



## Research Paper

## Defining the feasibility of same day adrenalectomy - A prospective matched cohort study

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## ARTICLE INFO

## Keywords:

Adrenalectomy

Laparoscopy

Keyhole

Day surgery

Outpatient

Day case

Ambulatory

Same day discharge

Enhanced recovery

Primary hyperaldosteronism

Cushing's syndrome

## ABSTRACT

**Background:** Despite technical advances, day surgery still accounts for <1 % of adrenal procedures. We investigated feasibility and safety of same day adrenalectomy (SDA).

**Methods:** We recruited 30 patients with primary hyperaldosteronism (PHA) or Cushing's syndrome (CS) into a prospective matched, single centre cohort study to evaluate the impact of exposure to a same day discharge pathway (SDA cohort;  $n = 10$ ) or inpatient adrenalectomy (PIPA cohort;  $n = 20$ ). We compared results to a matched cohort ( $n = 40$ ) from our prospective in-patient adrenalectomy registry (RIPA cohort).

**Results:** Mean age was  $51.3 \pm 8.5$  years, with 43 % female, 3.3 % ASA I and 96.7 % ASA II. Lesion size was  $17 \pm 9$  mm (range 5–40 mm). 80 % of patients presented with PHA. The predefined primary endpoint (discharge on same calendar day without major complications, emergency presentation or readmission) was achieved in 100 % of SDA, but none of the in-patients ( $\chi^2 = 57$ ;  $p < 0.0001$ ). The secondary endpoint (discharge within 23 h of surgery without major complications, emergency presentation or readmission) was achieved in 100 % of SDA, 90 % of PIPA (n.s.), 33 % of RIPA (33 %;  $\chi^2 = 14.6$   $p < 0.001$ ), and 51.5 % of IPA patients ( $\chi^2 = 8.5$   $p < 0.01$ ). Combining SDA and PIPA cohorts, 93.3 % of treatment episodes met widely used (WHO, United States) definitions of day surgery as completion of the hospital care episode within 23 h. Patients admitted for SDA were highly satisfied (100 %).

**Conclusion:** Same day discharge after adrenalectomy is feasible, safe, and well-perceived in appropriately selected patients with PHA and Cushing's syndrome.

## Introduction

Minimally invasive endoscopic trans-peritoneal, posterior retroperitoneoscopic and robotic approaches have revolutionised the practice of adrenalectomy [1,2]. They improve patient comfort, lessen analgesic use and curtail length of stay [3].

The use of adrenal day surgery has stagnated over the past 15 years [4]. The benefits of less invasive and safer surgery, with less blood loss, and reduced pain, due to the minimal surgical access path, are yet to be fully translated into better health outcomes for patients [5]. The definition of day surgery differs between US-American and Commonwealth authors. The US criterion, adopted by World Health Organization

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<https://doi.org/10.1016/j.sopen.2023.07.009>

Received 6 June 2023; Received in revised form 10 July 2023; Accepted 16 July 2023

Available online 20 July 2023

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(WHO) and the International Association of Ambulatory Surgery<sup>1</sup> is any surgical admission shorter than 23 h, whilst the UK definition is discharge on the same calendar day [5].

Outpatient adrenalectomy was established around the millennium by several groups [6–8], yet <200 patients have since been described in mostly retrospective series and practice audits (Table 4) [9–12]. Amongst 4807 from the database of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), <2 % underwent adrenalectomy via a day surgery pathway [4]. According to current UK data, the average length of stay for adrenalectomy is around 3 days [13]. “Adrenalectomy” does not feature as a topic on the website of the British Association of Day Surgery.<sup>2</sup>

The rare use of day surgery pathways for the delivery of adrenal surgery is out of step with comparable surgical procedures, such as laparoscopic cholecystectomy, appendectomy and not rooted in risk: comparison of 19,315 patients from the ACS NSQIP identified that 1458 patients undergoing laparoscopic adrenalectomy exhibited the same operative risk as routine laparoscopic cholecystectomy [14].

We here explored adrenal day surgery with prespecified several hypotheses, namely that SDA is feasible and safe and would shorten length of stay. We provide the first fully prospective study evaluating the use of same day adrenal surgery in a small but representative cohort. Encouraging outcomes support wider exploration of this approach.

## Methods

We report an observational analytical study compliant with STROBE criteria for cohort studies (<https://www.strobe-statement.org/>). This prospective matched cohort study was performed in a single tertiary referral centre in the UK. The NHS Health Research Authority considered this study under IRAS Project ID 321097. Inclusion and exclusion criteria are shown in Table 1. Cohort size was calculated for a power of 80 %, accepting a value for  $\alpha$  of 0.05 (two-sided), a value for  $\beta$  as 0.20, on the assumption that the probability of completing uncomplicated discharge within the same calendar day was 85 % in ADS patients ( $p_1$ ), and 5 % in patients admitted for inpatient surgery ( $p_0$ ). For a ratio of exposed vs unexposed at 0.3, this identified a total sample size of 12 patients, whereof 9 exposed to day surgery and 3 unexposed, i.e. admitted for inpatient surgery (<http://riskcalc.org:3838/samplesize/>).

Comprising established frameworks of the *Day Surgery Unit* (<https://www.kch.nhs.uk/patientsvisitors/patients/day-surgery-patients>),

**Table 1**  
Inclusion/exclusion criteria applied to case and control cohorts.

Criteria	Inclusion	Exclusion
Size	<5 cm	>5 cm
Age	< 70 years	≥ 70 years
Comorbidities	ASA I & II	ASA III & IV
Endocrine functionality	Prim. hyperaldosteronism PHA	Pheochromocytoma
	Cushing's syndrome (CS)	Paraganglioma
	Non-functional adrenal nodule	Cushing's disease (CD)
Laterality	Unilateral	Adrenal malignancy
BMI	≤33	Bilateral
Drugs	Anti-hypertensives	>34
Inclusion/exclusion criteria applied to the SDA cohort only		
Distance from hospital	≤60 min	>60 min
Support at home	Yes	No

ASA American Society of Anaesthesiologists physical status class; BMI body mass index; SDA same day adrenalectomy cohort.

<sup>1</sup> [https://theiaas.net/wp-content/uploads/2022/06/Day\\_Surgery\\_Manual.pdf](https://theiaas.net/wp-content/uploads/2022/06/Day_Surgery_Manual.pdf).

<sup>2</sup> <https://bads.co.uk/>.

we designed a study protocol for prospective allocation of patients requiring laparoscopic adrenalectomy to either a day surgery pathway or inpatient surgery. The protocol was designed locally by our experienced endocrine surgeons, and the anaesthetic team. Patient selection for the day surgery pathway was based on National GIRFT (Getting It Right First Time) guidelines (National day surgery delivery pack September 2020).

The indication for adrenal surgery was based on extensive endocrine work-up. For PHA patients, this typically included lateralization by adrenal vein sampling. Following informed consent, trans-peritoneal laparoscopic adrenalectomy was performed under general anaesthesia in a 75-degree lateral position in three-port technique.

On the SDA pathway, patients were monitored in the recovery unit for about 4–6 h following surgery. The ultimate decision for same-day discharge was reserved for the senior patient review by the operating surgeon, based on the patient meeting prior established day surgery criteria. The criteria for discharge included normal vital signs, the ability to eat and drink, provided there was no episode of nausea or vomiting, ability to pass urine spontaneously, ambulation without support, pain controlled with over-the-counter medications and return to pre-operative baseline self-care. Following surgery, inpatients were treated on hospital wards following routine observation during recovery periods of various durations. The decision to discharge was made during daily ward rounds of inpatient wards, applying set discharge criteria. A prescription for oral analgesics was given to all patients. A trained nurse contacted all patients by phone on day one and day two post-surgery. All patients were reviewed in the endocrine surgery outpatient clinic 1–4 weeks after the operation, and were reviewed at least once after the 30-day mark to determine outcomes up to 30 days. Inpatients were treated following standard of care protocols with identical follow-up processes as for the SDA pathway.

All relevant parameters were recorded prospectively. We recorded exposures (admission path for surgery) and related eligibility criteria (Table 1) including the post-operative place of return post discharge, and an estimated time of travel home-to-hospital agreed with the patient. We recorded matching criteria (age stratified into groups 18–40, 40–55, and 55–70 years; lesion size <20 mm vs 20–50 mm; endocrine pathology as PHA vs CS), outcome predictors (lesion size in mm; age in years and endocrine function), potential outcome modifiers (laterality left versus right; ASA status I vs II; gender, body mass index BMI) and outcome confounders including duration of surgery, estimated blood loss (< 50mls vs >50mls), operative time (incision to completion of closure), total anaesthesia time (intubation to extubation), transfusion of blood or blood products, conversion to open surgery. We recorded outcome parameters contributing to our four predefined composite outcomes. This included length of stay in hours (admission to determination of discharge), length of post-operative stay in hours (arrival in recovery room to determination of discharge), 30-day readmission status, and 30-day status of complications according to Clavien-Dindo [15].

All study endpoints were pre-defined. The primary endpoint was a composite outcome comprising a) same-day discharge of the patient (no overnight hospital stay) b) absence of a complication above grade II Clavien-Dindo [15] and c) no readmission to this or other hospitals or emergency presentation for any reason. The patient was assessed as failing the primary endpoint if any criterion was not fulfilled. The secondary endpoint was as above, but with day surgery adrenalectomy defined as patient discharge within 23 h of completion of surgery. As collateral information, we also assessed patient satisfaction on the SDA pathway only, defined as overall satisfaction (highly satisfied, satisfied or not satisfied) using a standardized tool. Patients received an independent questionnaire feedback form link via email and a letter by post to record patient's satisfaction, post-operative pain and experience, and were asked to provide suggestions for improving the service. The questionnaire utilized questions to assess patient's perception of several domains including preparation for theatre, pre-operative experience, discharge experience, and overall satisfaction in the outpatient/

inpatient setting (Suppl. Form A).

Differences between cohorts were assessed as values for mean  $\pm$  standard deviation (SD), median, chi square tests ( $\chi^2$ ) and significance of differences (two-tailed). Relative risk was calculated using SPSS software version 18.0. Significance was defined at  $p < 0.05$ .

## Results

The initial assessable cohort comprised 57 consecutive patients scheduled for laparoscopic adrenalectomy at our centre between 01 September 2021 and 30 June 2022. Complete data inclusive of 30-day outcomes were recorded in all 57 patients. 27 patients (47.4 %) failed to meet eligibility criteria set out in Table 1 or could not be matched to patients in the SDA cohort. Of the remaining 30 patients, 10 (33.3 %) were eligible for SDA and preferred admission to the day surgery

pathway (SDA cohort); all completed it. To each of these SDA patients we could match 2 patients prospectively recruited to the inpatient pathway ( $n = 20$ ; PIPA). To each SDA patient we could also match 4 patients whose data had been prospectively recorded, yet outside the recruitment period, during their inpatient adrenalectomy episode between 01 May 2007 and 30 August 2021 ( $n = 40$ ; RIPA). For this retrospective cohort, complete datasets had been prospectively recorded for all patients. The pairs of 6 patients matched to each SDA patient were also considered in an inpatient cohort ( $n = 60$ ; IPA).

Matching proceeded on a case-by-case basis based on each of the 10 patients in the SDA cohort. Matching criteria comprised factors with known impact on clinical outcome: age (age groups of  $\pm 5$  years), lesion size ( $\pm 5$  mm), and endocrine function (primary hyperaldosteronism PHA vs Cushing's syndrome CS). As all patients admitted to the SDA pathway had functional lesions, we could not match non-functional

**Table 2**  
Outcome predictors, modifiers and confounders across cohort strata.

	All (n=70)	SDA (n=10)	PIPA (n=20)	$\chi^2$ p value	RIPA (n=40)	$\chi^2$ p value	IPA (n=60)	$\chi^2$ p value
<b>Outcome predictors</b>								
Matching criterion								
Lesion size								
<20mm	50	8	15	$\chi^2 = 0.0$	27	$\chi^2 = 0.6$	42	$\chi^2 = 0.4$
20-50mm	20	2	5	p=n.s	13	p=n.s	18	p= n.s
Matching criterion								
Age (years)								
18-40	9	1	2	$\chi^2 = 0.0$	6	$\chi^2 = 0.0$	8	$\chi^2 = 0.5$
40-55	39	6	12	p= n.s	21	p= n.s	33	p= n.s
55-70	22	3	6		13		19	
Matching criterion								
Pathology								
PHA	56	8	16	$\chi^2 = 0.0$	32	$\chi^2 = 0.0$	48	$\chi^2 = 0.0$
CS	14	2	4	p=n.s	8	p=n.s	12	p=n.s
Lesion size								
Mean	19.1 $\pm$ 8.9	16.9 $\pm$ 12	17.9 $\pm$ 9.4		20.3 $\pm$ 7.8		19.5 $\pm$ 8.4	
Median	18.0	15.0	15.0	n.s	20.0	n.s	20.0	n.s
Range	5-42	5-40	6-40		7-42		6-42	
Age (years)								
Mean	51.3 $\pm$ 8.5	51.3 $\pm$ 8.6	51.3 $\pm$ 9.2	n.s	51.4 $\pm$ 8.3	n.s	51.4 $\pm$ 8.5	n.s
Median	50.5	51.0	51.0		50.5		50.5	
Range	33-69	39-69	33-68		37-69		33-69	
<b>Outcome modifiers</b>								
Left-sided lesion	44/70 63%	6/10 60%	11/20 55%	n.s	27/40 68%	n.s	38/60 63%	n.s
ASA grade 2	64/70 91.4%	9/10 90.0%	20/20 100%	n.s	35/40 87.5%	n.s	55/60 91.7%	n.s
<b>Outcome confounders</b>								
Operative time (min)								
Mean	110 $\pm$ 43	79 $\pm$ 13	115 $\pm$ 39	$\chi^2 = 16.5$	116 $\pm$ 46	$\chi^2 = 9.1$	116 $\pm$ 44	$\chi^2 = 10.5$
Median	95.0	80.0	115.0	p<0.001	111.0	p<0.01	112.0	p<0.01
Range	37-244	60-105	60-181		37-244		37-244	
Blood loss <50mls	70/70	10/10	20/20	n.s.	20/20	n.s.	60/60	n.s.
Conversion to open surgery	0/70	0/10	0/20	n.s.	0/20	n.s.	0/60	n.s.
Blood transfusion	0/70	0/10	0/20	n.s.	0/20	n.s.	0/60	n.s.

To each patient of the day surgery adrenalectomy cohort (DSA) we matched 2 patients prospectively recruited and undergoing in-patient surgery (PIPA cohort) and 4 patients matched against our prospectively recorded register (RIPA cohort). The categories used for matching are underlined in grey. Differences of RIPA, PIPA and IPA cohorts against the DSA cohort are exhibited as  $\chi^2$  values with their two-tailed significance ( $p$  values). As there were no significant differences between RIPA and PIPA cohorts (data not shown) they were also treated as a cohort comprising inpatients from the retrospective and prospective cohorts (IPA cohort).

adenomas. We did not match for gender, lesion laterality or ASA status (status I or II), as these do not tangibly impact short term outcomes.

Outcome predictors, modifiers and potential confounders of patients are provided in Table 2. Comparison between SDA and PIPA cohorts, SDA and RIPA cohort, and PIPA and RIPA cohort did not identify any significant differences for matching criteria (Table 2). PIPA and RIPA cohorts were consequently also considered as inpatient adrenalectomy cohort IPA, which again did not differ from the SDA cohort or the PIPA cohort (Table 2).

Beyond data exhibited in Table 2, there were no significant differences between PIPA and RIPA, or either and IPA ( $p =$  not significant). Although not matched, gender distribution and BMI indices were not different between cohorts ( $p =$  not significant). It is noteworthy that 80 % of patients presented with PHA. Across cohorts, median lesion size was 15–20 mm and 84 % of lesions were smaller than 29 mm in the IPA and SDA cohort alike. Median operating time was significantly shorter by around half an hour in the SDA cohort, without any evidence for differences in lateralization, blood loss, or lesion pathology as potential drivers of this observation.

Table 3 provides comprehensive data about predefined outcomes and the accessory outcome patient satisfaction. Across cohorts, no patient experienced a clinically impactful complication, here defined as Clavien-Dindo complication above grade 2. No patient was readmitted after surgery. The prospectively studied inpatient cohort PIPA met US/WHO criteria for day surgery in 90 % of cases, whilst this was true for only 33 % of the retrospectively studied cohort RIPA, with an odds ratio of 18.7 (95%CI 3.8–92.9;  $P = 0.0003$ ) to be discharged within 23 h in the PIPA cohort. The mean length of stay was markedly and significantly higher in the retrospective study cohorts.

All SDA patients chose “highly satisfied” over “satisfied” or “unsatisfied” and all would recommend SDA over inpatient admission if asked to advise a patient with their own circumstances.

## Discussion

Our prospective cohort study provides level II evidence that day surgery adrenalectomy is feasible and can safely be delivered. Collateral explorations indicate that it enjoys favourable patient perception and

offers economic benefits. Our findings align with sparse prior studies in the field (Table 4). Only two prior studies comprising 22 patients employed a prospective approach [6,8] using a dedicated ambulatory adrenalectomy pathway, as is the case in our study. The biggest clinical cohort has been reported by Gartland and colleagues [11]. In their retrospective study, they considered any patient undergoing laparoscopic adrenalectomy as a potential candidate for same day discharge and formulated discharge plans based on ad hoc observations during post-operative recovery [16]. Whilst entirely reasonable, this approach does not address the potential of upfront planning of adrenal procedures for dedicated outpatient surgery facilities. We have addressed this issue here.

We find that most patients with PHA or Cushing's syndrome, yet without malignancy or unrelated challenges (ASA status), can be treated in a day surgery pathway (Table 3). We ensured pre-admission correction of chronic hypokalaemia in PHA to avoid needs to steer post-op potassium levels. Blood pressure medication was reduced to single agent, with patients instructed to stepwise self-introduce former non-aldosterone antagonist medications if blood pressure was not controlled at home. Patients with Cushing's syndrome were provided with routine oral steroid cover until next clinic review within 14 days, averting needs to prescribe taper dosages in the fresh post-operative period.

Whilst the primary endpoint “uncomplicated same day discharge” could necessarily only be achieved by prospective admission to the SDA pathway, it is remarkable that 90 % of prospectively admitted patients on the inpatient pathway could be discharged within 23 h of admission, satisfying widely used definitions of day surgery (WHO, United States etc). The secondary endpoint “uncomplicated discharge within 23h of admission” was achieved in 93.3 % of patients in the PIPA cohort. It is noteworthy that this is markedly different from our own prior experience documented in the RIPA cohort, where management did not particularly focus on discharge timing. A shift towards same day discharge can be achieved without compromising patient safety. Briefly, our results indicate two different areas with room for manoeuvre: shifting eligible patients from short inpatient stays to day surgery pathways and shifting discharge planning of inpatients to an earlier timeframe.

**Table 3**  
Predefined outcomes and key drivers.

	All (n = 70)	SDA (n = 10)	PIPA (n = 20)	$\chi^2$ p value	RIPA (n = 40)	$\chi^2$ p value	IPA (n = 60)	$\chi^2$ p value
<b>Primary outcome</b>								
Discharge on calendar day of surgery and no readmission and no complication Clavien-Dindo >2	10/70 14.3 %	10/10 100 %	0/20 0 %	$\chi^2 = \text{inf}$ $p < 0.001$	0/40 13	$\chi^2 = \text{inf}$ $p < 0.001$	0/60 18	$\chi^2 = \text{inf}$ $p < 0.001$
<b>Secondary outcome</b>								
Discharge within 23 h of surgery and no readmission and no complication Clavien-Dindo >2	41/70 58.6 %	10/10 100 %	18/20 90 %	n.s	13/40 33 %	$\chi^2 = 14.6$ $p < 0.001$	31/60 51.7 %	$\chi^2 = 8.5$ $p < 0.01$
<b>Outcome drivers</b>								
Mean length of stay after surgery (hours)	34.0 ± 22.7	7.6 ± 2.6	25.5 ± 19.0	$\chi^2 = 6.3$ $p < 0.01$	45.0 ± 9.7	$\chi^2 = 6.3$ $p < 0.01$	38.5 ± 21.5	$\chi^2 = 13.7$ $p < 0.01$
Post-op emergency presentation	0	0	0	0	0	0	0	0
Re-admission to hospital within 30 d	0	0	0	0	0	0	0	0
Complications clavien-dindo ≤2	0	0	0	0	0	0	0	0
Complications clavien-dindo >2	0	0	0	0	0	0	0	0
<b>Accessory outcome</b>								
Patient satisfaction highly satisfied recommends DSA		10/10 100 %	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Outcomes were prospectively recorded for all cohorts, including day surgery adrenalectomy cohort (DSA), in-patient surgery during recruitment (PIPA cohort) and for prior patients on our prospectively recorded register (RIPA cohort). Clavien-Dindo identifies complications graded per Clavien-Dindo classification. Differences were assessed by chi square test and provided as  $\chi^2$  values with their two-tailed significance ( $p$  values). As there were no significant outcome differences between RIPA and PIPA cohorts (data not shown) they were also treated as a cohort comprising inpatients from the retrospective and prospective cohorts (IPA cohort). n.a. = not available.

**Table 4**  
Prior reports on same days adrenalectomy and day surgery.

Author	Year	Patients n	Design	Discharge		Comment
				Same day	23 h	
Gill [8] Ohio, US university hospital	2000	9	Prospective; ambulatory adrenalectomy protocol. Inclusion criteria, informed consent, age < 70 years, BMI < 40, lesion < 5 cm, no pheochromocytoma	9 100 %		7 × PHA; no readmissions; 1 × abscess
Rayan [7] Massachusetts US university hospital	2000	19	Chart review of consecutive patients; PHA 11, Cushing's 3; other 3; pheochromocytoma 1; NFA 1	–	8 42.1 %	Age 41 + 14 years; 11 patients stayed >24 h; lesion size 3.3 cm; OP time 3.3 h; average LOS 1.5 days
Edwin [6] Norway university hospital	2001	13	outpatient laparoscopic adrenalectomy protocol; all PHA; exclusion pheo, >10 cm, malignant; >30 min form hosp.; no carer at home	13 100 %		Median OP time 38 min (35–112); “excellent satisfaction in 12/13, medium 1/13 at day 1 and 7
Mohammed [9] Canada university hospital	2009	17	Retrospective; select patients between 1994 and 2006	13 76.5 %	3 17.6 %	Age 52.4 years; one admitted; lesion size 1–5.8 cm; no revision, readmission or death; supposed cost benefits of \$1478
Ramirez-Plaza [10] Spain university hospital	2011	22	Inclusion: ASA1/2; <65 years; lesion <6 cm; lesion not pheo; within 30 min from hospital	3 13.6 %	19 86.4 %	Age 50.9 years; mean OP time 57 min; med OP 60min (15–120); one readmission d3 (collection)
Gartland [11] Massachusetts & Alabama, US university hospital	2021	99 + 104	Retrospective; clinical practice audit; all comers considered as potential DSU unless other organ removal or bilateral ADX; no criteria; ASA2 35 %; ASA 3 63 %	99 100 %	104 100 %	Age 56 (47–66); median OP time 91mins (73–132); lesion size 3.5 cm (1.9–4.5); readmission 2 %; 30d complications 4.0 %
Shariq [4] ACS NSQIP, US database	2021	88	Retrospective NSQIP data; NFA 51 %; PHA 15 %, Cushing's 0; other 34 %; ASA3 46 %;			Age 50.5 (42–60); BMI >30 37 %; T2DM 15 %; After adjustment for confounders, same-day discharge was not associated with 30-day overall complications (OR 1.17, 95 % CI 0.35–3.85; <i>P</i> = 0.80) or unplanned readmissions (HR 2.77, 95 % CI 0.86–8.96; <i>P</i> = 0.09). No readmissions; discharge plan discussed in 94 %, felt better prepared for recovery than inpatients; more informed about complication; slightly higher experience score
Pigg [12] Alabama, US university hospital	2022	33	Retrospective inst. database	33 100 %	?	
Own data London, UK university hospital	2022	10 + 60	Prospective; ambulatory adrenalectomy protocol. Inclusion criteria, informed consent, age < 70 years, BMI < 40, lesion < 5 cm, no pheo	10 100 %	31 51.7 %	

In this cohort study, pathway choice for day surgery suitability followed UK national guidelines developed in partnership with the Getting It Right First Time (GIRFT) Academy, Centre for Perioperative Care (CPOC) and the British Association of Day Surgery (BADS) [17,18], identifying some 15 % of our adrenalectomy cohort. Surgical risks of adrenalectomy may be lived off by the end of surgery. Satisfactory technical resolution of operative challenges minimises their impact on patient care. The observation of volume-outcome correlation in adrenal surgery also supported a confident approach as three surgeons have shared an annual caseload of about 60–75 patients for more than a decade, and hence all qualify as experienced, high-volume adrenal surgeons [19]. Across disciplines the outcome of day surgery is defined by medical and social factors [18]. The limited size of our same day cohort size was mostly due to exclusion of ASA 3 patients, which regularly account for about 30–60 % of large or National adrenalectomy cohorts [11,20,21]. However, ASA criteria are not recommended for the assignment to day surgery pathways by GIRFT and BADS criteria [17,18], and we might have been overcautious to include this criterion.

Our secondary composite endpoint was discharge within 23 h of surgery without Clavien-Dindo complication grade 3 or higher and no readmission within 30 days. This endpoint satisfies day surgery criteria widely used in the United States and beyond [5], where 23 h stay surgery is commonly referred to as day surgery. This endpoint was reached in 74.5 % across our cohort, and no invasive medical interventions were required in this group. 70 % of our patients who up-front failed criteria for same day surgery could still be discharged within 23 h, satisfying a wider definition of day surgery.

Looking forward we need to expand our understanding of risk factors to fail same day discharge. A higher degree of surgical difficulty is not amongst them [22,23]. A recently proposed 5-item frailty index (5-iFI) deserves further exploration [24]. The anaesthetic regime will also deserve a detailed review [25]. Lesion type has been proposed as major risk factor for an adverse post-operative evolution, but a dedicated study

has shown that after adjusting for demographic differences, BMI, and comorbidity scores, no tumor type was associated with increased complication rate [26]. Instead, primary hyperaldosteronism predicted fewer complications and shorter length of stay [26]. The lacking adverse impact of pheochromocytoma status [26] may be owed to the fact that most of such patients are younger and around 90 % exhibit an mFI-5 score of 0 or 1 [26].

In terms of safety, hospital admission for 1–3 days rather than same day surgery holds little promise to enhance safety. A highly instructive study into the timing of complications following adrenalectomy in 4844 patients on the ACS-NISQIP database identified that the majority of complications occurred after day 2, and 43.2 % only after expiry of the median length of stay of 3 days [27]. In that light, future trials may seek to exploit an early outpatient review of patients in the window 48–72 h after surgery.

We did not identify patient perception or cost issues to pose significant obstacles, but neither should be identified as main driver for transitioning adrenalectomy to day surgery pathways.

#### Limitations of this study

Whilst we offer first level 2 evidence relating to the implementation of SDA pathways, the lack of randomization and small cohort size caution against over interpretation of study outcomes. Rather than informing current change and field-wide implementation, this study offers a clear rationale for a future randomised controlled trial to provide level I evidence to inform future guidelines. The availability of an on-call nurse for contact during the first 48 h after surgery surely is an enhancing feature, which may otherwise be compensated for by a stakeholder of the surgical team agreeing to provide a phone number for 24/7 urgent contact during that time.

## Conclusion

In select patient cohorts, same day surgery and 23 h admission offer safe and effective options to provide minimally invasive adrenalectomy.

## CRedit authorship contribution statement

Gabriele Galata': Co-designed the study, protocol development (endocrine surgery), data collection, scoring, provision of patient care as per study protocol, writing and revising initial and final manuscript.

Katerina Alexandrou: Ethics approval, data curation (health economy data), writing and revising of initial and final manuscript.

Nadia Talat: Curation of institutional prospective database, data integrity, writing and revising final draft.

Helena Hanschell: Curation of institutional prospective database, writing and revising final draft.

Ammar Al-Lawati: Data collection (data from surgical pathway), provision of patient care as per study protocol, writing and revising final draft.

Patrick Klang: Data collection (data from surgical pathway), provision of patient care as per study protocol, writing and revising final draft.

Assef Jawaada: Data collection (data from surgical pathway), provision of patient care as per study protocol, writing and revising final draft.

Fraser Dunsire: Protocol development (anaesthesia), data collection, scoring, provision of patient care as per study protocol, writing and revising final draft.

Johnathan Hubbard: Protocol development (surgery), data collection, scoring, provision of patient care as per study protocol, writing and revising final draft.

Dylan Lewis: Protocol development (radiology), data collection (imaging and interventional tests for lateralization), scoring, provision of patient care as per study protocol (cross-sectional imaging; adrenal venous catheter sampling for lateralization), writing and revising final draft.

Simon Aylwin: Protocol development (endocrinology), data collection, scoring, provision of patient care as per study protocol, lead of King's Adrenal Multidisciplinary Team Meeting where all patients were discussed in detail, writing and revising final draft.

Klaus-Martin Schulte: co-designed study, protocol development, supervision, provision of patient care as per study protocol, data analysis, writing initial draft, lead of writing final draft.

## Funding/support statement

This study received funding from the British Association of Day Surgery to support publication costs.

## Ethical approval

The NHS Health Research Authority of the United Kingdom considered this study under IRAS Project ID 321097 and advised that human research ethics approval was not required.

## Declaration of competing interest

None of the authors has any conflict of interest to disclose.

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