Uptake and outcomes of robotic gynaecological surgery in England (2006-2018): a study using administrative hospital data.

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Abstract

Objective: To review uptake and outcomes of robotic gynaecological surgery in England between 1st April 2006 and 31st March 2018. Design: Retrospective cohort study. Setting: Hospitals of the English National Health Service (NHS). Population or sample: Women aged 18 years and above who had elective gynaecological surgery. Methods: Robotic gynaecological procedures were defined as procedures that used a robotic minimal access approach for hysterectomy, adnexal surgery and urogynaecological surgery (sacrocolpopexy, sacrohysteropexy and colposuspension). Numbers of procedures were reviewed by year and mapped to the 44 NHS regions. Main outcome measures: Length of stay (nights in hospital), laparotomy (conversion during primary procedure or after return to theatre for management of complication), and 30-day emergency readmission rates by year and procedure type. Results: 527217 elective gynaecological procedures were performed in the English NHS (1st April 2006 and 31st March 2018), of which 4384 (0.83%) were performed with robotic assistance (3864 (88%) hysterectomy, 706 (16%) adnexal surgery, 192 (4%) urogynaecological surgery). There was gradual rise in uptake but marked geographical variation. Median (IQR) length of stay (LOS) was 1(1-2) night, laparotomy rate: 0.3% and 30-day emergency readmission rate: 4.7%. LOS was statistically but not clinically different across time. Other outcomes did not differ by year. Conclusions: Robotic gynaecological procedures is increasingly being used in the English NHS, predominantly for hysterectomy, although overall in small proportions (2.6% in the most recent study year). There was wide geographical variation in robotic uptake across England and overall, outcomes were comparable to those reported in other countries.

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Funding: This study was supported by a grant from the National Institute for Health Research (NIHR) Health Services and Delivery Research (HS&DR) Programme (14/70/162).

Keywords:

Robotic, gynaecological, surgery, administrative hospital data.

Tweetable abstract:

Robotic gynaecological surgery is increasingly being used in the English NHS with good outcomes but there is wide regional variation.

INTRODUCTION

The prototype of surgical robotics, da Vinci Surgical System (Intuitive Surgical Inc, Sunnyvale, California, USA), was approved for use in gynaecology by the American Food and Drug Administration (FDA) in April 2005 [1]. Since then, gynaecology has been the second leading speciality after urology utilising robotic surgery worldwide[2]. In addition to proven patient benefits of minimally invasive surgery, such as reduced bleeding, quick recovery and improved cosmesis, robotic surgery also offers surgical benefits of wristed instruments, three-dimensional vision and comfortable surgeon ergonomics[3-5]. It has been used to perform hysterectomy for benign and malignant disease, myomectomy, and tubal surgery with a full abdominal approach as well as to perform prolapse and fistula repairs with a combined abdomino-vaginal approach, producing outcomes that are comparable to laparoscopic surgery [6-8].

In this study we reviewed the uptake and outcomes of robotic gynaecological surgery in England between April 2006 and March 2018.

MATERIALS AND METHODS

We used the Hospital Episodes Statistics (HES), a routinely collected administrative dataset which includes a record of all admissions to National Health Service (NHS) hospitals in England [9, 10]. HES data are primarily collected to guide government payment of the activity undertaken by the hospitals and therefore often analysed and reported according to 'financial years' (1st April to 31st March).

The study population included all women aged 18 years and above who underwent an elective robotic gynaecological procedure as in-patients between 1st April 2006 and 31stMarch 2018.

Surgical procedures were defined according to the United Kingdom (UK) Office for Population Censuses and Surveys Classification version 4.8 (OPCS-4) codes [11-13]: hysterectomy (Q07), adnexal surgery (Q22, Q23, Q24), and urogynaecological surgery, including sacrocolpopexy (P24.2, P24.3, P24.5), sacrohysteropexy (Q54.5), and colposuspension (M52.3). The code Y75.3 was used to identify robotic procedures. Detailed definitions of the OPCS-4 codes that were used are provided in the supplementary material (Appendix S1).

If multiple procedures were recorded during the same hospital admission, only one procedure was counted, first considering hysterectomy, followed by urogynaecological surgery and then adnexal surgery.

Procedure numbers were reported by year to identify time trends in the uptake of surgery. Procedure numbers were also mapped to the 44 geographical areas with an average population size of about 500,000 adult women, known as Sustainability and Transformation Partnership (STP) areas. These areas were set up to improve delivery of NHS services[14, 15].

We determined length of hospital stay (LOS) in terms of nights spent in hospital, obtained as the difference between admission date and discharge date. Laparotomy including conversion during the primary procedure or after return to theatre for surgical management of complication was captured using the following OPCS-4 codes: Y50.2, T30; T30.1, T30.2, T30.3, T30.4, T30.8, T30.9. 30-day emergency re-admission was identified by monitoring readmissions to any NHS hospital in England within 30 days of the primary procedure regardless of the cause.

The relationship between categorical variables (laparotomy or readmissions, and year of surgery) was explored using the Pearson chi-square test following tabulations, and where the cell value was less than five, using Fisher's exact test. The equality of median length of stay across years was tested using the non-parametric k-sample test on the equality of medians in STATA, with cases at the median split evenly between the above and below groups. P-values are reported from the chi-square statistic. $P < 0.05$ was considered significant.

RESULTS

527217 elective gynaecological procedures were performed in the English NHS between 1st April 2006 and 31stMarch 2018, of which 4384 (0.83%) were performed with robotic assistance. These constituted: 3486 (80%) hysterectomy, 706 (16%) adnexal surgery, and 192 (4%) urogynaecological surgery. The total number of robotic procedures rose from 2/ 41173 (0%) in 2006-2007 to 1152/ 43929 (2.6%) in 2017-2018 (Figure 1,2).

Of the 141 NHS hospitals that provided gynaecological surgery during the study period, 76 hospitals (53.9%) had carried out at least one robotic procedure. The median number (interquartile range) of procedures by hospital was 5 (1-38). Of the 76 hospitals that had carried out robotic gynaecological surgery, 44 had performed 1 to 10 procedures (Figure 2).

The number of all robotic procedures was also mapped to the 44 STP areas. Median number (interquartile range) of procedures by STP area was 52 (16 to 148), demonstrating wide geographic variation in the uptake of robotic gynaecological surgery (Figure 3).

Only 99 robotic procedures were carried out between 1st April 2006 and 31st March 2010. Considering the 4285 robotic gynaecological procedures carried out from 1st April 2010 onwards, we observed an increase in the annual number of robotic hysterectomies from 124 in 2010-2011 to 928 in 2017-2018 and the annual number of adnexal surgeries from 18 in 2010-2011 to 211 in 2017-2018 (Table 1). The number of urogynaecological procedures was considerably lower with no evidence increase over time (13 in 2010-2011 and 14 in 2017-2018).

Median LOS (interquartile rage) was 1 (1-2), 1 (0-2) and 2 (1-3) nights, conversion to laparotomy rate 0.3%, 0.5% and 0%, and 30-day emergency readmission rate 4.8%, 4.7%, and 3.8% for hysterectomy, adnexal surgery and urogynaecological procedures, respectively with no evidence of changes over time during the study period (Table 1).

DISCUSSION

Main findings

Robotic gynaecological surgery was sporadically used in England between in 2006 and 2010. Since then, there has been a steady increase in its uptake, especially for hysterectomies and adnexal surgeries. However, there was wide regional variation with only about half of the English NHS hospitals being involved. Robotic assistance was used in 1152 procedures between 1st April 2017 and 31st March 2018 to carry out hysterectomy, adnexal and urogynaecological surgery which constituted 2.6% of the total number of these procedures carried out in the English NHS [16].

Strengths:

To our knowledge this is the first study of the uptake of robotic gynaecological surgery in the whole of English NHS since 2006, following the FDA approval of da Vinci surgical system for use in gynaecology (2005) up to March 2018. Our population included over half a million patient undergoing elective gynaecological procedures.

HES data is subject to rigorous quality assurance processes and its use in research had been validated [17-19]. Using national hospital data, we underwent a comprehensive review of both benign and malignant gynaecological hysterectomy/ adnexal surgery cases as well as urogynaecological procedures approached abdominally. It has been argued that independent evaluation of robotic surgery is challenging as it is an "operator-dependent expensive technology" [6]. However, our results derived from national administrative data from NHS hospitals that provide 95% of inpatient care in England are independent of both surgeons and the industry [20].

Limitations:

Our study was limited by its retrospective nature and we could only examine outcomes available in HES data.

Interpretation in light of other evidence:

The upward trend in the use of robotic gynaecological surgery in England is in line with the results observed elsewhere and in other specialties. Wright and colleagues demonstrated a rise in the total number of robotic procedures in the United States (US) from ~ 21,000 to 34,000 between 2009 and 2012 with 4.5 fold increase in robotic general surgical procedures during the same period [21]. Similarly, Stewart et al studied a US population of ~ 150,000 general surgical oncology patients between 2010 and 2014, and showed 5-fold increase in the number of robotic procedures during the study period, which was significantly larger than the increase in laparoscopic (1.1-fold) and open (1.2-fold) procedures[22]. Damle et al studied diffusion trends of robotic colorectal procedures in the US (2011-2015) and demonstrated increase in robotic procedure numbers (from 2.6% to 6.6% of total procedures), centres offering them (from 105 to 140) as well as significant increase patient complexity[23]. Papalekas and colleagues studied routes of hysterectomy done for both benign and malignant conditions for over 5000 patients at a community and a teaching hospital in the US between 2010 and 2014, and demonstrated a 60% and 20% increase in the robotic approach at those hospitals respectively[24].

Marcus et al compared diffusion trends of robotic prostatectomy, partial nephrectomy and hysterectomy in the UK using HES data between 2006 and 2014. They concluded that diffusion of these procedures was rapid, moderate and slow respectively, attributing this to institutional, surgeon and patient specific factors[25]. This agrees with our findings that the proportion of elective robotic gynaecological procedures took over a decade to rise from negligible levels to 2.6% of total number of procedures studied.

Mapping robotic procedure numbers to geographical English regions suggest clustering around areas that are likely to represent cancer centres[26]. Factors related to the funding, surgical expertise and the role of specific centres in gynaecological training are likely to have contributed to this regional variation.

Our evidence on outcomes is very similar to the results of the most recent Cochrane review on robotic gynaecological surgery (2019)[6]. However, it is important to note that the rate of conversion to laparotomy that we observed, which included both intraoperative conversions to laparotomies and those after return to theatre, was much lower than those reported in observational studies with rates of intraoperative conversions to laparotomy ranging from 2.4 to 8.7% [27, 28].

We did not find changes in outcomes over time, in contrast to others[28]. The variation in median LOS for hysterectomy, adnexal surgery and total procedures was statistically but not clinically significant (table 1). It has to be taken into account that we only studied a small range of outcomes and that the statistical power to assess the impact of a 'learning curve' was limited.

CONCLUSION:

We demonstrated an overall increase in uptake of robotic surgery in gynaecology. However, its use remains low with considerable regional variation and only 50% of NHS hospitals being involved. We recommend future studies explore reasons behind these findings.

Disclosure of interests

DGT acted as consultant for Cambridge Medical Robotics (CMR) – surgical, but was not involved in data extraction or analysis. All other authors have no conflicts of interest to disclose.

Contribution to authorship

The study was conceived and designed by all authors. RSG and IGU organised the datasets and performed the statistical analysis, DEH wrote the first draft of the manuscript; DEH and IGU wrote the final manuscript, with input from JvdM and DGT. All authors approved the final text.

Ethics approval

The use of Hospital Episode Statistics data for the purpose evaluations of care delivered by the NHS was approved by the Confidentiality Advisory Group of the NHS Health Research Authority (15/CAG/0148). The data are anonymised and therefore their use does not require ethical approval and individual-level patient consent.

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Supporting information

Appendix S1: Full list of 4-digit HES codes included in the study.

List of figures and tables:

Figure 1:

Numbers of elective robotic gynaecological procedures in England between 1st April 2006 and 31st March 2018. See text for further information.

Figure 2:

Left: NHS England Hospital distribution by elective robotic gynaecological procedure number. Right: Elective robotic gynaecological procedures in England (%) breakdown.

Figure 3:

Distribution of elective robotic gynaecological procedures (1st April 2006 - 31st March 2018) across the 44 Sustainability and Transformation Partnership (STP) areas of England. STPs are geographical areas with an average population size of about 500,000 adult women, and were set up to improve delivery of NHS services in these areas [14, 15].

Table 1:

Outcomes of elective robotic gynaecological surgery in England (2010-2017) by procedure and year. *3153 additional adnexal procedures were recorded in the same episode as hysterectomy (counted in hysterectomies)

and 3 recorded in the same episode as other gynaecological procedures (counted in other gynaecological surgery). **Include sacrocolpopexy, sacrohysteropexy and colposuspension grouped together due to small numbers of individual procedures to avoid potential disclosure of hospital/patient identity. 8 sacrocolpopexies and 1 colposuspensions were recorded in the same episode as hysterectomy; three of these episodes also had adnexal surgery recorded (counted in hysterectomies). LOS: Length of (hospital) stay, IQR: inter-quartile range.

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Procedure	Outcome	2010	2011	2012	2013	2014	2015	20
Hysterectomy	Number of procedures	124	130	199	258	432	603	75
	LOS (median, IQR)	1 (1-2)	1 (1-2)	1 (1-2)	1 (0-2)	1 (1-2)	1 (1-2)	1
	Laparotomy % (n)	-	0.8 (1)	0.5 (1)	1.2 (3)	0.2 (1)	0.3 (2)	0.
	Re-admission % (n)	3.2 (4)	3.1 (4)	3.5 (7)	5.4 (14)	3.9 (17)	5.0 (30)	4.
Adnexal surgery*	Number of procedures	18	38	52	40	66	109	14
	LOS (median, IQR)	1 (1-2)	2 (1-3)	1 (1-2)	1 (1-3)	1 (0-2)	0 (0-1)	0
	Laparotomy % (n)	-	-	-	-	-	-	-
	Re-admission % (n)	0 (0)	2.6 (1)	1.9 (1)	2.5 (1)	4.5 (3)	5.5 (6)	5.
Urogynaecological procedures**	Number of procedures	13	29	35	28	28	16	22
	LOS (median, IQR)	2 (2-3)	2 (1-2)	2 (1-2)	2 (2-2.5)	2.5 (1-3)	2 (1-3)	2.
	Laparotomy % (n)	-	-	-	-	-	-	-
	Re-admission % (n)	7.7 (1)	0 (0)	5.7 (2)	3.6 (1)	7.1 (2)	6.3 (1)	0
TOTAL	Number of procedures	155	197	286	326	526	728	91
	LOS (median, IQR)	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	1
	Laparotomy % (n)	-	0.5 (1)	0.4 (1)	1 (3)	0.2 (1)	0.3 (2)	0.
	Re-admission % (n)	3.2 (5)	2.5 (5)	3.5 (10)	4.9 (16)	4.2 (22)	5.1 (37)	4.

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