chaves et al (2017) Brazil³⁵ | Gynaecology surgery | Qualitative prospective study | To engage trainees to use the TM features of surgery on their own smartphones and tablets as an educational tool. | 94% of the answered items were in agreement, 4.1% were neutral answers, and only 1.7% corresponded to negative impressions about the system. Cronbach’s α was 0.82, which represents a good reliability level. Spearman’s coefficients were highly significant in 4 comparisons and moderately significant in the other 20 comparisons. | This study presents a local streaming video system of live surgeries to smartphones and tablets and shows its educational utility, low cost and simple usage, which offers convenience and satisfactory image resolution, thus being potentially applicable in surgical teaching. |

¹³ Meneghel, S. et al. BMJ Open 2020;10:e039457. doi:10.1136/bmjopen-2020-039457
³⁴ Haller, S. et al. J Med Internet Res 2003;5(1):e4. doi:10.2196/jmir.5.1.e4
³⁵ Chaves, M. et al. PLoS One 2017;12(12):e0193478. doi:10.1371/journal.pone.0193478
| Authors       | Subspecialty                  | Study design          | Aim                                                                 | Results                                                                                                           | Conclusion                                                                                       |
|--------------|-------------------------------|-----------------------|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Boatin et al (2015) USA | General obstetrics and gynaecology | Qualitative study     | To develop a teaching conference between two institutions, one based in Boston, USA and the other in Mbarara Uganda | Over 30 months, 30 lectures were given using teleconferencing between USA and Uganda. A number of conferencing tools were used: direct telephone connection, Ventrilo conferencing system and Skype via personal computer or smart phone. PowerPoint lectures were stored in a collective Dropbox that could be accessed and downloaded prior to lecture dates. | A successful collaboration in medical education via teleconference is sustainable, low cost, and beneficial to both resource-rich and resource-poor institutions. Expertise can be shared bilaterally and internationally by individuals who are potentially unable travel. |
| Browne et al (2000) USA | General obstetrics and gynaecology | Qualitative study     | To use video teleconferencing to improve the continuity of curricula among geographically dispersed clerkships | Describes the use of interactive video teleconferencing as a tool to link and improve a multisite undergraduate core clerkship in obstetrics and gynaecology. The site coordinators, clerkship director, and administrative personnel from the parent institution meet approximately 3 weeks after the completion of each core clerkship for live, real time and interactive broadcast to complete student evaluations, review curricula, and discuss problems with current students and other pertinent educational issues. | Video teleconferencing provides a mechanism to ensure consistency in curriculum and student evaluations and provides administrative support to distant sites. |
| Cordasco et al (2015) USA | Veteran women's health | Qualitative study     | A women's health focused educational and virtual consultation programme using televideo conferencing. The study aimed to perform a formative evaluation of the programme's development and implementation. | In 53 post session surveys received, 89% agreed with the statement ‘The information provided in the session would influence my patient care’. Among 18 interviewees, all found the programme useful for building and maintaining women's health knowledge. All interviewees also reported that sessions being conducted during their lunch hour limited consistent participation. | This women’s health education and virtual consultation programme is a promising modality for building and maintaining primary care provider knowledge of women’s health, and influencing patient care. |
| Authors (year)                  | Subspecialty                        | Study design                      | Aim                                                                 | Results                                                                                                                                                                                                 | Conclusion                                                                                          |
|--------------------------------|-------------------------------------|-----------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| Van Dongen et al (2016)        | Reproductive medicine               | Randomised controlled trial       | To evaluate a personalised e-therapy programme (Internet based) for women during fertility treatment aimed to reduce the chance of having clinically relevant symptoms of anxiety and/or depression after unsuccessful ART treatment. | The acceptability was good, as was the integration within current clinical guidelines and care. However, the demand reflected by a participation rate of 44% was low, since most women declined participation because they felt no need for support at that moment. The practicality of the intervention was moderate illustrated by a relatively high dropout rate (30%) due to practical concerns. The intervention was effective, shown by a reduction in the percentage women having clinically relevant symptoms of anxiety and/or depression in the compliant intervention group compared with the control group 3 months after the first ART cycle; risk difference of 24% (95% CI 2% to 46%; p=0.03). | In clinical fertility care, personalising an e-therapy programme to the patients’ risk profile is promising and feasible. |
| Grossman and Grindlay (2017)   | Early pregnancy, medical termination| Retrospective cohort study        | To compare the proportion of medical abortions with a clinically significant adverse event among TM and in-person patients at a clinic system in Iowa during the first 7 years of the service | During the study period, 8765 TM and 10 405 in-person medical abortions were performed. Forty-nine clinically significant adverse events were reported (no deaths or surgery; 0.18% of TM patients with any adverse event(95% CI 0.11% to 0.29%)) and 0.32% of in-person patients(95% CI 0.23% to 0.45%)). The difference in adverse event prevalence was 0.13% (95% CI 20.01% to 0.28%). 42 emergency departments responded to the survey (35% response rate) none reported treating a woman with an adverse event after medical abortion. | Adverse events are rare with medical abortion, and TM provision is non-inferior to in-person provision with regard to clinically significant adverse events. |
| Authors          | Subspecialty              | Study design        | Aim                                                                 | Results                                                                                           | Conclusion                                                                 |
|------------------|---------------------------|---------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Mamas et al (2016) Greece 41 | Gynaecology: uterine transplant | Simulation cohort study | To assess the TRE of the uterus graft (UG) on TM systems, in uterus transplant (UT). Studied by diagnostic sensitivity-specificity analysis based on simulation of TRE of the UG on 10 MRI sets of female pelvic digital images by two radiologists, assessing the vascular variations of the grafts and the inflammatory and neoplastic lesions of the UG. | The pregrafting TRE of the UG showed: Diagnostic unreliability for vascular variations and a high diagnostic reliability for inflammatory and neoplastic diseases of the UG (100%) | MRI-based TRE of the UG in UT is feasible and highly reliable for the remote pregrafting diagnosis of UG pathological lesions, but unreliable for integrated vascular anatomic and pathological UG remote evaluation for pregrafting and pretransplant decision support and planning. |
| Kim et al (2016) South Korea 42 | Gynaecology Prospective cohort study | To develop web-based digital cervicography system, and validate it compared with conventional film cervicography. | 63 cases were finally analysed after excluding technically defective cases that cannot be evaluated on analogue images. The generalised kappa for analogue versus digital image was 0.83, for analogue versus scanned image 0.72, and for digital versus scanned image was 0.71; all were in excellent consensus. | Digitalised cervicography system can be substituted for the film cervicography very reliably, and can be used as a promising telemedicine (TM) tool for cervical cancer screening. |
| Barlow et al (2012) USA 43 | Paediatric and adolescent gynaecology | Qualitative study | To assess whether Telehealth would be appropriate for paediatric and adolescent gynaecological services in a tertiary care centre and to determine patient/family interest. | Of the 1533 patient visits, 469 (30.6%) were potentially appropriate for telehealth based on geography. According to clinic physicians, only 51 of these 469 visits (10.9%) were appropriate for telehealth. The main reasons for being inappropriate were the need for physical examination (n=238, 57.0%), imaging (n=57, 13.6%), or issues regarding sexuality/privacy (n=45, 10.8%). Of the 51 appropriate visits, 28 patients/families (55.0%) expressed interest in telehealth. | Currently, telehealth appears to be appropriate for only a small subset of patients/families. |

*Table 2 Continued*
### Table 2  Continued

| Authors (year) | Specialty | Study design       | Aim                                                                 | Results                                                                 | Conclusion                                                                 |
|---------------|-----------|--------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Schadel et al (2005) Germany | Gynaecology | Prospective cohort study | To evaluate the diagnostic reliability of cervical examination using digital colposcopy compared with conventional binocular colposcopy. | A total of 315 patients were examined and diagnosed by a colposcopist onsite. During the colposcopic examination, digital camera images were stored on a PC (median five pictures per patient). A second physician, experienced in colposcopy, re-evaluated the initial diagnostic findings using the stored digital images. The primary and secondary findings in each patient were categorised according to the Rome classification system. There was agreement between the primary and secondary examiners in 69% of cases (k=0.60). There was no systematic bias in terms of under-rating or over-rating. The proportion of non-assessable colposcopic examinations was 9%. | Digital colposcopy was reliable and provided advantages in terms of a better follow-up examination and internal quality control of the diagnosis. The pilot study suggests that telecolposcopy may provide better training and further education for physicians and students, and may also improve the diagnostic possibilities in gynaecology. |
| Etherington (2002) UK | Gynaecology | Prospective cohort study | Aim to investigate the negative predictive value of colposcopy and to demonstrate the use of TM to develop a secondary screening technique for use in primary care. | 81 out of 97 women were studied by both techniques. Using a diagnosis of normal or abnormal, telecolposcopy had a sensitivity of 88.9% and a specificity of 93.3%. There was very good agreement between the telecolposcopy screener and the colposcopist (Cohen’s kappa statistic=0.70). Furthermore, telecolposcopy screening did not grade any cases of colposcopic high-grade CIN as normal. | The pilot study has established the validity of diagnosing from transmitted computerised video clips. |
| Stewart et al (2001) UK | Fertility | Randomised controlled trial | To compare patient satisfaction with telephone discussions versus clinic appointments, in couples after unsuccessful IVF/ICSI treatment | Couples were separated into those undergoing their first treatment cycle (100 couples) and those undergoing their second or subsequent treatment cycle (85 couples) and then randomised to either a telephone or appointment follow-up. Satisfaction was assessed by a postal questionnaire and analysis conducted on an ‘intention-to-treat’ basis. An overall response rate of 91% was achieved. | Analysis indicated no statistically significant difference between telephone and appointment groups with regard to the degree of satisfaction. However, there was an association between the type of follow-up and the duration of discussion; telephone follow-up discussions were significantly shorter than appointment follow-ups. |
| Authors (year) | Subspecialty | Study design | Aim | Results | Conclusion |
|---------------|--------------|--------------|-----|---------|------------|
| Harper et al (2000) USA | Gynaecology | Retrospective cohort study | To demonstrate the technical performance and clinical feasibility of a telecolposcopic system through assessment of image transmission veracity, ease of office system implementation and the patient’s acceptance of the electronic image transmission. | 79 women participated in the trial. 3 to 20 images were captured for each woman, documenting cervical squamous intraepithelial lesions and vaginal and vulvar diseases. With complete visualisation of the squamocolumnar junction, there was an 86% agreement between the remote and review sites (k=0.533, p=0.019). The interobserver agreement for colposcopic impressions was 86% (k=0.684, p<0.001), and for colposcopic impressions with histology within one level of disease severity, 86% (k=0.78, p<0.001). Colposcopists’ and patients’ satisfaction with telecolposcopy was excellent. | The telecolposcopic system described in our study is technically feasible, can be implemented in an office system with limited technical support, and is preferred by women who have to travel many miles to receive referral healthcare. |
| Quercia et al (2017) Switzerland | Cervical cancer screening | Prospective cohort study | To assess the feasibility of a mobile health (m-Health) data collection system to facilitate monitoring of women participating to cervical cancer screening campaign. | A total of 151 women were recruited in the study. Technical problems, including transmission of photos, HPV test results and pelvic examination data, have subsequently been solved through a system update. | The quality of the data was satisfactory and allowed monitoring of cervical cancer screening data of participants. |
| Haggerty et al (2016) Romania | Gynaecology | Prospective cohort study | To assess the feasibility of two technology-based weight loss interventions in obese women with endometrial hyperplasia and cancer | 20 women were randomised (TM: n=10, Text4Diet: n=10), and 90% lost weight. Many were early stage (70%) and grade (43.8%) disease with a median age of 60.5 years. A statistically greater weight loss was observed in the TM arm (median loss: 9.7 kg (range: 1.6–22.9 kg)) versus 3.9 kg (range: 0.3–11.4 kg) in the Text4Diet arm (p=0.0231). Similarly, weight loss was greater in the TM (7.6%) as compared with the Text4Diet arm (4.1%, p=0.014). Mean serum levels of IL-2 were significantly lower at intervention end as compared with baseline. | A technology-based weight loss intervention is feasible in women with Type I endometrial cancer/hyperplasia. Both interventions produced weight loss, although more person-to-person contact produced more significant outcomes. Reductions in expression of IL-2 were related to weight loss. |

ART, assisted reproductive technology; CIN, Cervical intraepithelial neoplasia; HPV, Human Papillomavirus; IL, interleukin; ISDN, Integrated Services Digital Network; TRE, Tele-Radiological Evaluation; TVT, Tension-free Vaginal Tape.
| Authors                      | Distance       | Type of device                                                                 | Cost                        | Bandwidth     | Latency     | Troubleshooting                                      |
|------------------------------|----------------|--------------------------------------------------------------------------------|                            |               |             |                                                       |
| **Clinical**                 |                |                                                                                |                            |               |             |                                                       |
| Bouwsma et al (2018)         | Not specified  | An interactive web portal facilitated self-management through the entire surgical pathway, by providing individual tailored convalescence advice preoperatively. Postoperatively, the web portal contained an interactive self-assessment tool to monitor recovery. | The intervention group was associated with cost savings of €56 compared with usual care. | Not specified.| Not specified.| No factors related to technology were specified.       |
| Netherlands                  |                |                                                                                |                            |               |             |                                                       |
| Grindlay and Grossman (2017) | Not specified  | TM: A remote physician who is licensed in Alaska electronically reviews the patient’s history and ultrasound images, and meets with the patient using a Health Insurance Portability and Accountability Act-compliant video teleconference platform. | Not specified.              | Not specified.| Not specified.| Few areas of improvement suggested:                  |
| USA                          |                |                                                                                |                            |               |             | 1. Video shows both doctor and patient on screen, one suggestion was to change the display for the patient so that only physician is seen, as some patients feel shy seeing themselves on-screen and thus distracted. |
|                              |                |                                                                                |                            |               |             | 2. One physician noted at times, they were unsure who else was in the room, this could be resolved with a wider angle camera. |
|                              |                |                                                                                |                            |               |             | 3. 5 participants note that on rare occasions there were minor technical issues such as setting up the camera or adjusting the volume, but these were typically resolved quickly. |
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|-----------|---------|----------------|
| Shehata et al (2016) Canada | Not specified. | Using a secure, web-based tool, primary care providers direct specific patient questions to obstetrics and gynaecology. The primary care provider has the opportunity to append diagnostic images, reports, pictures, or any other information that can aid the specialist in understanding the problem or the reason for consultation. The case is then assigned to the single ob-gyn participating who was participating in the project at the time, resulting in a notification email to that specialist with the expectation that it will be completed within 7 days. | Not specified. | Not specified. | Not specified. | No technical issues identified. |
| Hitt et al (2016) USA | Telecolposcopy done at eight remote sites in Arkansas sending data to a clinician in central Arkansas. Distance not specified | Not specified. | Start-up costs US$44 000 per site or US$352 000 for all eight remote sites. Additional costs can be incurred such as clinic personnel time spent at both the remote site and UAMS, clinical space to perform the procedures and other supplies. | Not specified. | Not specified. | Not specified. | Not specified. |
| Jefferis et al (2016) UK | Not specified. | Telemedical review, telephone communication. | Not specified. | Not specified. | Not specified. | No technical issues identified. |
| Authors (year)                  | Distance                     | Type of device                                                                 | Cost                        | Bandwidth       | Latency | Troubleshooting                                      |
|-------------------------------|------------------------------|--------------------------------------------------------------------------------|-----------------------------|------------------|---------|------------------------------------------------------|
| Ricard-Gauthier et al (2015)  | Switzerland                  | Images from Madagascar analysed by physicians in Geneva.                        | A minimum of 3 pictures were taken for all participants with a smartphone during the examination: one of the native cervix, one after application of acetic acid (1 min after application) and one after application of Lugol’s iodine. | Not specified. | Not specified. | No technical issues identified.                     |
| Catarino et al (2015)         | Switzerland                  | Images from Madagascar analysed by physicians in Geneva.                        | Photos were taken at a distance of about 15 cm from the cervix, with 2.5 optical zoom. Image capture was conducted by using a smartphone (Samsung Galaxy S5), which has a 16 megapixels camera, with an aperture size of F2.2, focal length of 31 mm and a pixel size of 1.12 μ m. All photographs were taken by a medical student, with no previous experience for VIA/VILI, who was trained for cervical image capture and assisted the physician during the examination. | Not specified. | Not specified. | No technical issues identified.                     |
| Stratton et al (2015)         | USA                          | Not specified Recruitment tools: telecolposcopy network, direct advertising and private Facebook page | Recruitment tools: telecolposcopy network, direct advertising and private Facebook page | Not specified. | Not specified. | No technical issues identified.                     |
| Noordegraaf et al (2014)      | Netherlands                  | Not specified The intervention group had access to an eHealth intervention, with detailed tailored preoperative and postoperative instructions on the resumption of work and daily activities, and with tools (eg, a video) to improve self-empowerment, communication with care providers and employer, and to identify recovery problems. | The intervention group had access to an eHealth intervention, with detailed tailored preoperative and postoperative instructions on the resumption of work and daily activities, and with tools (eg, a video) to improve self-empowerment, communication with care providers and employer, and to identify recovery problems. | Not specified. | Not specified. | No technical issues identified.                     |
| Gomperts et al (2014)         | Netherlands                  | Not specified Patients from Brazil who contacted ‘Women on Web’ online TM service | Patients from Brazil who contacted ‘Women on Web’ online TM service | Not specified. | Not specified. | No technical issues identified.                     |
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|-----------|---------|-----------------|
| Hitt et al (2013) USA<sup>21</sup> | Telecolposcopy done at eight remote sites in Arkansas sending data to a clinician in central Arkansas. Distance not specified | During each weekly 3 hours clinic, an advanced practice nurse/nurse practitioner at each of the four remote sites, who has been trained in the mechanics of colposcopy, performs the exams and collects biopsy specimens under the real-time interactive supervision of an experienced Obstetrics-Gynaecology Faculty member at the central hub site in Little Rock. | The study model of using one physician with four nurse practitioner examiners and four assistants produced an hourly cost of US$321.00, or a cost of US$40 per exam. This compares with a traditional model incorporating four doctor examiners with four assistants producing an hourly cost of US$416.00 or a cost per exam of US$52. | Not specified. | Not specified. | Complications with the telecolposcopic method were rare during the study period. Two patients required referral to the hub site due to the presence of very large endocervical polyps that required removal with the patient under anaesthesia. Another two patients were referred to the hub site because of anxiety states requiring intravenous sedation for the examination. |
| Gomperts et al (2012) Netherlands<sup>22</sup> | Not specified. Women from 88 different countries enrolled online | ‘Women on Web’ TM tool: interactive online consultation and follow-up. | Not specified. | Not specified. | Not specified. | No technical issues identified. |
| Kldashvili and Schrader (2010) Georgia<sup>23</sup> | The images reviewed in the same location 100 days later. | Cases photographed with the 2.0 universal serial bus (USB) digital eyepiece microscope camera with a resolution of 2048×1536 pixels. | Not specified. | Not specified. | Not specified. | No technical issues identified. |
| Authors                      | Distance       | Type of device                                                                 | Cost                                                                 | Bandwidth | Latency | Troubleshooting                                      |
|------------------------------|----------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------|-----------|---------|------------------------------------------------------|
| Radley et al (2006) UK       | Not specified  | The electronic pelvic floor symptoms assessment questionnaire was located on a portable workstation in each clinic. Data were transferred on a weekly basis to the secure central inhospital server. Once this transfer had been carried out, all data on the portable workstations were erased. | The costs of computer hardware relate to the units currently in use. The computers used were Dell OptiPlex GX270 PCs with 2.8 GHz Pentium processors installed with the Windows XP operating system (total cost £600). A-frame TS15LBRE1001 screens (cost £590). The installation, networking and maintenance of touchscreen computers are dependent on local IT department costs. In this unit, this amounts to £200 per unit. | Not specified | Not specified | No technical issues identified. |
| Perisic and Rasic (2006) Serbia and Montenegro | Not specified  | The images were acquired using a videocolposcope (I SO-FC, Carl Zeiss), a videorecorder (SLV-E 180E, Sony). | Not specified | Not specified | Not specified | No technical issues identified. |
| Etherington et al (2002) UK   | Not specified  | Not specified                                                                 | Not specified | Not specified | Not specified | The pilot study identified 97 women who were suitable for inclusion. Full data were available from 81 cases: five defaulted. Telescreening appointments, six had telocolposcopy images that were unable to be interpreted and five did not attend their colposcopy appointments. |
| Allen-Davis et al (2002) USA  | Not specified  | Telephone consultation, Device—NS | Not specified | Not specified | Not specified | No technical issues identified. |
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|-----------|---------|-----------------|
| Atlas et al (2000) Israel | Videoconferencing and analysis of cancer cases between two units from the USA and Israel | A videoconferencing unit with a 32 in (81 cm) monitor and several microphones was used in each location. The units were linked by ISDN, usually three lines. A radiograph viewing box and a microscope with an attached video-camera were employed. | Not specified | Not specified | Not specified | No technical issues identified. |
| Tates et al (2016) Netherlands | Same building, different rooms | Laptop and a webcam with a built-in microphone. The intern and patient interacted through Skype. The intern would initiate a video call with the patient and the consultation began. | Not specified | Not specified | Not specified | No technical issues identified. |
| Education | Video and audio interaction between computers in operating room (OR) and a remote computer via internet or intranet. Distance not specified. | Software to connect operating room computer and mentor's computer: Ethernet cable to connect two personal computers. Video UltraVNC and Audio Microsoft NetMeeting. | OR computer: £600 Mentor's computer: £700 Video converter: £50 Bluetooth: £30 Cables: £20 Software video: Free, audio: free Total: £1400 | Not specified | UltraVNC with enhanced video driver reduced the problem to a minimum. Audio latency slightly longer when using a wireless Bluetooth headset than with a hard-wired system. | Main technical issues: quality and the latency of the video and audio material. However, latency did not seem to interfere with the overall interaction between surgeons. |
**Table 3 Continued**

| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|----------------|----------|----------------|------|-----------|---------|-----------------|
| Katz *et al* (2017) Israel<sup>31</sup> | Web-based instructor feedback, physical distance not specified. | TM simulator, developed at the Technion—Israel Institute of Technology, Haifa, Israel—was used; the technology involves a Wizard of Oz (WOZ) simulator. The simulator used for training is a low-fidelity, Web-based application that was developed using Microsoft SharePoint 2010 technology. The computerised interactive simulator was coupled with an instructor who monitored students’ progress and provided web-based immediate feedback. | The simulator is described as a low cost and globally accessible | Not specified | Not specified | Not specified |
| Yoost *et al* (2017) USA<sup>32</sup> | Clinicians were more than 3 hours away from the students’ location. | Sessions involved the use of high-definition teleconferencing equipment. All presentations occurred in real time and were interactive. Throughout the programme, an online portal was present for students to ask anonymous questions of the presenters, which were answered during the following session. | Not specified | Not specified | Not specified | Not specified |
| Chekerov *et al* (2008) Germany<sup>33</sup> | Not specified | Special web-based software was developed for this project in cooperation with a professional contract research organisation (Alcedis GmbH). | Not specified | Not specified | Not specified | Not specified |
| Haller and Gabathuler (2003) Switzerland<sup>34</sup> | Teleconference between three different cities in Switzerland | Transmission organised with an ISDN line | Transmission was organised with an ISDN line (128kbits/s), upgraded to 384kbit/s in 2000 | Not specified | Disadvantages: 1. Limited resolution, 2. Adaptation of movements dependent on the amount of ISDN lines, 3. Presentations sometimes have to be filmed, 4. Mixed use of multipoint 128/384 kbit/s is error sensitive 5. Interactivity with use of multipoint is hardly used. |
Table 3  Continued

| Authors (year)          | Distance                   | Type of device                                      | Cost          | Bandwidth                  | Latency               | Troubleshooting                                                                 |
|-------------------------|----------------------------|-----------------------------------------------------|---------------|----------------------------|-----------------------|--------------------------------------------------------------------------------|
| Chaves et al (2017)     | Outside the operating room, 5–10 m away | Hardware involved in streaming system:               |               |                            |                       | A wireless adapter TP-LINK, model TL-WN722N, with an external 4dBi antenna was included in the streaming system to perform the transmission with a better signal. | Improvements suggested included adding audio transmission simultaneously with the video transmission, which could allow the surgery to be narrated. Another suggestion would be to incorporate recording for use in a video library. |
| Brazil                  |                            | ► One Webcam Logitech C270                           |               |                            |                       |                                                                                |
|                         |                            | ► One Raspberry Pi two model B                       |               |                            |                       |                                                                                |
|                         |                            | ► One wireless adaptor TP-LINK TL-WN722N             |               |                            |                       |                                                                                |
|                         |                            | ► One 5600 mAh battery                              |               |                            |                       |                                                                                |
|                         |                            | The live streaming was performed with a local wireless network created by the streaming system itself. The smartphones and tablets were property of the medical students/ residents and were able to connect to this local wireless network through an access password, so that they could watch the surgery's camera video streaming in real time on a web browser. |               |                            |                       |                                                                                |
|                         |                            | Hardware:                                            |               |                            |                       |                                                                                |
|                         |                            | Raspberry Pi 2:                                      | US$39.50      |                            |                       |                                                                                |
|                         |                            | Webcam Logitech C270                                 | US$22.00      |                            |                       |                                                                                |
|                         |                            | Wireless adapter TP-LINK model TL-WN722N             | US$12.50      |                            |                       |                                                                                |
|                         |                            | Internal support of a construction hardhat:        | US$50 cents   |                            |                       |                                                                                |
|                         |                            | Battery 5600 mAh:                                   | US$10.00      |                            |                       |                                                                                |
| Boatin et al (2015)     | Between Boston and Uganda  | Communication via web conferencing was the primary mode of teleconferencing. Each planned conference would begin with an international phone call between organisers on each end to establish contact prior to web conferencing. Web conferencing tools used included Ventrilo and Skype, through a number of interfaces: personal and hospital computer and smart phones. |               |                            |                       | Not specified 6 of 30 lectures had to be cancelled due to problems with internet connectivity |
| USA                     |                            | The programme was introduced on a budget of under US$500. |               |                            |                       |                                                                                |
|                         |                            | In Boston, free Wi-Fi connections were available through network systems. In Mbarara, no Wi-Fi networks were available. Internet access was obtained by purchasing cellular data through established commercial networks. Approximately 100 MB and 300–500 MB of data is typically required for an hour of continuous audio and web conferencing, respectively. |               |                            |                       |                                                                                |
| Authors          | Year  | Distance                                                                 | Type of device                                                                 | Cost               | Bandwidth  | Latency  | Troubleshooting                                                                 |
|------------------|-------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------|------------|----------|--------------------------------------------------------------------------------|
| Browne et al     | 2000  | Teleconferencing between medical educators from six different sites of the same City | Video teleconferencing: a video teleconference, liquid-display crystal projector, and video and audio recorders are used. | Not specified      | Not specified | Not specified | Data security arose as a major concern, including possible effect on student privacy and confidentiality issues. Occasional hardware problems (details not published). |
| Cordasco et al   | 2015  | USA 38, Telemedicine education programme organised by an organisation from Los Angeles for healthcare providers within Greater Los Angeles | Videoconference group discussions, device used in each location not specified. | Not specified      | Not specified | Not specified | Not specified                                                                 |
| Van Dongen et al | 2016  | Not specified, The e-therapy programme consisted of digital psychoeducation and CBT. Online text providing psychoeducation as well as exercises that were presented as ‘home work’ were offered and aimed to support more adaptive coping behaviour and more helpful cognitions regarding treatment and its outcome. Participants logged in at home, weekly, at the time that suited them best. | Not specified      | Not specified | Not specified | Not specified                                                                 |
| Grossman and Grindlay | 2017 | USA 40, TM abortion care involves video discussion, device not specified. | Not specified                  | Not specified      | Not specified | Not specified | Not specified                                                                 |
|                  |       |                                                                                         |                                |                    |            |          |                                                                                     |
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|------------|---------|-----------------|
| Mamas et al. (2016) Greece | Not specified | Pelvic MRI sets of digital images taken by ACS-NT GYROSCAN MRO POWERTRACK 6000 to 1.5T (by Phillips) and projected on the electronic space of the DICOM workstation of the intranet of the department of radiology. | Not specified | Not specified | Not specified | Not specified |
| Kim et al. (2016) South Korea | Not specified | First, analogue images were obtained by conventional cervicography system (Cerviscope, National Testing Lab World-wide, Fenton, Missouri, USA) that has been used to take a 35 mm film photograph of the cervix after applying 5% acetic acid to the cervix. Second, digital images of each patient were also taken at the same time by digital camera (Dr. Cervicam, National Testing Lab, Seoul, South Korea). The films were transferred to a central processing facility for the development of analogue images. Digital images made by digital camera were transmitted online. | Not specified | Not specified | Not specified | Not specified |
| Barlow et al. (2012) USA | Average distance 75.8 km to clinic. | Not specified | Not specified | Not specified | Not specified | Not specified | Not specified |
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|-----------|---------|-----------------|
| Schadel et al (2005) Germany | Not specified | The digital colposcopy system consisted of a standard binocular colposcope (ZEP 505, M/s. Zeiss, Germany) supplemented with a CCD camera (MediLive, M/s. Zeiss, Germany) for imaging, a PC with frame-grabber card (LC1, M/s. DBS, Germany) for storing static images and specially developed software (ColpoData, M/s. LMTB, Germany) to archive patient data and images. | Not specified | Not specified | Not specified | Not specified |
| Etherington (2002) UK | Examination and images of patients in inner city Birmingham GP practice, images transferred to hospital colposcopy clinic for analysis—exact distance not specified. | The TM system was based on a standard PC with a video-capture card and an ISDN connection. Numerous video clips or still images could be captured for each patient. Still images were captured as JPEG files and video clips as AVI files. | Not specified | Not specified | Not specified | 6 cases from early in the study could not be included due to poor image quality or inadequate images. |
| Stewart et al (2001) UK | 84 couples living <50 miles from clinic and 75 couples living >50 miles from clinic | Telephone consultation, device not specified | Not specified | Not specified | Not specified | Not specified |
| Harper et al (2000) USA | Review site: Dartmouth Hitchcock Medical Center. Two remote sites (exact distance not specified) | Not specified | Not specified | Not specified | Not specified | Not specified |
| | | | | | | |

Table 3 Continued
| Authors (year) | Distance | Type of device | Cost | Bandwidth | Latency | Troubleshooting |
|---------------|----------|----------------|------|-----------|---------|-----------------|
| Quercia et al (2017) Switzerland | Data from rural Madagascar to Switzerland | Medical consultations were performed with a Samsung Galaxy S5 using the m-Health application. Data collected by the application were automatically sent in real time to a central database. Therefore, the patient’s file could be consulted at any time and any place. | Not specified | Not specified | Not specified | Reversible errors: Resolved with application update included: 1. Transmission of the photos 2. Transmissions of the GeneXpert results 3. Transmission of the pelvic examination data |
| Haggerty et al (2016) Romania | Not specified | The TM arm participated in weekly telephone counselling sessions with weights being recorded via aWiFi scale from Withings. The texting arm received a text messaging programme called Text4Diet that delivered 3–5 personalised text messages daily on various monthly themes. | Not specified | Not specified | Not specified | The main limitation in internet access for this urban population was the restriction that participants frequently did not have ‘private’ WiFi access that was required by the scale model used for this study (ie, participants were using public internet and could not sign into the network to connect with the scale). |

CBT, Cognitive Behavioural Therapy; UAMS, University of Arkansas for Medical Sciences; VIA, Visual Inspection after Acteic acid; VILI, Visual Inspection with Lugol’s Iodine.
Table 4  Study characteristics

| Authors (year) | Duration of study | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators |
|---------------|-------------------|------------------------------------------------------|----------------------------------|---------------------|-----------------|
| Bouwsma et al (2018) Netherlands | 2011–2014 | Patients | Operation: benign gynaecological surgery—hysterectomy and/or laparoscopic adnexal surgery Usual care n=206 Care programme n=227 | Usual care n=206 Care programme n=227 | Secondary care 9 different hospitals |
| Grindlay and Grossman (2017) USA | October–Nov 2013 | Provider’s experience | 8 in-depth interviews | 8 providers, eligibility criteria: physician, advanced practice clinician, nurse, medical assistant/patient care coordinator, clinic manager, or counsellor on staff at a clinic providing medical abortion via TM. | 8 clinic providers involved with medical abortion using telemedicine |
| Shehata et al (2016) Canada | July 2011–January 2015 | E-Consults directed to obstetrics and gynaecology | 394 e-consults directed to Ob-Gyn | E-Consults were submitted by 151 primary care providers—126 medical doctors and 25 nurse practitioners—91% with urban practices and 9% with rural practices. | All eConsults were answered by a single Royal College of Surgeons of Canada–certified obstetrician–gynaecologist (ob-gyn) who had been in independent practice for 7 years at the start of the project. |
| Hitt et al (2016) USA | 15 months January 2014–April 2015 | Patients | 940 unique patients seen via telecolposcopy | 940 patients had telecolposcopy performed at 8 remote sites, each given an impression based on the assessment by the hub-site clinician in UAMS located in central Arkansas. | Number of doctors involved not specified. |
| Jefferis et al (2016) UK | 5 years: 1 January 2010–31 December 2014 | Patient requiring follow-up after tension-free vaginal tape insertion | 262 patients who underwent day case tension-free vaginal tape insertion were followed up via telemedicine. | 262 patients | All cases of primary retropubic TVT slings performed by one unit over a 5-year period. No. operators not specified. |
| Ricard-Gauthier et al (2015) Switzerland | 5 months: July 2013–November 2013 | Patients | 88 HPV-positive women were screened for cervical cancer. | 88 patients had cervical smartphone images taken for remote analysis. | One on-site physician in Madagascar, and three physicians in Geneva analysing the smartphone images. |
| Catarino et al (2015) Switzerland | 8 months; January 2014–August 2014 | Patients | 95 HPV-positive women were screened for cervical cancer | 95 patients had cervical smartphone images taken for remote analysis. | One on-site expert in Madagascar, and three physicians in Geneva analysing the smartphone images. |
### Table 4 Continued

| Authors (year)         | Duration of study | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators |
|------------------------|-------------------|--------------------------------------------------------|----------------------------------|---------------------|------------------|
| Stratton et al (2015)  | USA               | Trial participants                                      | 19 months: September 2012–March 2014 | 37 participants were enrolled over the 19-month time period. | The largest proportion of participants (46%) was enrolled from the telecolposcopy network. Others were enrolled through outside institutions (43%), in-house referrals (8%), or direct advertisement (3%). Most participants were motivated to join the study to take care of their health issues. Only 2 participants joined the Facebook private page. | The availability of a large number of potential participants from the telecolposcopy network increased recruitment to this clinical trial by 85% over other traditional means of recruitment. |
| Noordegraaf et al (2014)| Netherlands       | Patients                                               | 18 months: March 2010–September 2011 | Women were randomly assigned to the intervention group (n=110) or the control group (n=105). The intervention group received an eHealth programme that provided personalised tailor-made preoperative and postoperative instructions on the resumption of daily activities, including work. The control group was provided with access to a control website. | A cohort of 215 women (aged 18–65 years) who had a hysterectomy and/or laparoscopic adnexal surgery for a benign indication. | The trial was carried out in 6 general and/or teaching hospitals and one university hospital. |
| Gomperts et al (2014)  | Netherlands       | Patients                                               | This study analyses the data of women from Brazil who contacted Women on Web from 1 January through 31 December 2011 and performed a medical abortion provided through Women on Web’s TM service. | 307 women who received and used the medication, and the outcome of the abortion was reported back. | 307 women | NS |

Continued
| Authors                  | (year)                      | Duration of study               | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators                                                                                                                                                                                                 |
|-------------------------|-----------------------------|---------------------------------|-------------------------------------------------------|---------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hitt et al (2013)       | USA                         | 18 months: January 2010–June 2011 | Patients                                              | 1298 telescopic exams          | 1298 patients       | Colposcopy services via interactive TM were set up at 4 separate spoke sites. During each weekly 3 hours clinic, an advanced nurse practitioner at each of the spoke sites performed the exams and collected biopsy specimens under the real-time, interactive supervision of an experienced faculty member at the hub site. Exact number of operators not specified. |
| Gomperts et al (2011)   | Netherlands                 | 20 months: February 2007–September 2008 | Patients                                              | 2585 women                     | 2585 women         | NS                                                                                                                                                                                                               |
| Kldiashvili and Schrader (2010) | Georgia                    | 100 days                        | Cytology slides                                       | 420 gynaecological cytology cases | 420 cases           | Two general practices, two community health clinics and a secondary care urogynaecology clinic.                                                                                                                                 |
| Radley et al (2006)     | UK                          | 8 months: June 2003 to January 2004 | Patients                                              | 432 women (204 in primary care and 228 in secondary care urogynaecology clinic) | 432 women           | Group 1 consisted of 15 gynaecologists who were not trained in colposcopy and were from primary healthcare. Group 2 consisted of six experienced colposcopists (specialists). Group 3 was a supervising team consisting of three experts (colposcopists who had more than 15 years' colposcopy experience). |
| Perisic et al (2006)    | Serbia and Montenegro       | NS                              | Patients                                              | 250 colpographs                | 250 patients        |                                                                                                                                                                                                                 |

Table 4 Continued
| Authors (year)          | Duration of study | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators |
|------------------------|-------------------|-------------------------------------------------------|---------------------------------|---------------------|------------------|
| Etherington et al (2002) UK | NS                | Patients                                               | 81 cases                        | 81 patients included for diagnosis comparison between telecolposcopic and colposcopic images | NS                |
| Allen-Davis et al (2002) USA | June 1996 to August 1996 | Patients                                               | 485 patients underwent telephone evaluation followed by same day appointment with physician, nurse midwife or physicians assistant | 485 patients       | NS                |
| Atlas et al (2000) Israel | 9 months          | International Tumour Board (ITB): Multidisciplinary team discussion of patient cases | 20 videoconferences, discussing 450 patients. Three key cases described. | 450 patient cases  | The ITB consists of doctors trained in cancer surgery, chemotherapy, radiation oncology, diagnostic radiology and tumour pathology, as well as nurses, nutritionists and oncology social workers. Exact numbers not specified. |
| Tates et al (2016) Netherlands | NS                | Simulated patients                                     | 48 simulated doctor–patient consultations | 6 certified simulated patients | 12 medical students |
| Gambadauro and Magos (2007) UK | 6 months          | Patients: range of gynaecological interventions including abdominal, vaginal and laparoscopic surgery. Simulation: pelvi-trainer sessions in endoscopy skills laboratory. | 20 operations                   | NS                  | NS                |
| Authors (year) | Duration of study | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators |
|---------------|-------------------|-----------------------------------------------------|---------------------------------|--------------------|-----------------|
| Katz *et al* (2017) Israel | Two separate sessions with groups of participants | E-learning simulation | Two training sessions, where participants were divided into those receiving an automated, self-assessment computerised case and an intervention group (WOZ) received the same computerised case accompanied by a human trainer supplying web-based immediate feedback and clarifications for each question. | First experiment: 10 control, 8 intervention subjects Second experiment: 7 control, 7 intervention subjects | NS |
| Yoost *et al* (2017) USA | Eight hours long telehealth sessions were offered over a course of 4 weeks in the spring of 2015 | Computer e-learning | 8 teaching sessions | 55 students | 8 teaching sessions |
| Chekerov *et al* (2008) Germany | 20 months December 2004 to August 2006 | Online Gynaecological Cancer Conference | 39 Tumour Board Conferences 144 patients’ cases presented | 667 participants | 121 peer-reviewed second opinions were sought |
| Haller and Gabathuler (2003) Switzerland | 1997–2001 | Lecture hall—videoconferencing | NS | NS | NS |
| Chaves *et al* (2017) Brazil | 4 weeks June–July 2016 | Patients | 5 operations (4 total abdominal hysterectomies and 1 oophoroplasty) | 21 medical students/residents | 5 operations observed |
| Boatin *et al* (2015) Boston, USA | 30 months: June 2012 to January 2015 | Lectures | 30 lectures | 30 lectures with approximately 20 attendees per session | NS |
| Browne *et al* (2000) USA | Two years: 6-week rotation with video teleconference occurring across sites half way through clerkship | Video teleconference | 20–22 students between 5 clerkship sites every 6 weeks | 20–22 students, site coordinators, clerkship director, administrative staff and occasionally department chairperson between 5 clerkship sites. | NS |
| Authors                        | Duration of study          | Setting (animal model, simulation, patients, cadavers)                                                                 | Variable number (operation, USS) | No. of participants | No. of operators                        |
|-------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------------|---------------------|-----------------------------------------|
| Cordasco et al (2015)         | 14 months: October 2012–December 2013 | Specialist at a ‘hub’ facility and primary care providers at multiple ‘spoke’ sites.                                       | 14 1 hour monthly sessions      | Interviews conducted with 18 primary care providers | Number of specialists delivering sessions not specified. |
| Van Dongen et al (2016)       | 28 months: February 2011–June 2013 | Patients                                                                                                                | 120 women starting their first ART cycle were randomised, 48% in the intervention group were compliant. | 120 women          | Women in the control group received care as usual, whereas women in the intervention group received in addition to their usual care access to a personalised e-therapy programme. Number of e-therapists involved not specified. |
| Grossman and Grindlay (2017)  | 7 years: July 2008–June 2015 | Patients—adverse events                                                                                                 | During the study period, 8765 TM and 10405 in-person medical abortions were performed. | Total: 19170 medical abortions, 49 clinically significant events reported (0.18% telemedicine patients, 0.32% in-person patients) | NS |
| Mammas et al (2016)           | NS                          | Pelvic MRI sets of digital images                                                                                     | 10 sets of pelvic MRI digital images | 10 sets of pelvic MRI digital images | 2 consultant radiologists |
| Kim et al (2016)              | 1 year: January 2013–December 2013 | Patients                                                                                                                | 100 cases from 5 centres were collected prospectively, of which 63 cases were valid to be included in the study. | Total 63 cases and associated 567 images were finally analysed to assess intraobserver consensus. | Nine certified specialists belonging to Korean Cervicography Research Group evaluated the digital images on DCS, 35mm analogue slides, and scanned images without patient information. |
| Barlow et al (2012)           | 1 year: July 2008–July 2009 | Patients                                                                                                                | 51 patient visits considered appropriate for telehealth, of which 28 patients/families expressed interest in telehealth. | 51 patient visits | NS |
| Schadel et al (2005)          | NS                          | Patients                                                                                                                | 286 patients, average 5 images per patient. | 315 patients participated in study, of which 286 patients were valid for re-evaluation by a second physician. | NS |
| Authors (year)       | Duration of study | Setting (animal model, simulation, patients, cadavers) | Variable number (operation, USS) | No. of participants | No. of operators                        |
|---------------------|-------------------|------------------------------------------------------|---------------------------------|---------------------|----------------------------------------|
| Etherington (2002)  | UK                | Patients                                             | 81 patients had full data available | 97 invited, 10 declined/did not attend all appointments, 6 had inadequate images, thus 81 women had full data for analysis | One experienced colposcopist           |
| Stewart et al (2001)| UK                | Patients                                             | 159 couples returned the questionnaire within 2 weeks of their follow-up discussion | 159 couples        | One clinic, number of clinicians involved in follow-up not specified |
| Harper et al (2000) | USA               | Patients                                             | 79 women, number of images captured for each patient varied from 3 to 20 | 79 women            | NS                                     |
| Quercia et al (2017)| Switzerland       | Patients                                             | 151 patients                    | 151 patients recruited, application collected 44 items of information per patient | NS                                     |
| Haggerty et al (2016)| Romania           | Patients                                             | 20 patients                     | 10 patients: TM arm 10 patients: Texting arm | NS                                     |
1992 to 2018. Following the initial screen, 243 studies were excluded due to the title alone and 70 abstracts were retained and examined. Of those, 13 were excluded because they were not relevant to the research questions (ie, not focused on TM), focused on other specialties, were not available in English or were duplicate studies. By duplicate studies, we refer to the retrieval of the same study through different the databases. Of the remaining 55 full-text publications that were examined, 16 were review or opinion articles and one focused on antenatal care. They were therefore excluded, leaving 39 studies for inclusion in the review. An overview of the search results and screening process is summarised in the study flow diagram (figure 1).

Study characteristics
Data from the 39 studies included in this review demonstrated considerable variation regarding the research question, methodology, study design, sample size and outcome measures. Of the 39 studies, 19 assessed gynaecological clinical practice; eight investigated gynaecological education, while one assessed the preceding pair concomitantly. 11 studies investigated the feasibility of TM within gynaecological practice. The majority of the studies were level IV evidence, as they were either case series, case-control or cohort studies. On the Newcastle-Ottawa quality assessment scale, 19 studies were classified as good, 12 fair and eight poor10 (table 5).

Sample sizes ranged from 6 to 19 170, although not all studies specified sample size. Of the 39 studies, the highest number were conducted in the USA (n=13), followed by the Netherlands (n=6), UK (n=6), Switzerland (n=4), Israel (n=2), Germany (n=2), Romania (n=1), Canada (n=1), Serbia and Montenegro (n=1), Brazil (n=1), Greece (n=1) and South Korea (n=1). Therefore, the majority originated from Europe and North America. One study was from Brazil published in 2017,34 one from South Korea published in 2016,35 one from Georgia published in 201022 and two from Israel published in 2000 and 2017.27 30 No obvious association is observed between the year of publication and the geographical region.

Various subspecialties of O&G were investigated the most common being cervical pathology/cytology in 13 studies16–18 21 23 25 26 42 44 45 47 48 followed by benign gynaecology in five studies,11 19 30 35 45 early pregnancy and medical abortion in four studies,12 20 22 40 fertility and reproductive medicine in three studies,23 29 40 urogynaecology in three studies,15 24 29 and gynaecological oncology in three studies.28 33 49

Different modes of TM have been used and reported in the different studies ranging from interactive and personalised web-based programmes giving preoperative and postoperative advice,11 19 39 video teleconferences,12 40 online/internet consultations20 22 and telephone consultations.13 15 27 29 34 46 48 49 Moreover, 11 studies investigated the effectiveness of telecolposcopy where an experienced clinician had made decisions and diagnosis remotely.14 16 17 21 25 26 42 44 45 47 TM has also been used for collaboration and training between clinicians and medical students; for example, e-consultations between primary and secondary care clinicians discussing the care of patients25 and in teleconferences providing expert and multidisciplinary input in oncological cases.39 41 Furthermore, the role of TM in medical education has been assessed in three studies where trainees were provided feedback from an experienced surgeon remotely, during real-time surgery.30 37 35 Studies on clinical outcomes did not report any adverse effects to the patients.

Colposcopy and cervical cytology
Hitt et al44 demonstrated the feasibility of telecolposcopy in 940 patients from rural areas. The assessment was done effectively by the hub-site clinician and the authors estimated mean transportation costs per patient saved to be S$33.25.14 Another study evaluated the feasibility of using smartphone digital images for the detection of Cervical Intraepithelial Neoplasia (CIN2)+ in 87 HPV-positive cases.16 There was no statistical difference in the sensitivity and specificity of the detection of CIN2+ between on-site and off-site physicians. Moreover, 95.6% of all images were deemed to be very good or acceptable for diagnostic purposes.16 Similarly, Catarino et al44 involving 332 patients demonstrated that off-site diagnosis of CIN was at least similar to that reached on-site.17

Hitt et al21 performed 1298 telecolposcopies whereby a nurse practitioner who has been trained in the mechanics of colposcopy performed the examination under real-time interactive supervision of an experienced colposcopist at the hub site.22 The study model of using one physician with four nurse practitioner examiners and four assistants produced an hourly cost of US$321.00, or a cost of US$40 per exam. This compared with a traditional model incorporating four doctor examiners with four assistants producing an hourly cost of US$416.00 or a cost per exam of US$52.21 The authors thus concluded that this method was cost effective and well received by patients.

Kldiashvili et al23 evaluated ‘telecytology’ whereby 420 cytological images were assessed by on-site and off-site cytologists.23 The study found a 94% concordance between routine versus digital images and 97% of digital images were rated as ‘good’ or ‘excellent’.23 Another study by Etherington et al performed videocolposcopy in 250 patients.25 The images produced were of sufficient quality for diagnosis.26 Harper et al performed colposcopies in 79 women whereby the images were sent to a hub site for further assessment and comparison.47 The interobserver agreement was as high as 86% (k=0.68) and the colposcopists’ and patients’ satisfaction was rated as ‘excellent’. The study concluded that the telecolposcopic system is technically feasible and is preferred by women as it cuts down travel costs.47

Perisic et al performed videocolposcopy in 250 patients.25 The diagnostic accuracy of three different groups was
# Table 5  Newcastle-Ottawa quality assessment table

| Authors (year) | Selection | Comparability | Outcome | Quality |
|---------------|-----------|---------------|---------|---------|
| **Clinical**  |           |               |         |         |
| Bouwsma et al (2018) Netherlands 11 | **** | * | ** | Good |
| Grindlay and Grossman (2017) USA 12 | ** | * | ** | Fair |
| Shehata et al (2016) Canada 13 | ** | * | ** | Fair |
| Hitt et al (2016) USA 14 | ** | * | ** | Fair |
| Jefferis et al (2016) UK 15 | ** | ** | Poor |
| Ricard-Gauthier et al (2015) Switzerland 16 | ** | * | ** | Fair |
| Catarino et al (2015) Switzerland 17 | *** | * | ** | Good |
| Stratton et al (2015) USA 18 | ** | * | ** | Fair |
| Noordegraaf et al (2014) Netherlands 19 | **** | * | ** | Good |
| Gomperts et al (2014) Netherlands 20 | ** | * | ** | Fair |
| Hitt et al (2013) USA 21 | **** | * | *** | Good |
| Gomperts et al (2011) Netherlands 22 | ** | * | ** | Fair |
| Kldiashvili, and Schrader (2010) Georgia 23 | *** | * | ** | Good |
| Radley et al (2006) UK 24 | *** | * | ** | Good |
| Perisic et al (2006) Serbia and Montenegro 25 | ** | * | ** | Fair |
| Etherington et al (2002) UK 26 | *** | ** | ** | Good |
| Allen-Davis et al (2002) USA 27 | *** | ** | ** | Good |
| Atlas et al (2000) Israel 28 | * | ** | Poor |
| Tates et al (2016) Netherlands 29 | *** | * | ** | Good |
| **Education**  |           |               |         |         |
| Gambadauro and Magos (2007) UK 30 | * | ** | Poor |
| Katz et al (2017) Israel 31 | *** | * | ** | Good |
| Yoost et al (2017) USA 32 | ** | * | ** | Fair |
assessed (inexperienced, experienced and expert colposcopists) which showed high interobserver agreement. The authors concluded that videocolposcopy can provide an accurate diagnosis, reduced travel distance and can enable training of healthcare staff.25 Schadel et al44 evaluated the use of digital colposcopy against conventional binocular colposcopy.44 Three hundred and fifteen patients had a colposcopic assessment onsite and had their images saved which were reviewed by another colposcopist. There was agreement between the examiners in 69% of cases (k=0.60). The authors concluded that digital colposcopy was reliable and provided advantages in terms of a better follow-up examination and internal quality control of the diagnosis.44

### Table 5

| Authors (year) | Selection | Comparability | Outcome | Quality |
|----------------|-----------|---------------|---------|---------|
| Chekerov et al (2008) Germany33 | * | ** | Poor |
| Haller and Gabathuler (2003) Switzerland34 | * | ** | Poor |
| Chaves et al (2017) Brazil35 | * | ** | Poor |
| Boatin et al (2015) Boston, USA36 | ** | * | ** | Fair |
| Browne et al (2000) USA37 | * | * | Poor |
| Clinical and education | ** | * | ** | Fair |
| Cordasco et al (2015) USA38 | ** | * | ** | Fair |
| Feasibility | *** | * | ** | Good |
| Van Dongen et al (2016) Netherlands39 | *** | * | ** | Good |
| Grossman and Grindlay (2017) USA40 | *** | * | ** | Good |
| Mammas et al (2016) Greece41 | * | * | Poor |
| Kim et al (2016) South Korea42 | *** | * | ** | Good |
| Barlow et al (2012) USA43 | ** | * | ** | Fair |
| Schadel et al (2005) Germany44 | *** | * | ** | Good |
| Etherington (2002) UK45 | *** | * | ** | Good |
| Stewart et al (2001) UK46 | *** | * | ** | Good |
| Harper et al (2000) USA47 | *** | * | ** | Good |
| Quercia et al (2017) Switzerland48 | *** | * | ** | Good |
| Haggerty et al (2016) Romania49 | *** | * | ** | Good |
interviews about the quality of the service, which involved access to patient notes, scan images and patient video teleconference. The healthcare providers felt that the patients were assessed sooner and that the service was feasible.12 Gomperts et al30 evaluated the outcome of self-administered mifepristone and misoprostol for medical abortion in 602 Brazilian women.20 The surgical intervention rate after medical abortion was 19%, 15.5% and 45% at 9, 10–12 and 13 weeks gestation, respectively. The study concluded that home use of the above medication in women before 13 weeks gestation through a TM service is safe and effective.20 The same group performed a study involving 2323 women from 88 different countries to analyse the factors influencing surgical intervention after medical abortion.22 These women were assessed by TM with interactive online consultation and follow-up. There were regional differences in the rates of surgical intervention, which may reflect different clinical practice and local guidelines.22

Gynaecological surgery
Bouwsma et al11 performed a randomised-controlled trial where 227 women underwent an internet-based personalised care programme after gynaecological surgery and 206 women had the usual postoperative care.11 The study demonstrated an accelerated recovery and reduced time to return to work in the intervention group which were both statistically significant.11 Moreover, the authors reported an estimated 54 euros savings per patient with the intervention group.11 A similar study by the same group recruited 110 patients who were randomly allocated to an eHealth intervention with tailored preoperative and postoperative instructions with regards to resumption of work and daily activities.19 Compared with the control group, the eHealth intervention was associated with reduced time to return to work (p=0.048). Furthermore, at 26 weeks post operation, the intervention group reported improved quality of life score compared with the control group (p=0.024).

Gambadauro et al (2007) developed a network-enhanced surgical training (NEST) telementoring system consisting of audio–visual interaction of the trainer with the trainee during gynaecological surgery.30 The authors concluded that NEST was a reliable and affordable learning tool.30 Chaves et al25 evaluated the effectiveness of a telementoring programme whereby gynaecology residents and medical students received education on their smartphones connected to a wireless network though live surgery.25 94% reported that the streaming video system was an effective educational tool.35

DISCUSSION
This systematic review is an analysis of where we stand with the use of TM at present; the COVID-19 pandemic has provided a catalyst for change, as it has forced us all to consider methods of remote care. The incorporation of TM into daily practice became a priority to help limit the spread of disease by limiting face-to-face contact. Our review presents the evidence of the promising role of TM within gynaecological practice and education. Of note, the majority of the selected studies were classified as good or fair using the Newcastle-Ottawa methodological assessment tool. The applications of TM to date have been shown to be safe and effective in providing remote care and training. This is in line with a recent review conducted in the field of general surgery.30

Clinical potential
Particular fields within gynaecology inherently lend themselves to TM approaches. This is evident by the number of studies focused on particular areas; of the 22 clinically focused studies, eight were within colposcopy13 15–17 20 22 24 25 with seven of them being classified as good and fair methodological quality. Moreover, the studies analysed in this review clearly demonstrate that telementoring can improve the education of medical professionals within gynaecology and may occupy a niche in surgical education by enabling the education of surgeons within and between hospitals. It has been shown in some settings to be a safe and effective method of implementing remote mentoring. Furthermore, Boatin et al36, a study of fair methodological quality, demonstrated that successful video conferencing can result in expertise being shared bilaterally and internationally across individuals who potentially are unable to travel. It could therefore be beneficial to both resource-rich and resource-poor institutions.36

The most consistent finding was that digital colposcopy was reliable and provided advantages with a better follow-up examination and quality control of the diagnosis. The cost varied depending on the particular use of TM and only a few studies explicitly outlined the cost of implementation of their TM systems. The initial cost must be weighed against potential saving such as reduced travel time, improved access to expert healthcare and thus potentially earlier diagnosis, and the long-term benefit of increased healthcare expertise via a wider education audience. This is a complex cost–benefit analysis, which will vary with type and setting of TM implementation and is certainly something to be considered in future studies.

Telementoring value
Robotic surgery has been demonstrated to have a role in telementoring in general surgery.51 No studies focusing on the use of robotic surgery for telementoring in gynaecology are currently available. One study compared clinical outcomes between telementoring and on-site mentoring of robotic assisted laparoscopic radical prostatectomy found no significant difference between the
two. This finding suggests there may be a further role for telementoring in gynaecological cases using robotic surgery as this technology becomes more widespread. Another emerging technology to consider is Google Glass, a wearable device that provides users hands-free access to computer functions. The potential benefit of this technology in telementoring has been demonstrated in both surgical and non-surgical medical settings. Moreover, more recent telecommunication technologies would certainly help to improve the perception of telementoring, particularly the advent of augmented and virtual reality. Again, there are no studies identified specific to gynaecology, however, based on the studies available from other specialties, it could well be piloted within gynaecology.

TM is unlikely to ever supersede on-site mentoring completely but should be used as an adjunct to traditional clinical practice and training. At present, there may be technical limitations to its widespread implementation owing to suboptimal internet penetration particularly in low-income countries and the fact that internet connectivity is concentrated within cities globally. In addition, the necessary infrastructure including telecommunications, specific electrical appliances and technical expertise of the personnel including the clinicians may be suboptimal in developing countries. Furthermore, highly motivated individuals are required to implement TM programmes whether that might be for clinical or educational purposes. Moreover, when it comes to telementoring, bandwidth should be over 521 kb/s and none of the selected studies reported such figure. Security will also play a crucial role in developing TM programmes in the future as this involves sharing and handling sensitive patient information. Therefore, the development of agreed frameworks to ensure that personal and sensitive information is encrypted appropriately is essential.

Limitations of the current evidence
The majority of studies included were observational in nature, without clear quantitative outcomes for statistical analysis and were classified as level IV evidence according to the Oxford Centre for Evidence-based Medicine preform. In a number of studies, the variable was low and thus the conclusion of the study was based on a single operator demonstrating a TM application within gynaecology. Therefore, there is the potential for a number of the included studies to be subject to selection bias, with certain patients, practitioners or students more amenable to the technology as it was more likely to be involved in the study resulting in positive outcomes with TM.

On the other hand, some studies included thousands of patients, in particular those focused on telecolposcopy and TM abortion care. These studies indicate the widespread nature of these applications. In these cases, one must consider that often low numbers of operators were involved and thus again selection bias may apply. In the future, randomised controlled studies involving larger numbers of patients and operators with measurable outcomes are required in order to be able to draw reliable conclusions.

CONCLUSION
This review is to our knowledge the only such review on the topic. The range of studies demonstrates the wide potential role of TM within gynaecology. However, this variety translates to broad conclusions based mostly on self-reported data. Reassuringly, the methodological quality of the majority of the reviewed studies were classified as good or fair. While some promising studies have been conducted, there is yet insufficient evidence to support the clinical or cost effectiveness of TM in gynaecology. The role of TM has more than ever become more obvious as we are undergoing the COVID-19 pandemic where effective TM strategies need to be implemented to provide safe and effective care to patients, without putting patients, doctors and the community at risk of the infection.

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