

# Transcatheter Aortic Valve Implantation

- UK TAVI Audit Slide Set
- 2007 to 2016

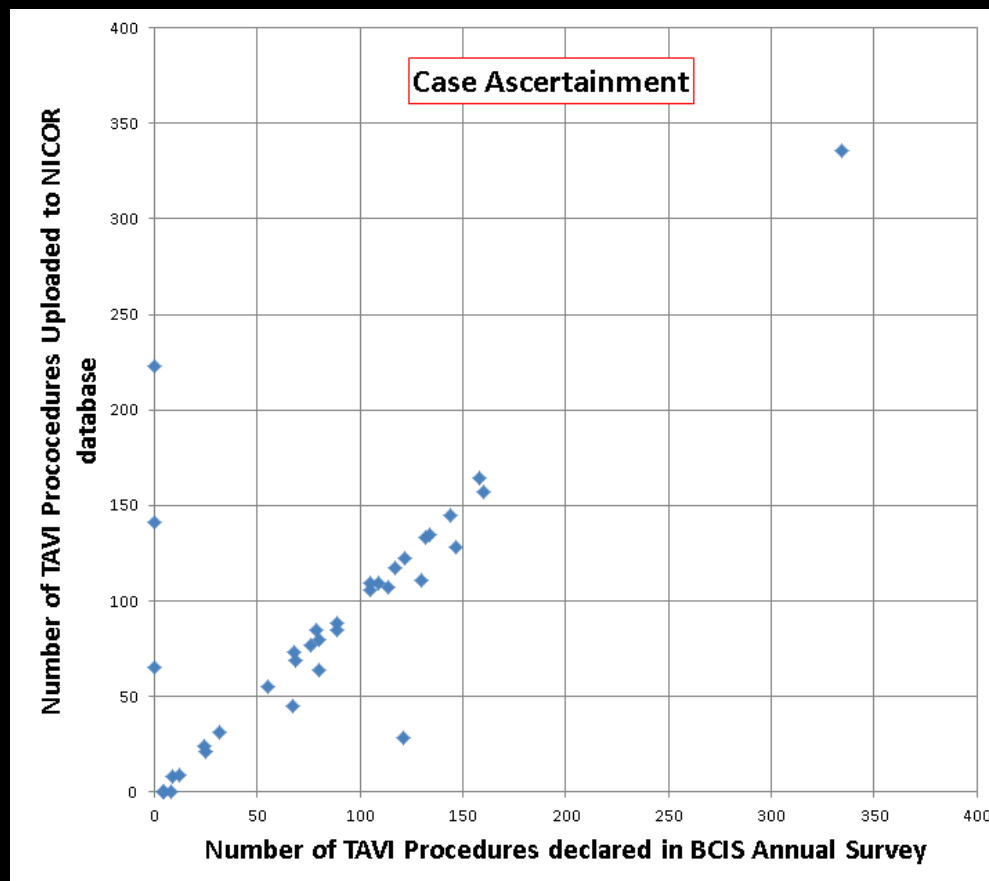
Peter Ludman  
on behalf of the UK TAVI Steering Group

Data extract taken in May 2017

# Number of procedures



# Case Ascertainment



Ascertainment data from BCIS Survey Monkey as June 2017

Procedures in the database but not yet declared from LGI, CHN, RVB

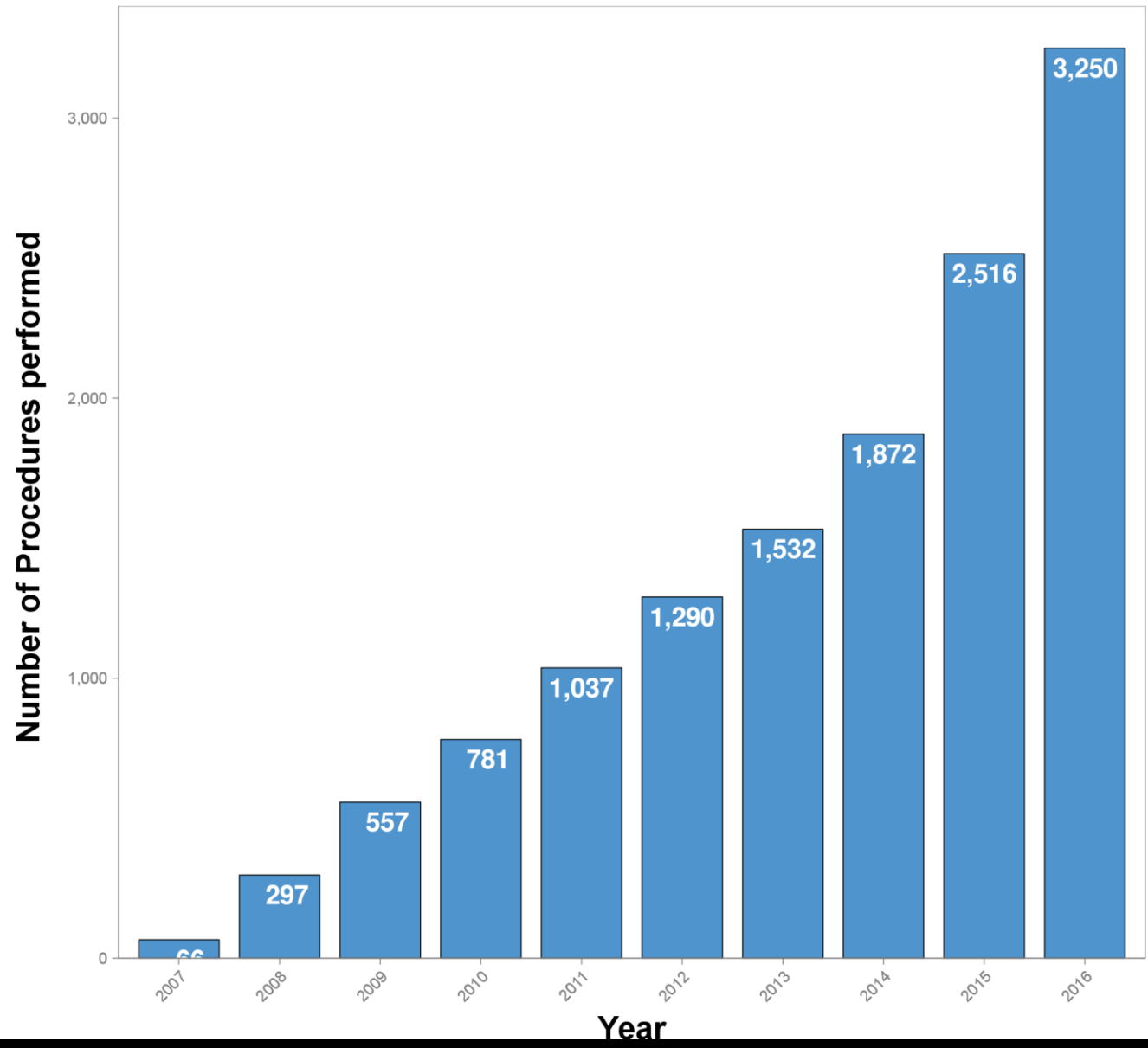
Procedures not uploaded to database AHM (4), CRO (5), NGS (8)

Partial upload of procedures: NCR (28 of 121)

Therefore the following analysis probably misses 110 cases of 3,250 (3%)

# Number of Procedures performed by Year

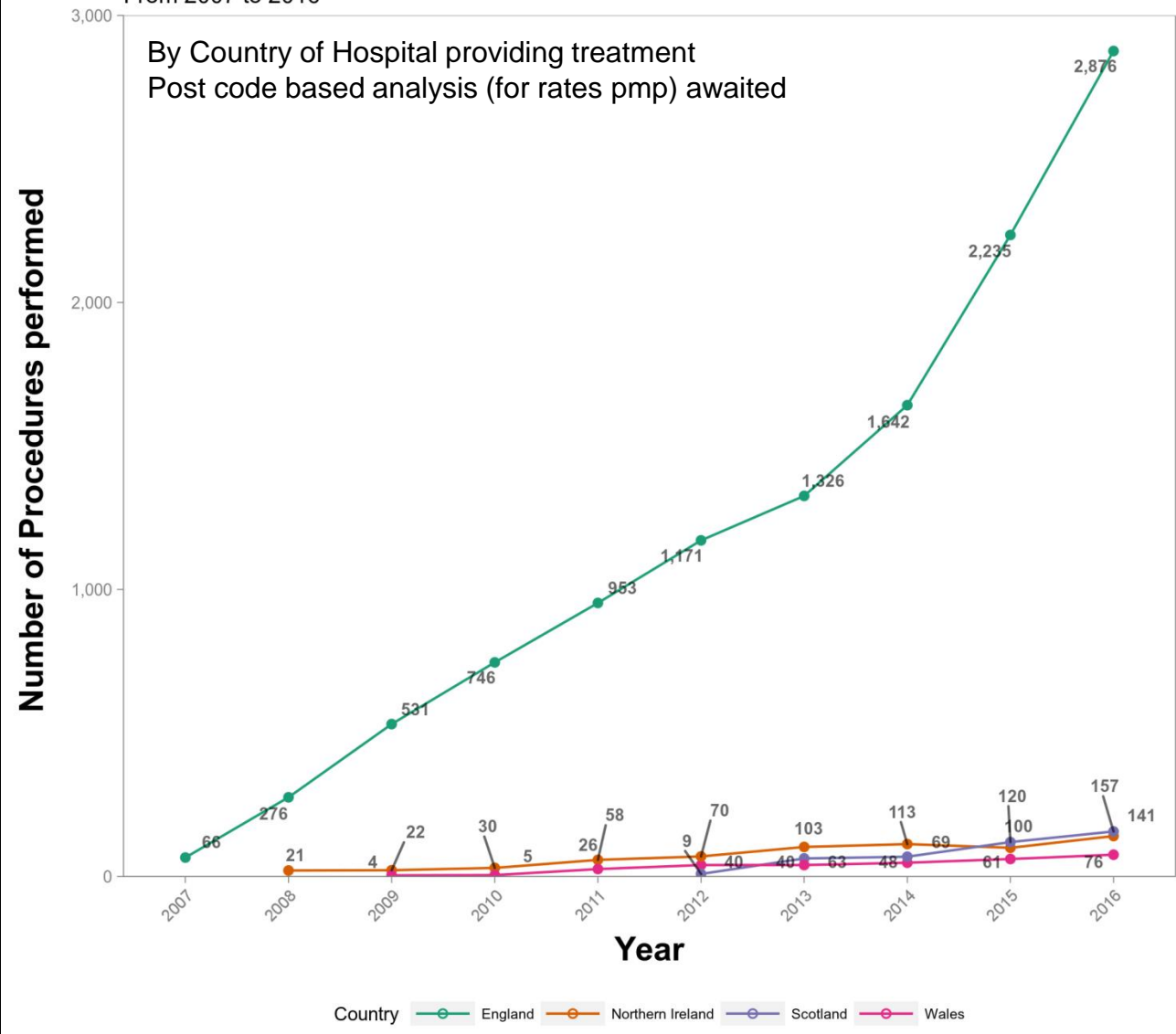
TOTAL UK  
From 2007 to 2016



UK rate pmp = 49.5

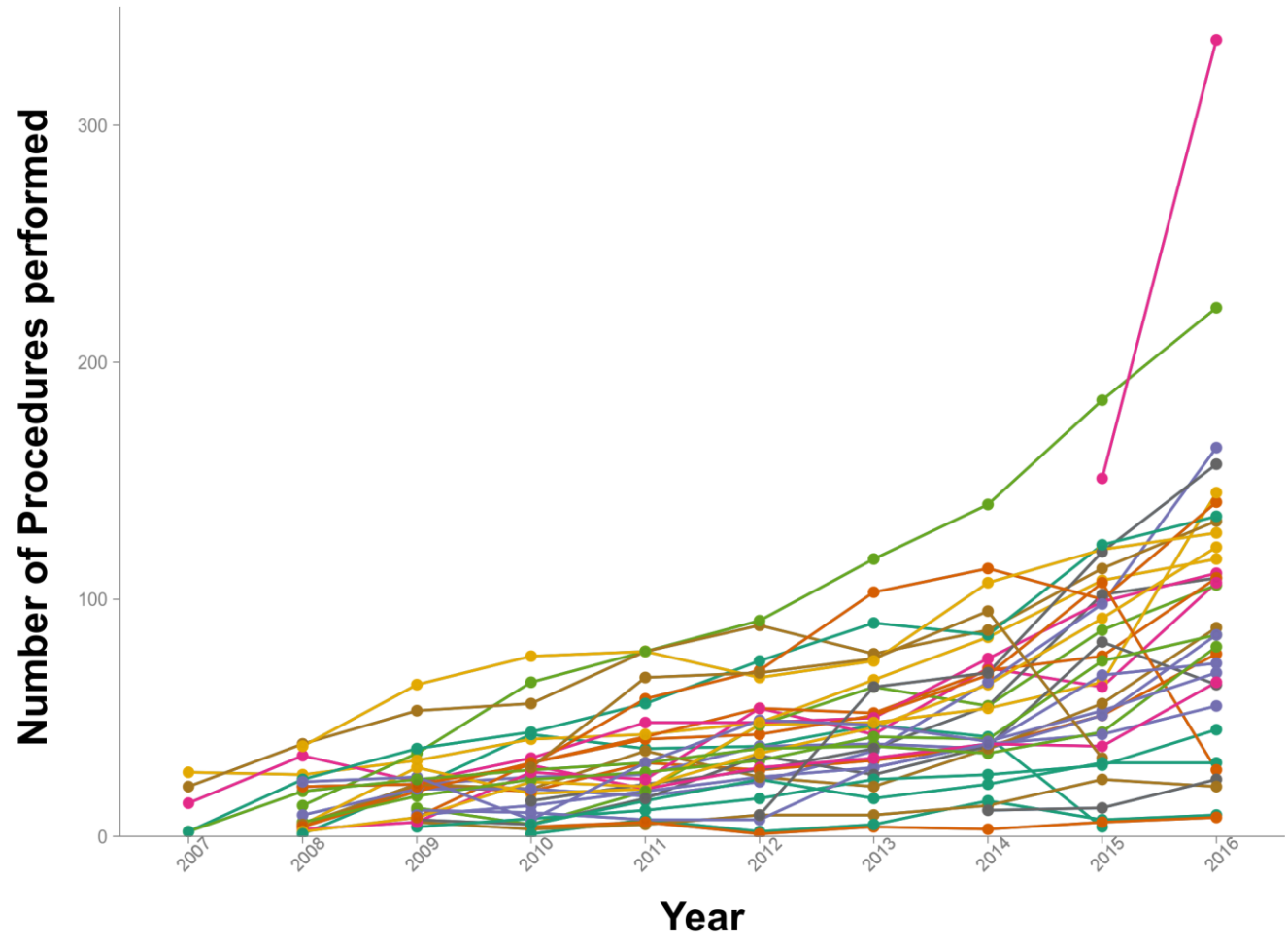
### Number of Procedures performed by Year Grouped by Country

TOTAL UK  
From 2007 to 2016



# Number of Procedures performed by Year grouped by Centre

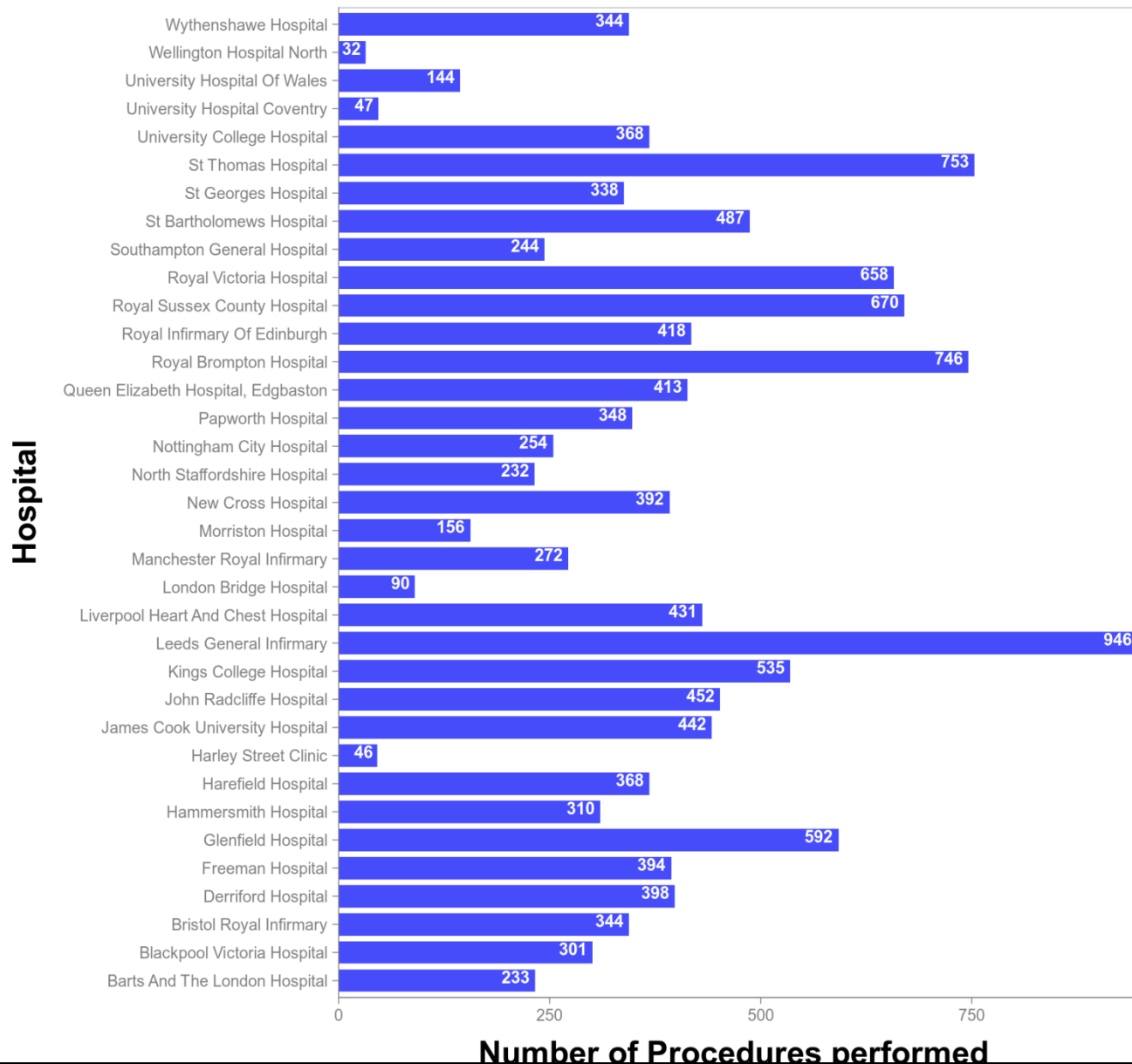
Total UK  
From 2007 to 2016



- |                               |                                    |                              |                                     |       |
|-------------------------------|------------------------------------|------------------------------|-------------------------------------|-------|
| Barts And The London Hospital | Harefield Hospital                 | London Bridge Hospital       | Queen Elizabeth Hospital, Edgbaston | St... |
| Blackpool Victoria Hospital   | Harley Street Clinic               | Manchester Royal Infirmary   | Royal Brompton Hospital             | St... |
| Bristol Royal Infirmary       | James Cook University Hospital     | Morriston Hospital           | Royal Infirmary Of Edinburgh        | Un... |
| Derriford Hospital            | John Radcliffe Hospital            | New Cross Hospital           | Royal Sussex County Hospital        | Un... |
| Freeman Hospital              | Kings College Hospital             | North Staffordshire Hospital | Royal Victoria Hospital             | Un... |
| Glenfield Hospital            | Leeds General Infirmary            | Nottingham City Hospital     | Southampton General Hospital        | We... |
| Hammersmith Hospital          | Liverpool Heart And Chest Hospital | Papworth Hospital            | St Bartholomews Hospital            | Wy... |

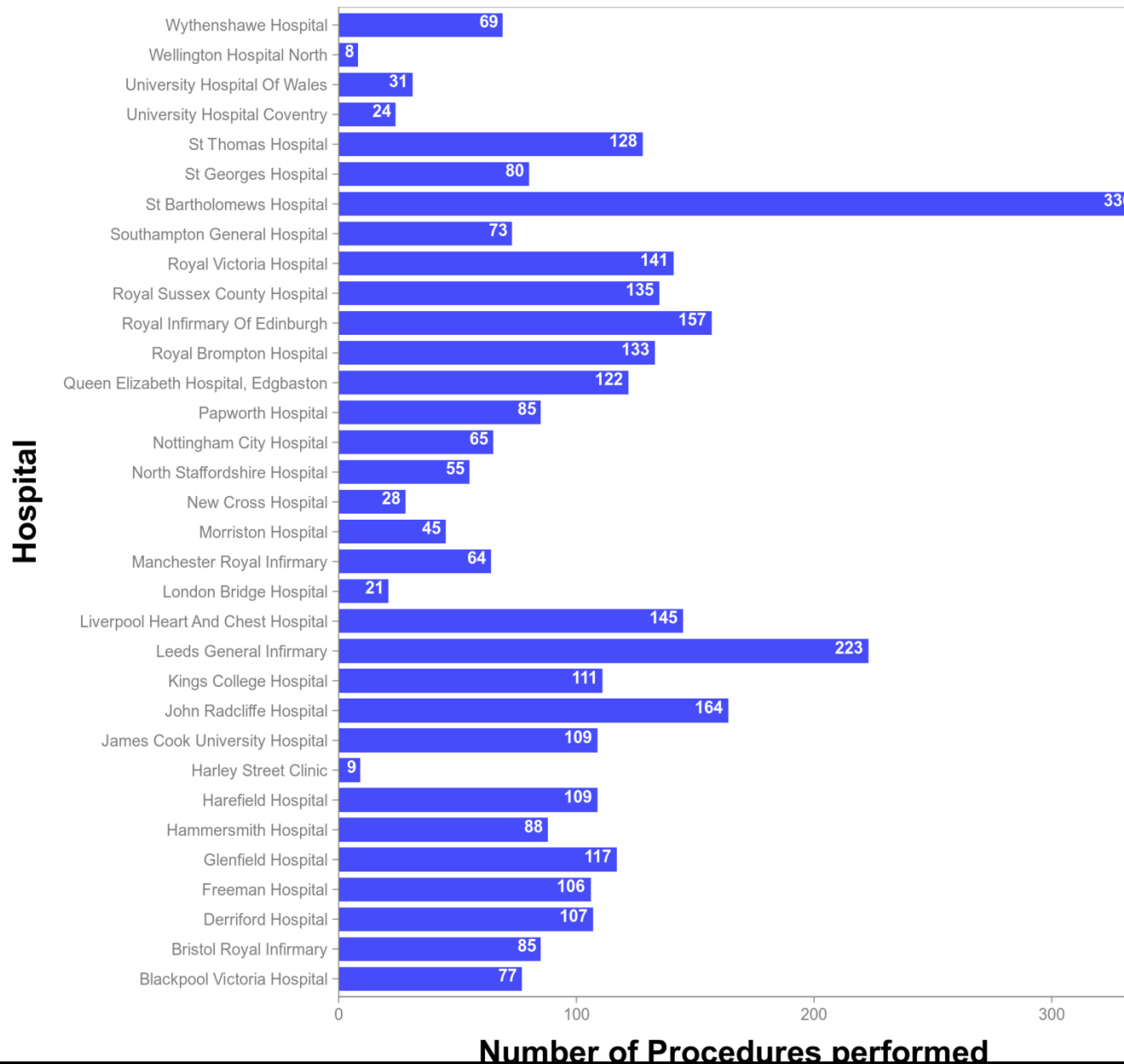
## Number of Procedures performed by Hospital

From 2007 to 2016



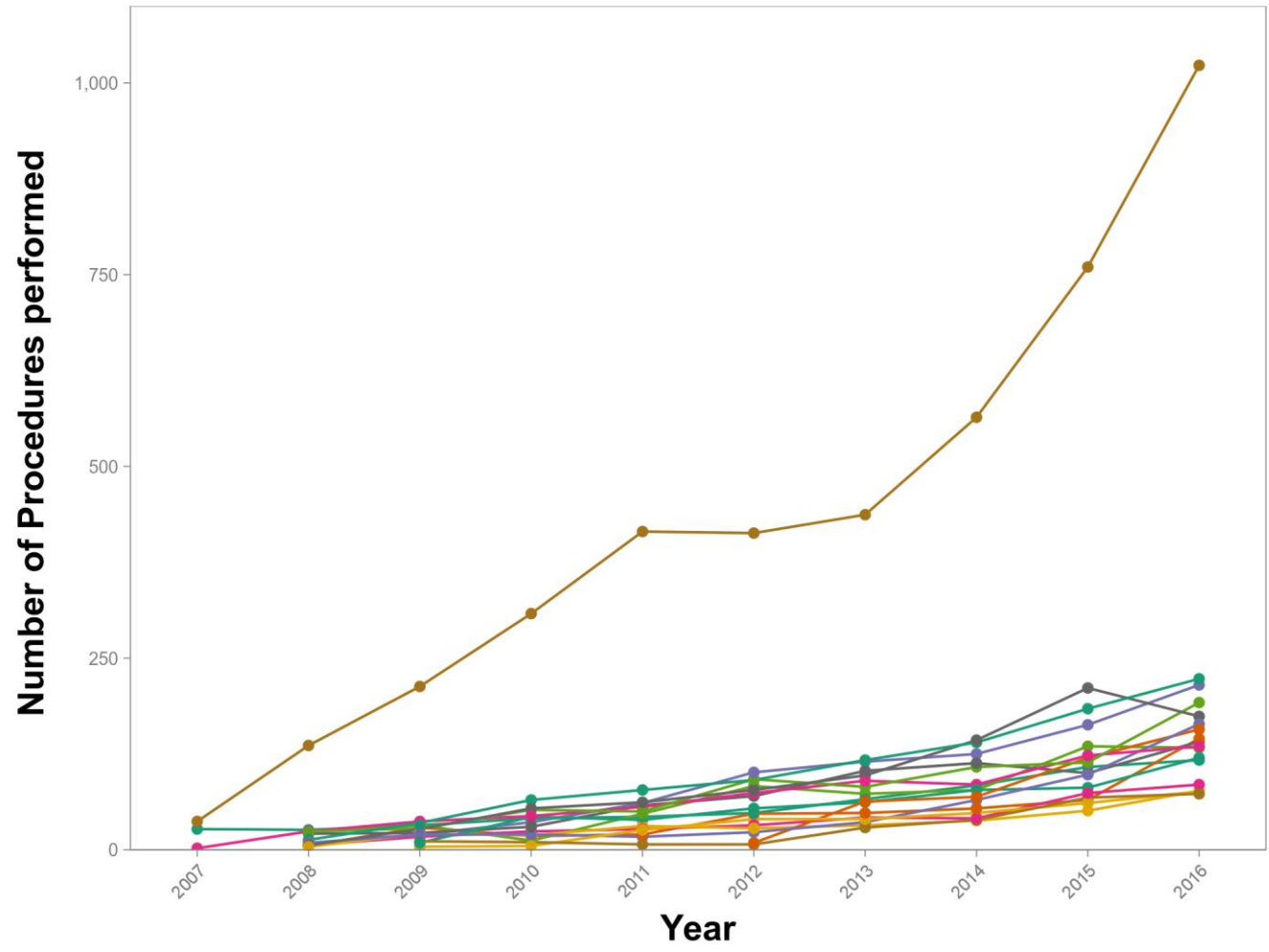
# Number of Procedures performed by Hospital

From 2016 to 2016



# Number of Procedures performed by Year Grouped by NHS Region

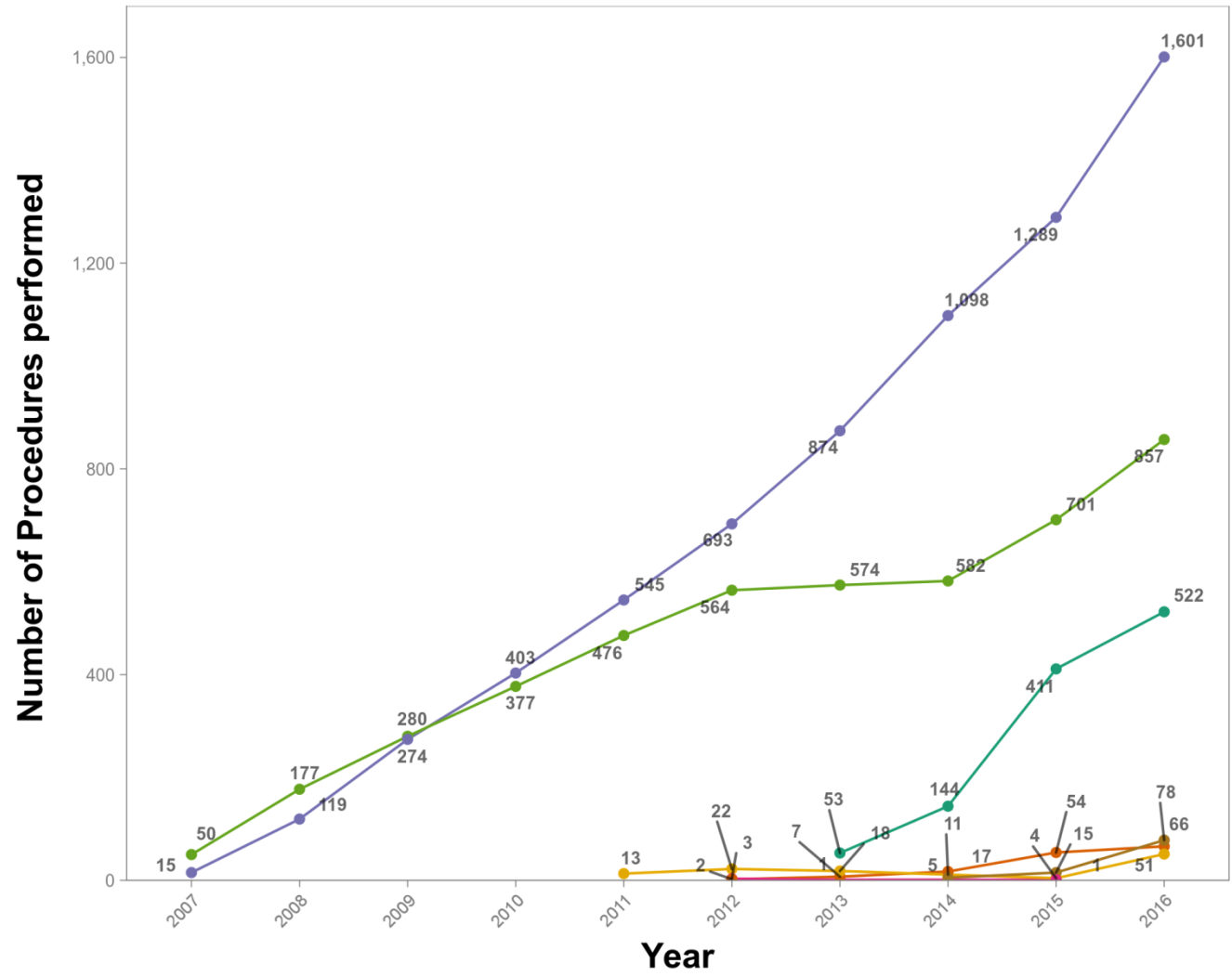
TOTAL UK  
From 2007 to 2016



- NHS Region
- Central Midlands
  - Cheshire and Merseyside
  - Cumbria and North East
  - East
  - Greater Manchester
  - Lancashire and South Cumbria
  - London
  - Northern Ireland
  - North Midlands
  - Scotland
  - South Central
  - South East
  - South West
  - Wales
  - West Midlands
  - Wessex
  - Yorkshire and

# Number of Procedures performed by Year Grouped by Valve manufacturer

TOTAL UK  
From 2007 to 2016



Valve manufacturer

- BSC. BOSTON SCIENTIFIC
- EDW. EDWARDS LIFESCIENCES
- MED. MEDTRONIC
- SYM. SYMPLICITY
- DFM. DIRECT FLOW MEDICAL
- JNV. JENAVALVE
- SJM. ST JUDE MEDICAL

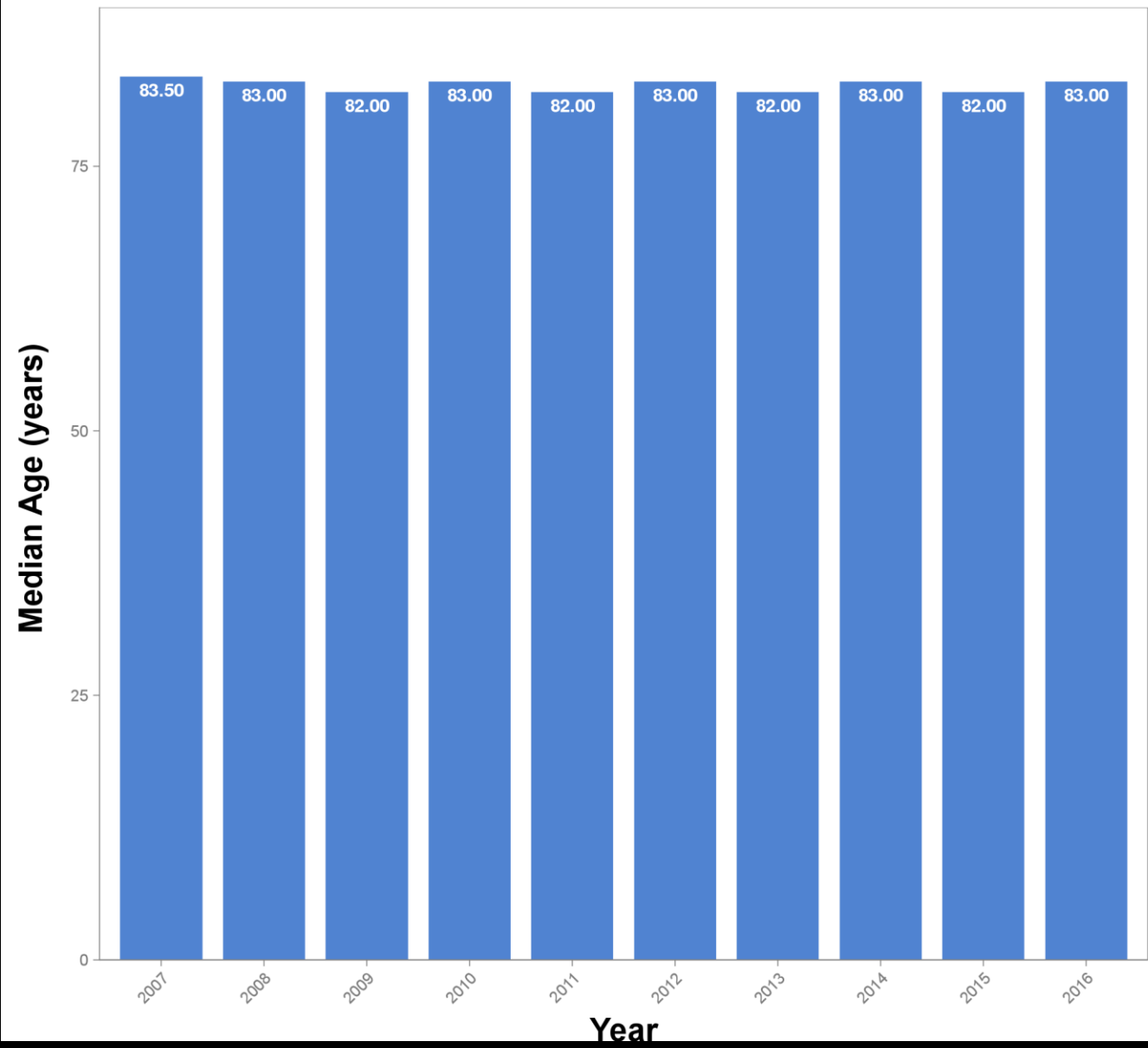
# Demographic features

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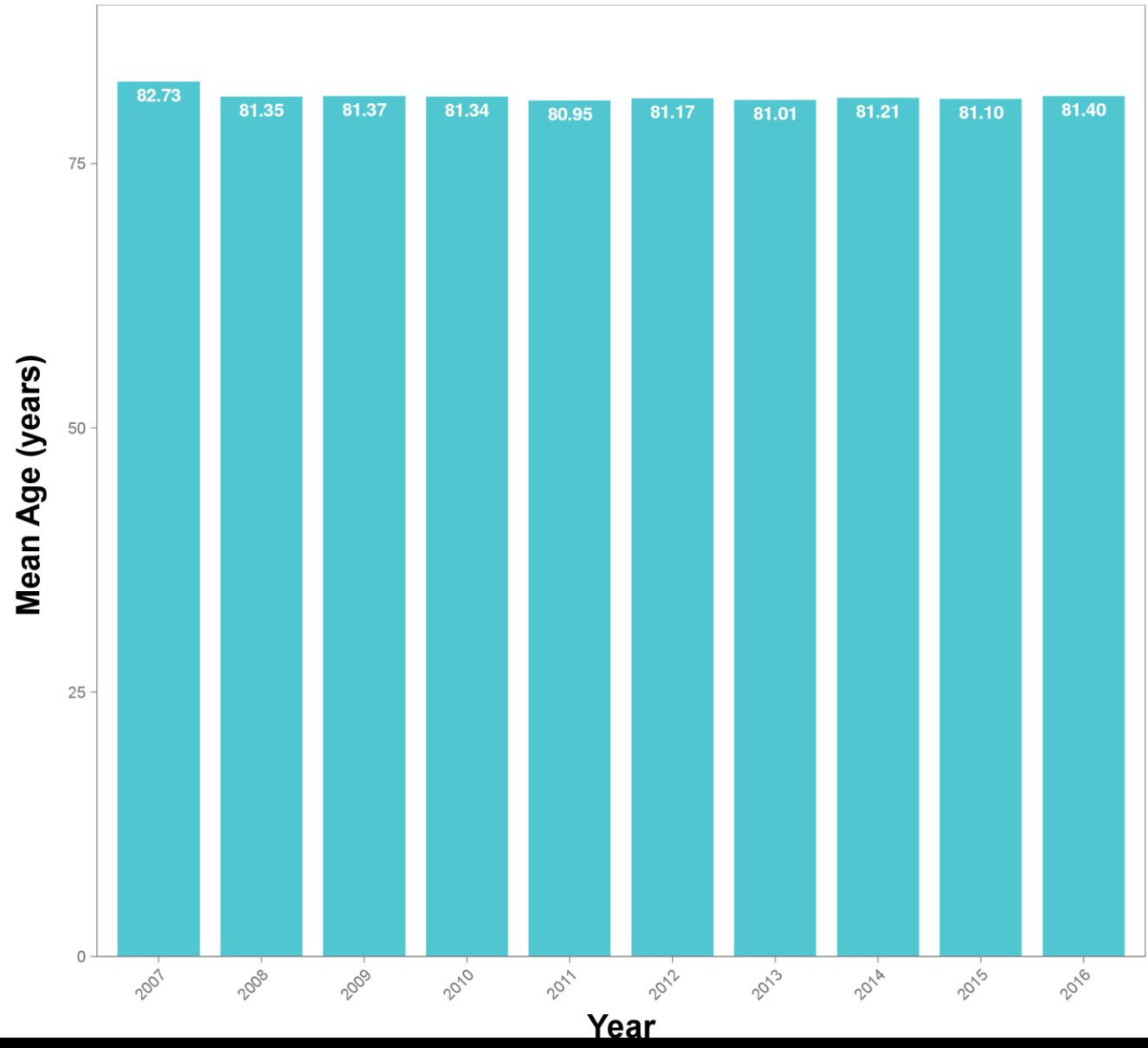
### Median Age (years) by Year

TOTAL UK  
From 2007 to 2016



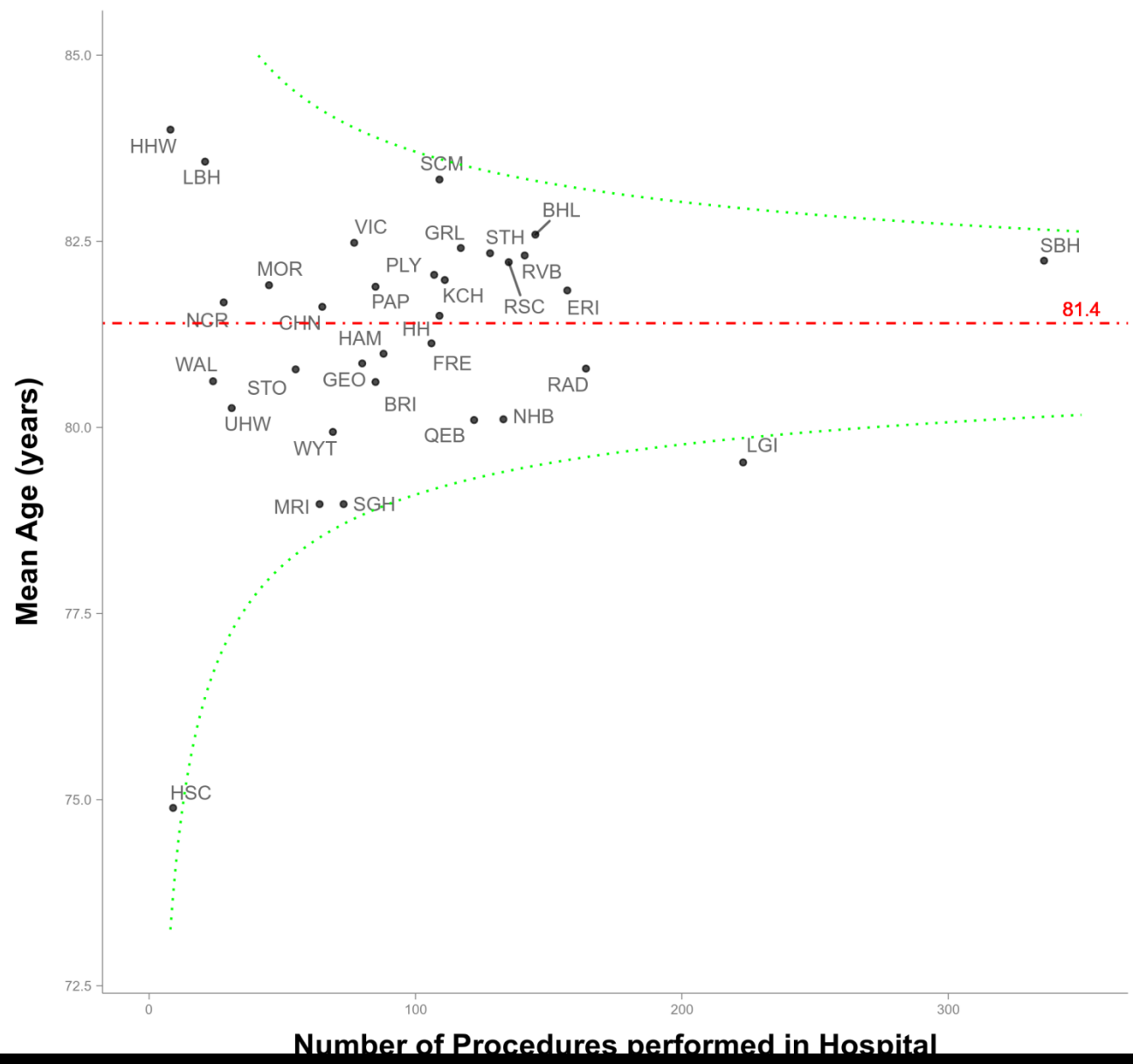
### Mean Age (years) by Year

TOTAL UK  
From 2007 to 2016



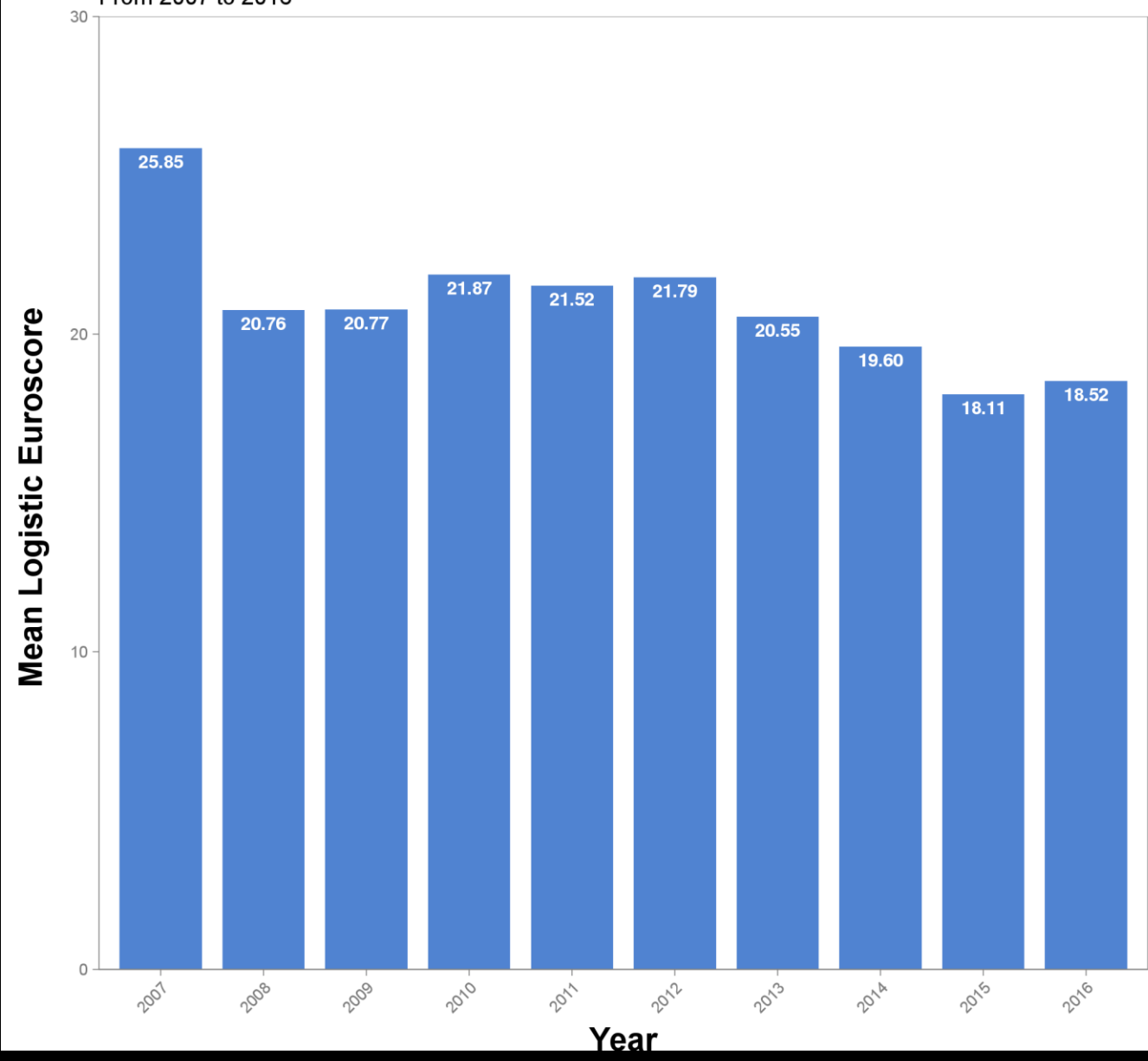
### Mean Age (years) by Number of Procedures performed in Hospital

From 2016 to 2016



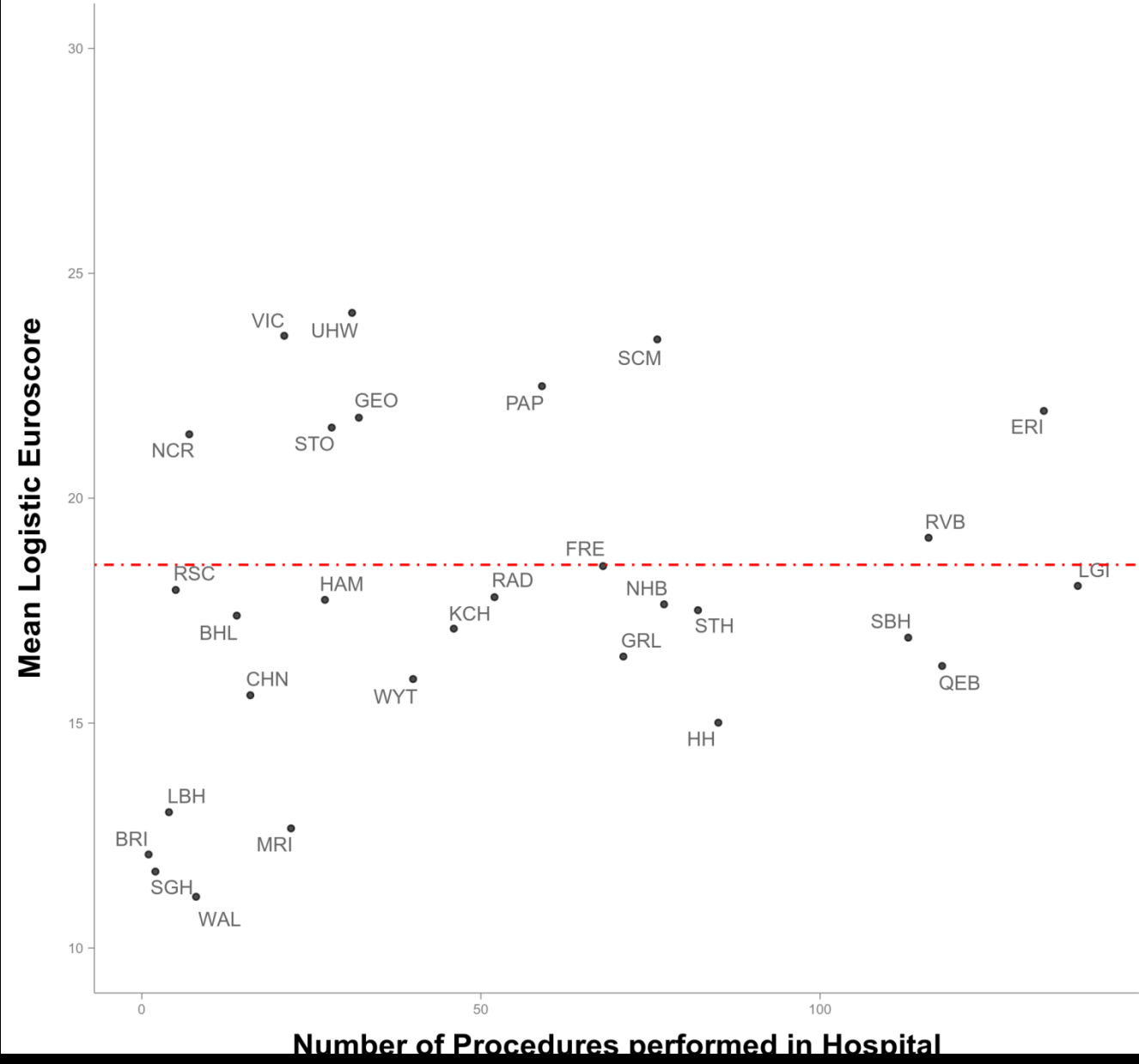
# Mean Logistic Euroscore by Year

TOTAL UK  
From 2007 to 2016



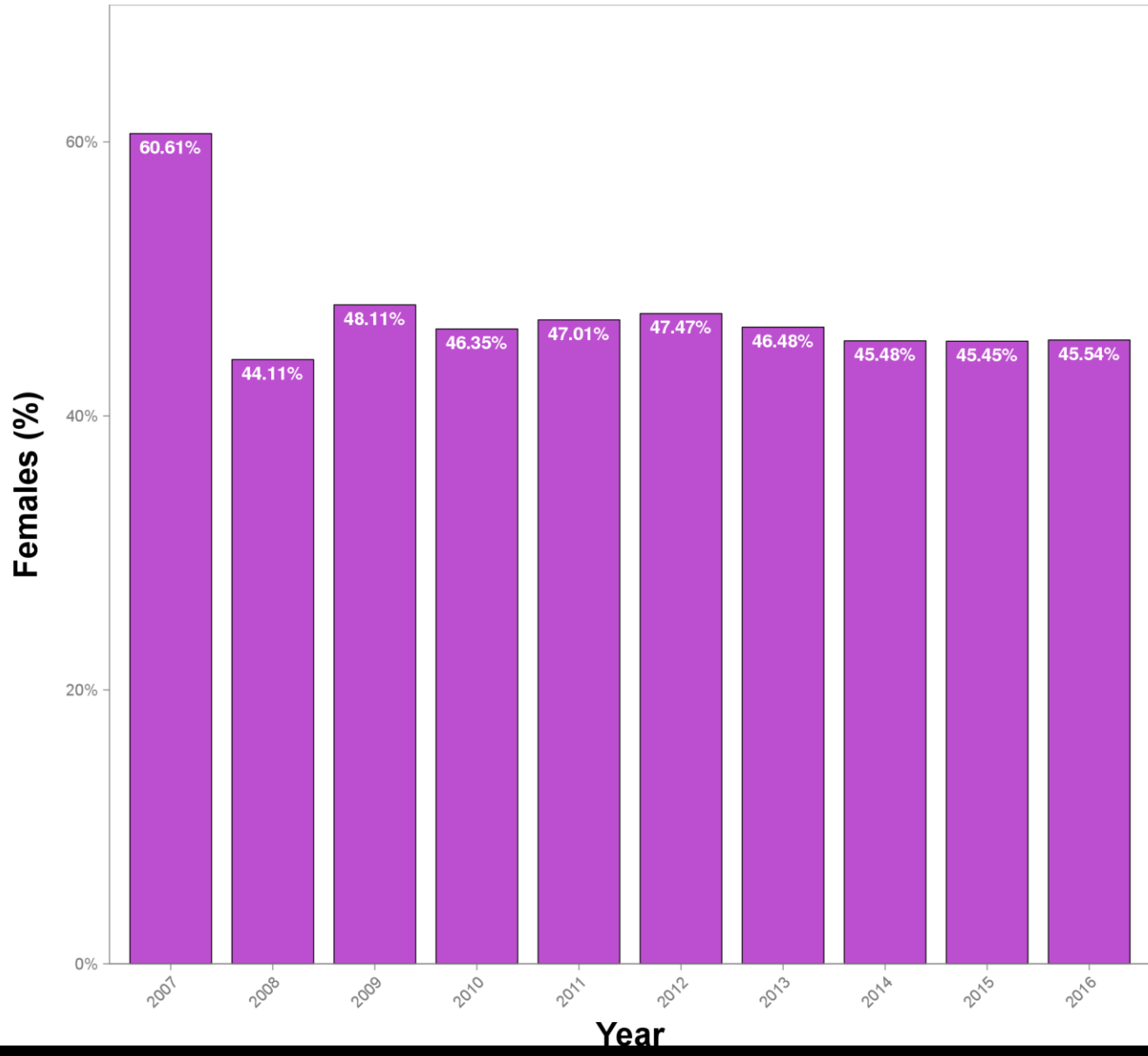
### Mean Logistic Euroscore by Number of Procedures performed in Hospital

From 2016 to 2016



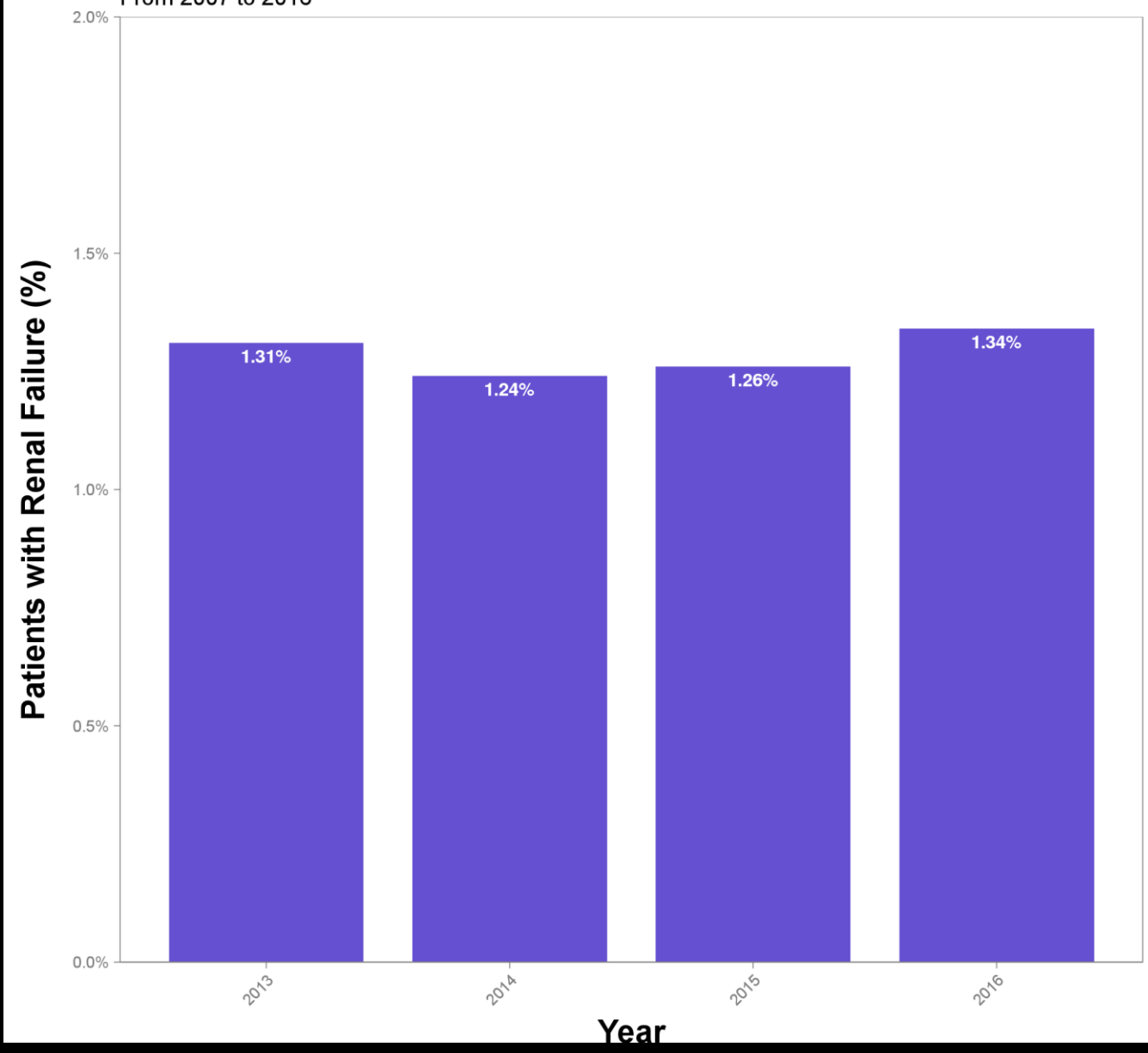
### Females (%) by Year

TOTAL UK  
From 2007 to 2016



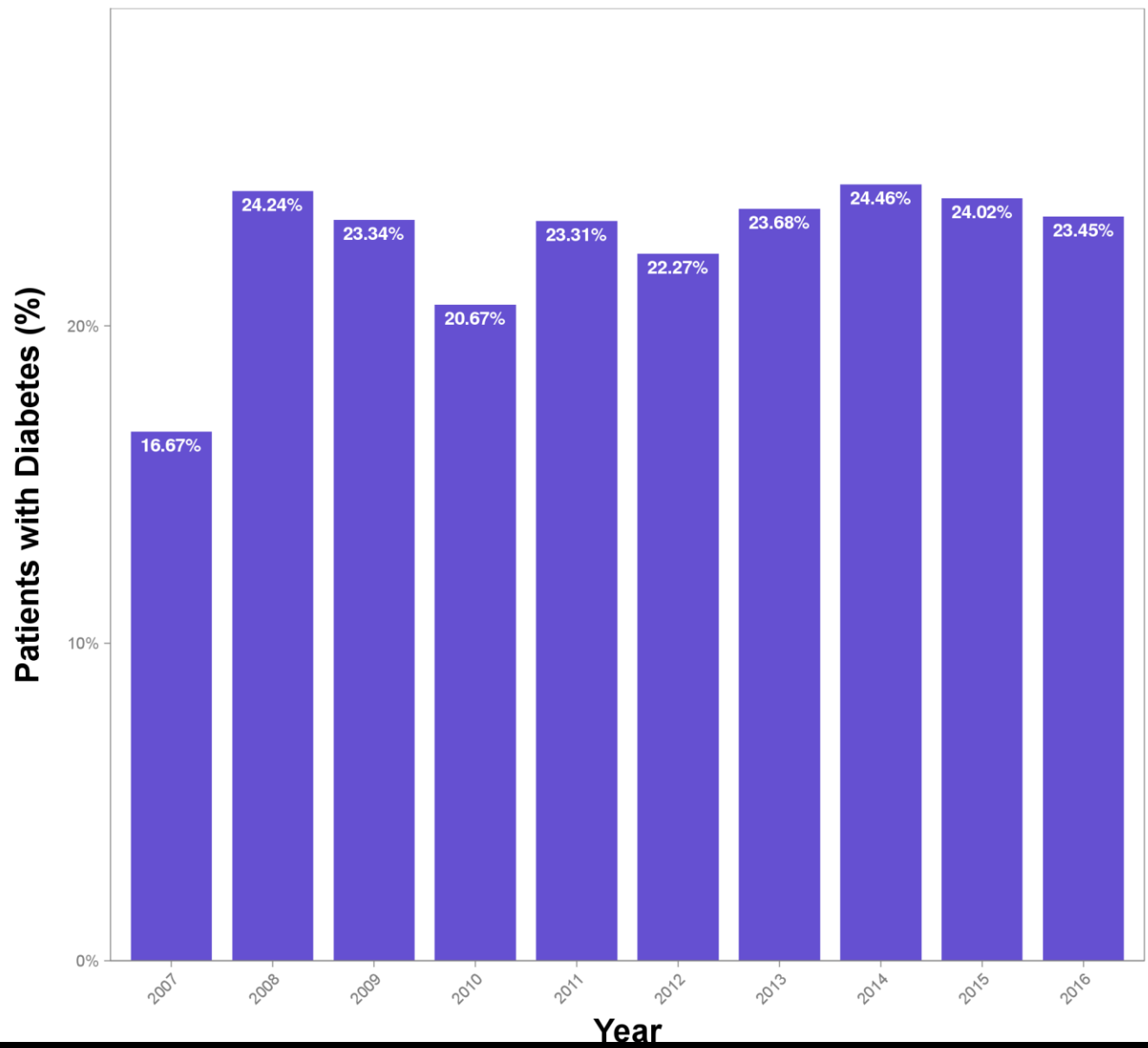
### Patients with Renal Failure (%) by Year

TOTAL UK  
From 2007 to 2016



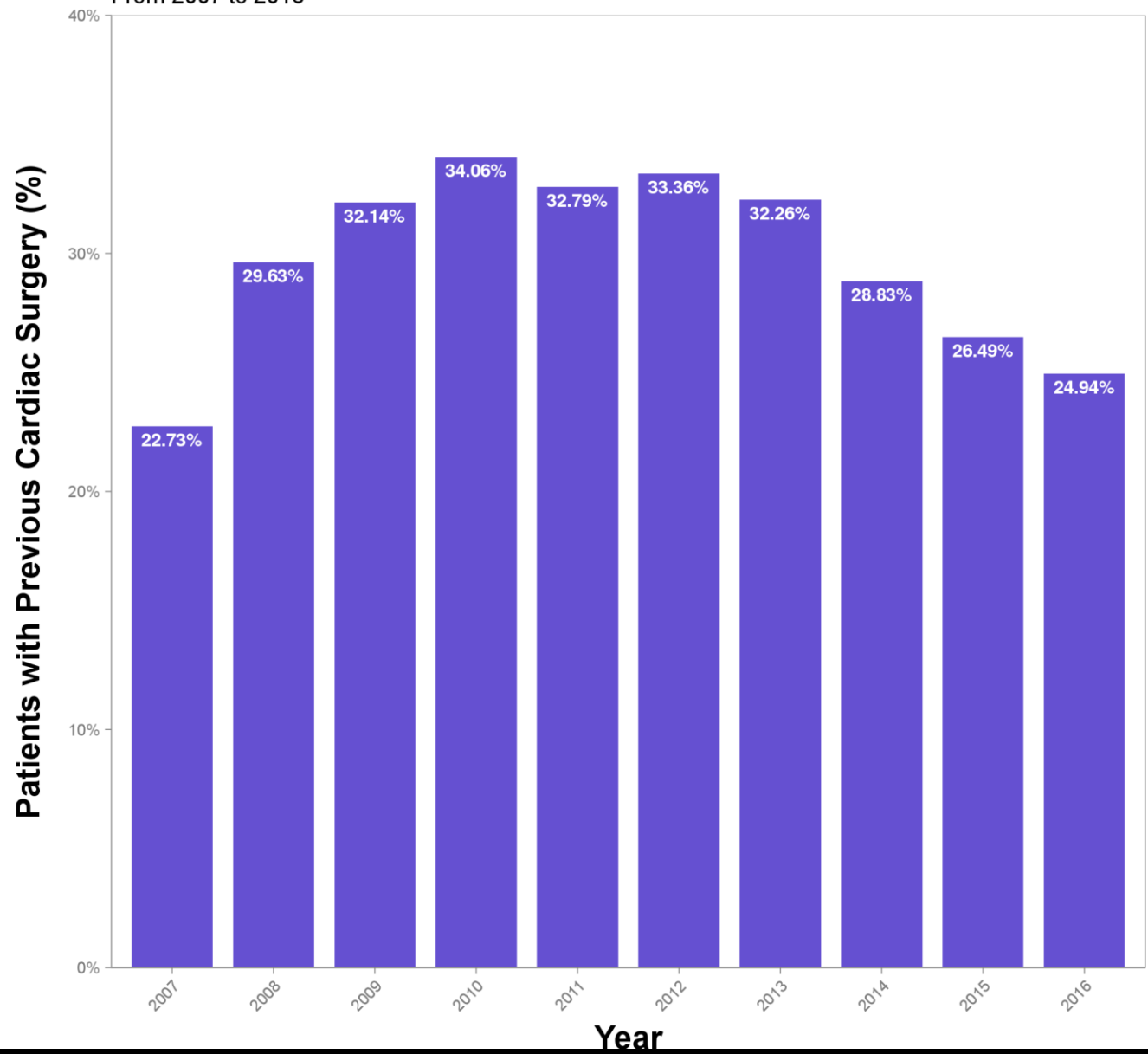
# Patients with Diabetes (%) by Year

TOTAL UK  
From 2007 to 2016



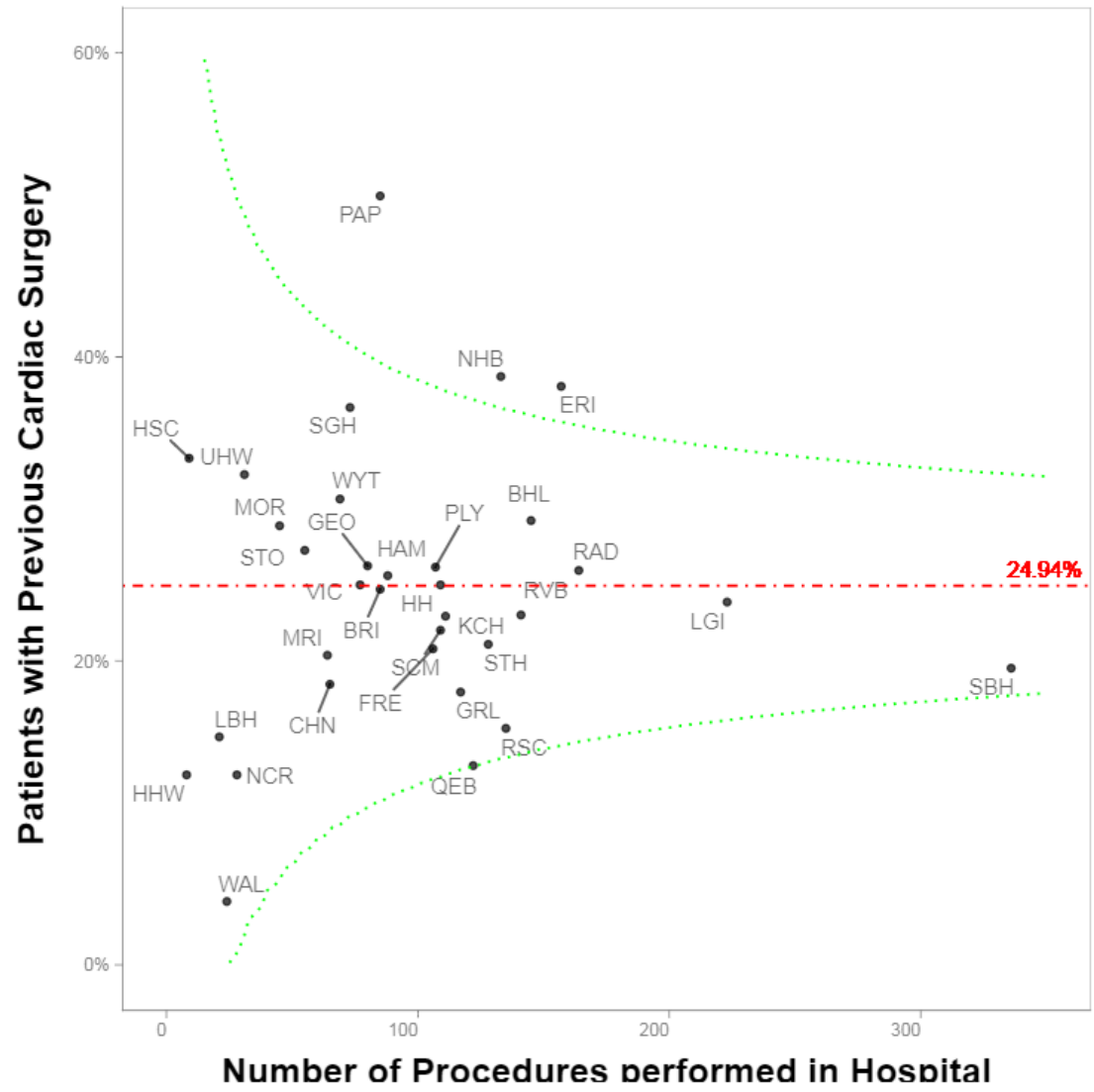
# Patients with Previous Cardiac Surgery (%) by Year

TOTAL UK  
From 2007 to 2016



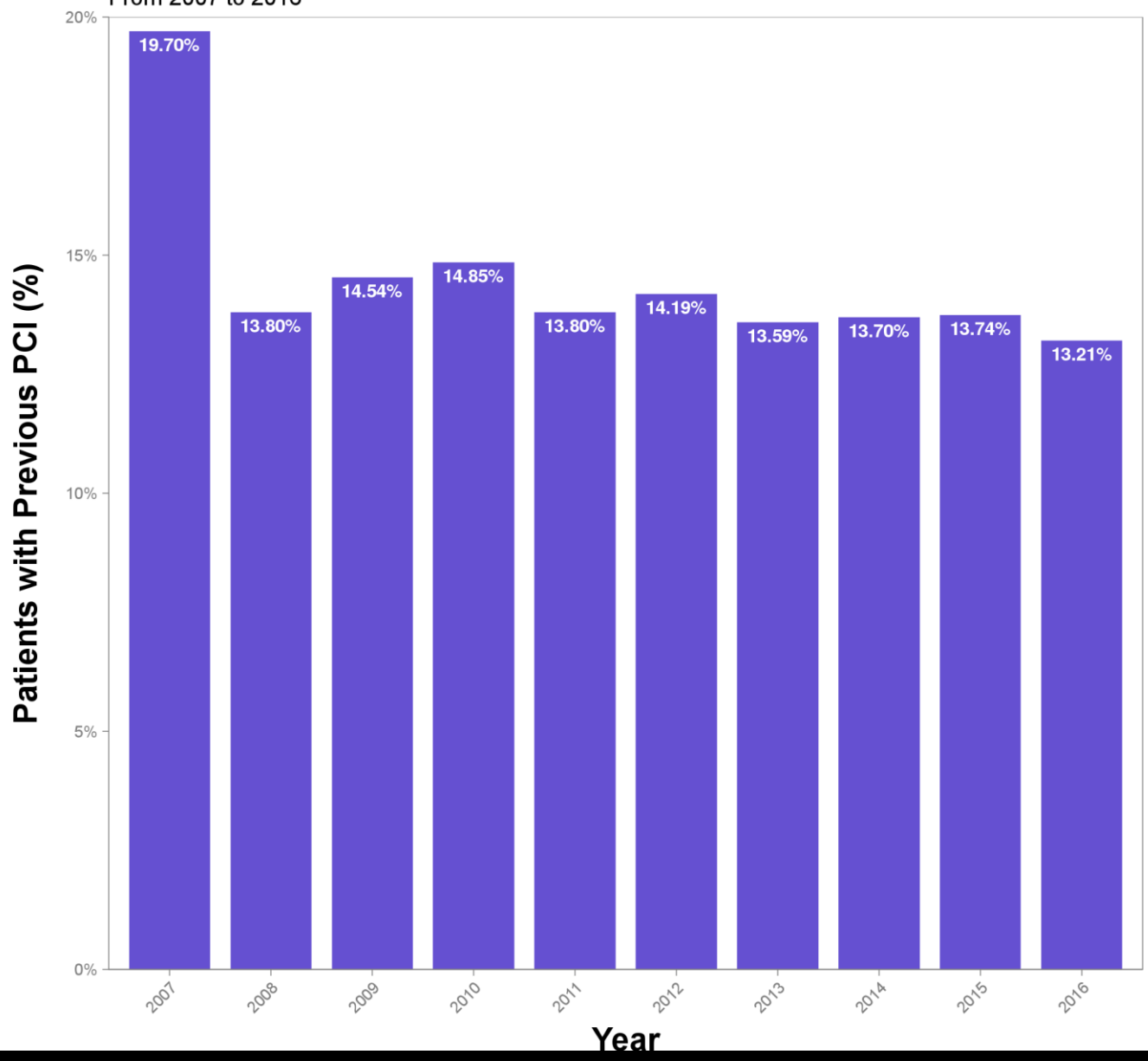
### Patients with Previous Cardiac Surgery (%) by Number of Procedures performed in Hospital From 2016 to 2016

(data extracted May 2017)



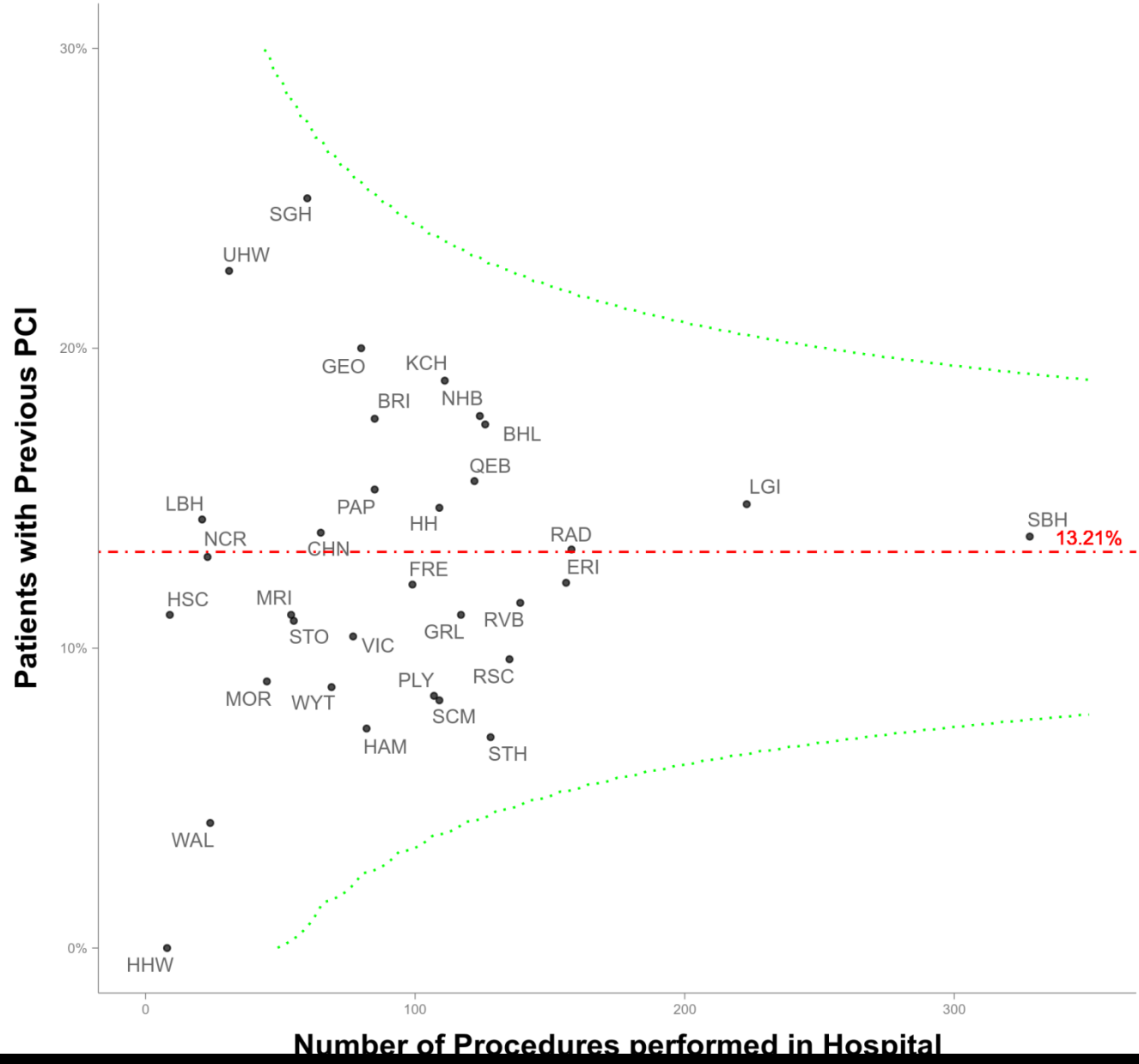
### Patients with Previous PCI (%) by Year

TOTAL UK  
From 2007 to 2016



# Patients with Previous PCI (%) by Number of Procedures performed in Hospital

From 2016 to 2016



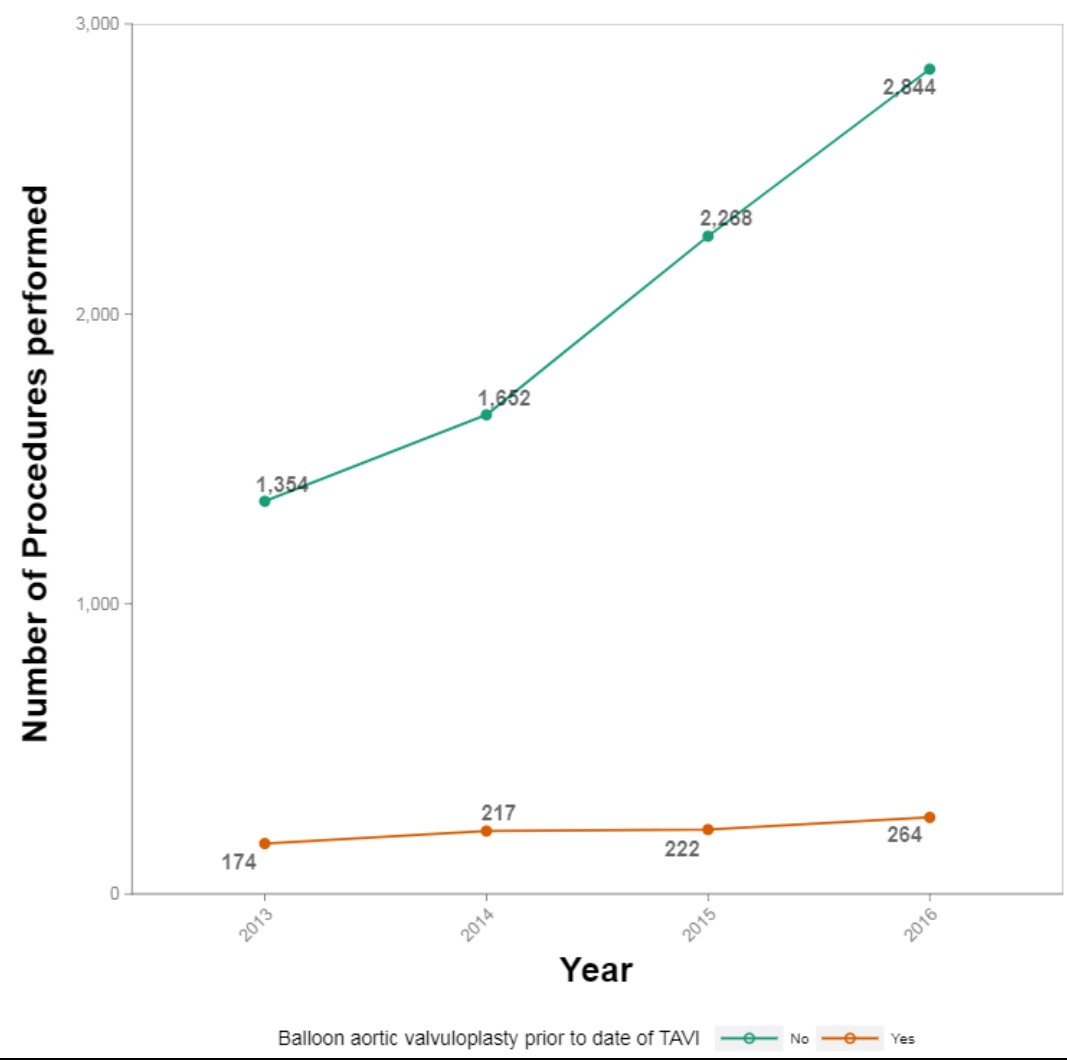
# Number of Procedures performed by Year

Grouped by Balloon aortic valvuloplasty prior to date of TAVI

TOTAL UK

From 2007 to 2016

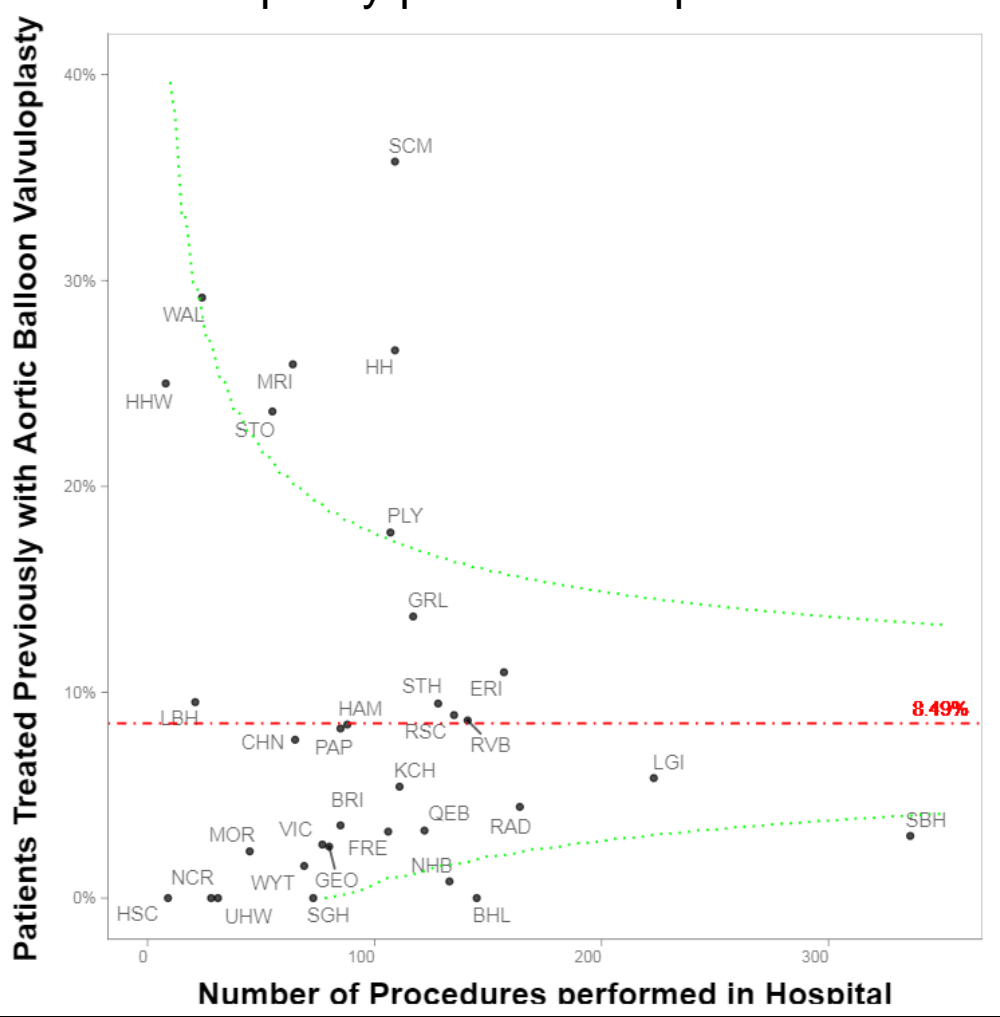
## Valvuloplasty prior to TAVI procedure date



# Patients Treated Previously with Aortic Balloon Valvuloplasty (%) by Number of Procedures performed in Hospital

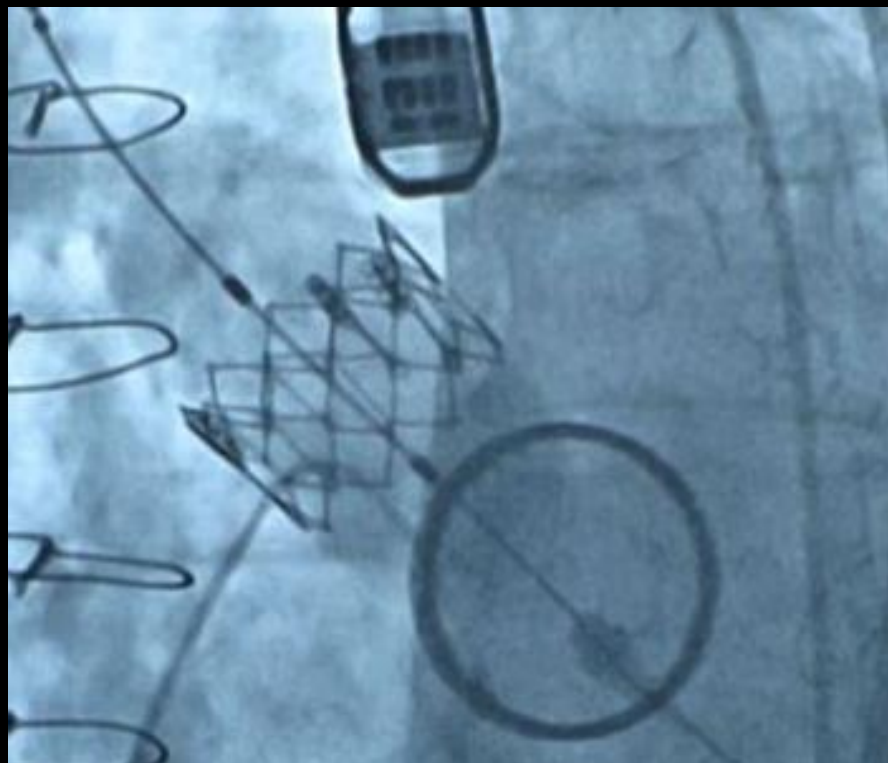
## From 2016 to 2016

### Valvuloplasty prior to TAVI procedure date



# Procedural details

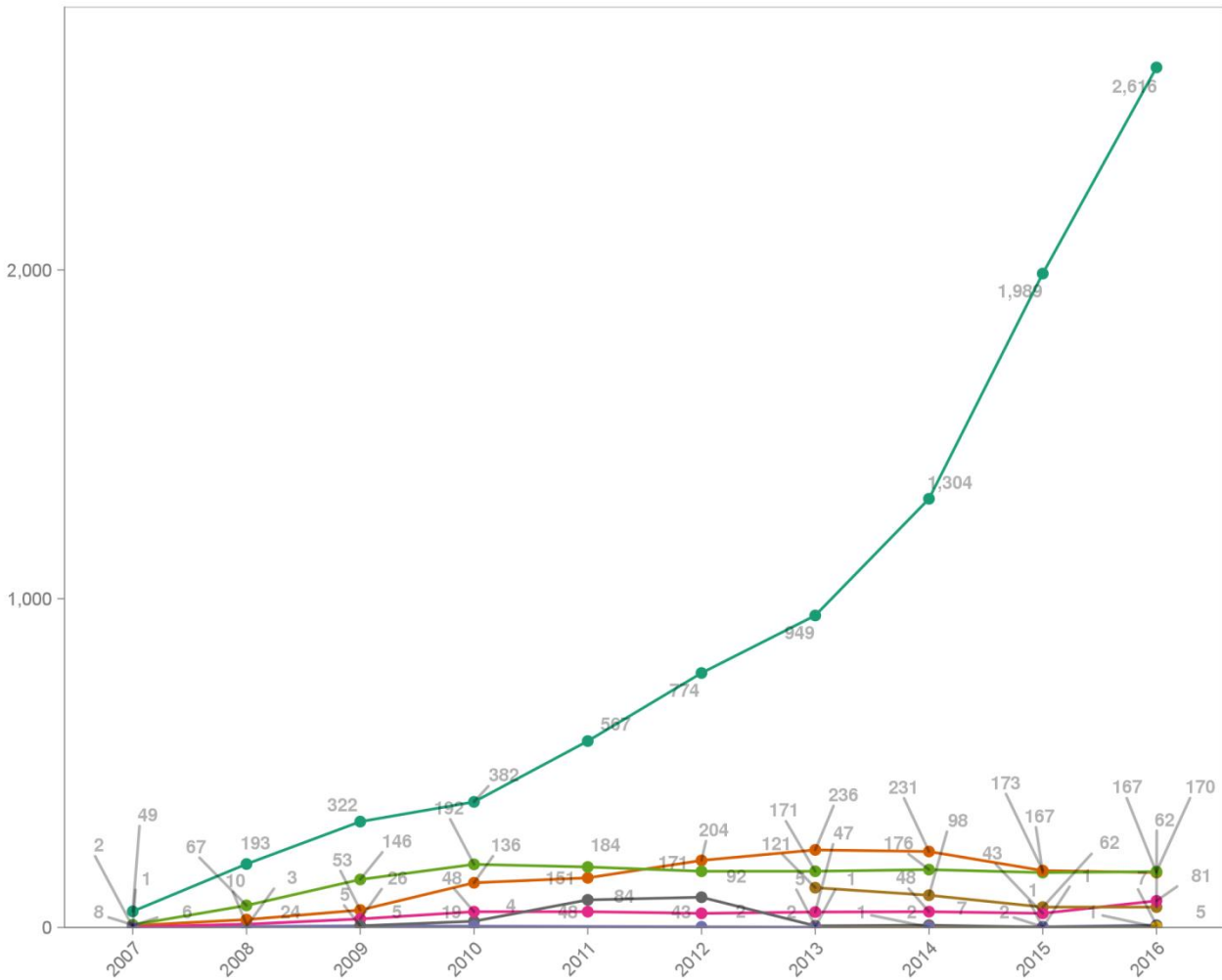
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# Number of Procedures performed by Year Grouped by Delivery approach

TOTAL UK  
From 2007 to 2016

Number of Procedures performed



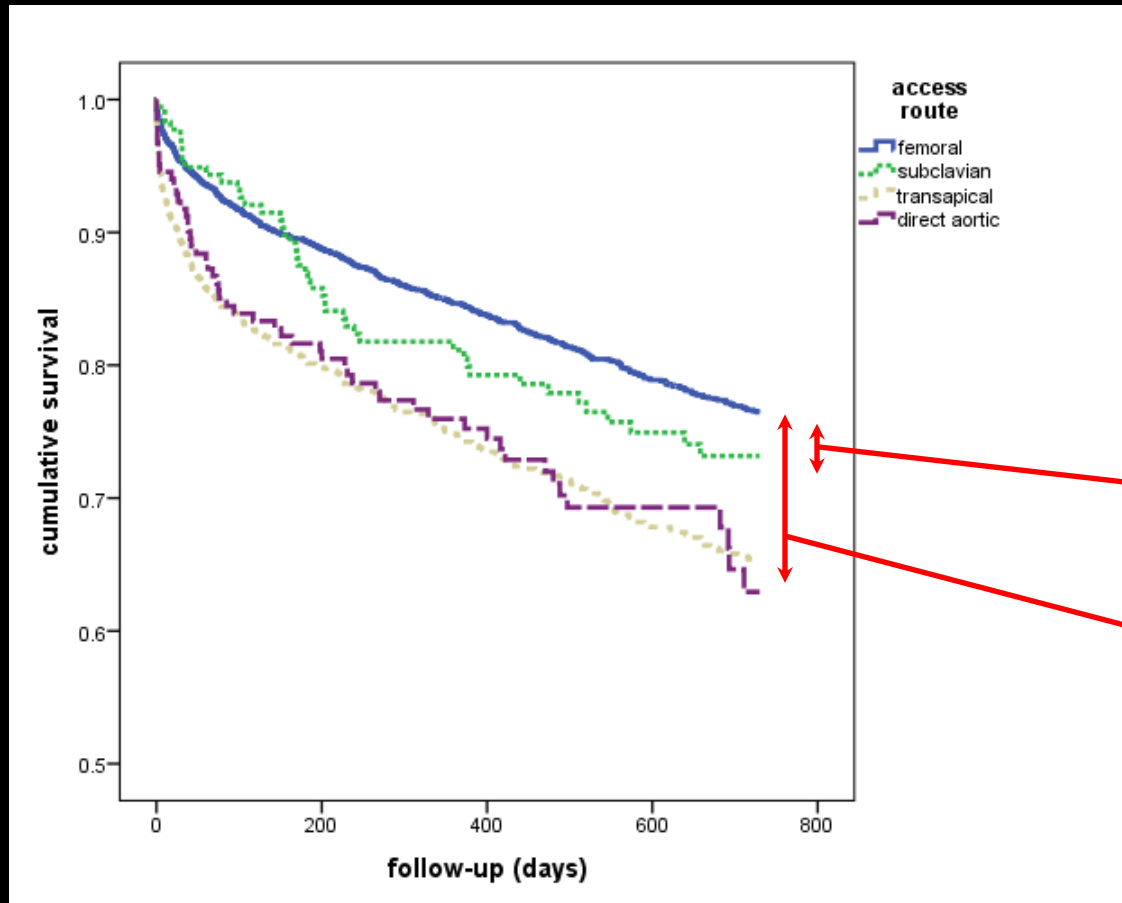
Delivery approach

- Femoral - percutaneous
- Femoral - surgical
- Transapical
- Direct aortic
- Carotid
- Subclavian
- Axillary
- Other

# Access Route

Fröhlich GM, Am J Cardiol 2015;116:1555–9

UK TAVI Registry data 2007 to 2012 FU to 2014



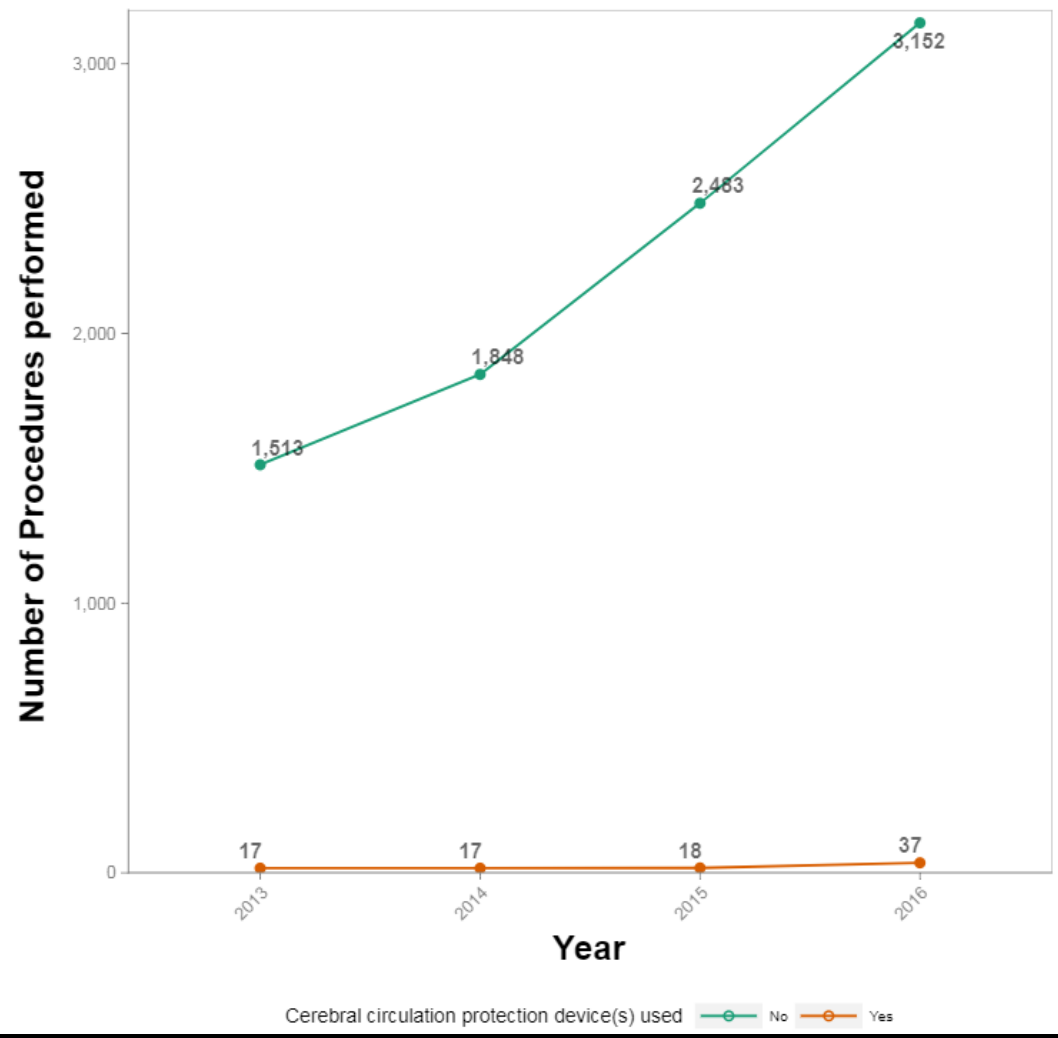
LES  
17.0% Femoral

22.1% SC  
21.2% TA  
20.3% DA

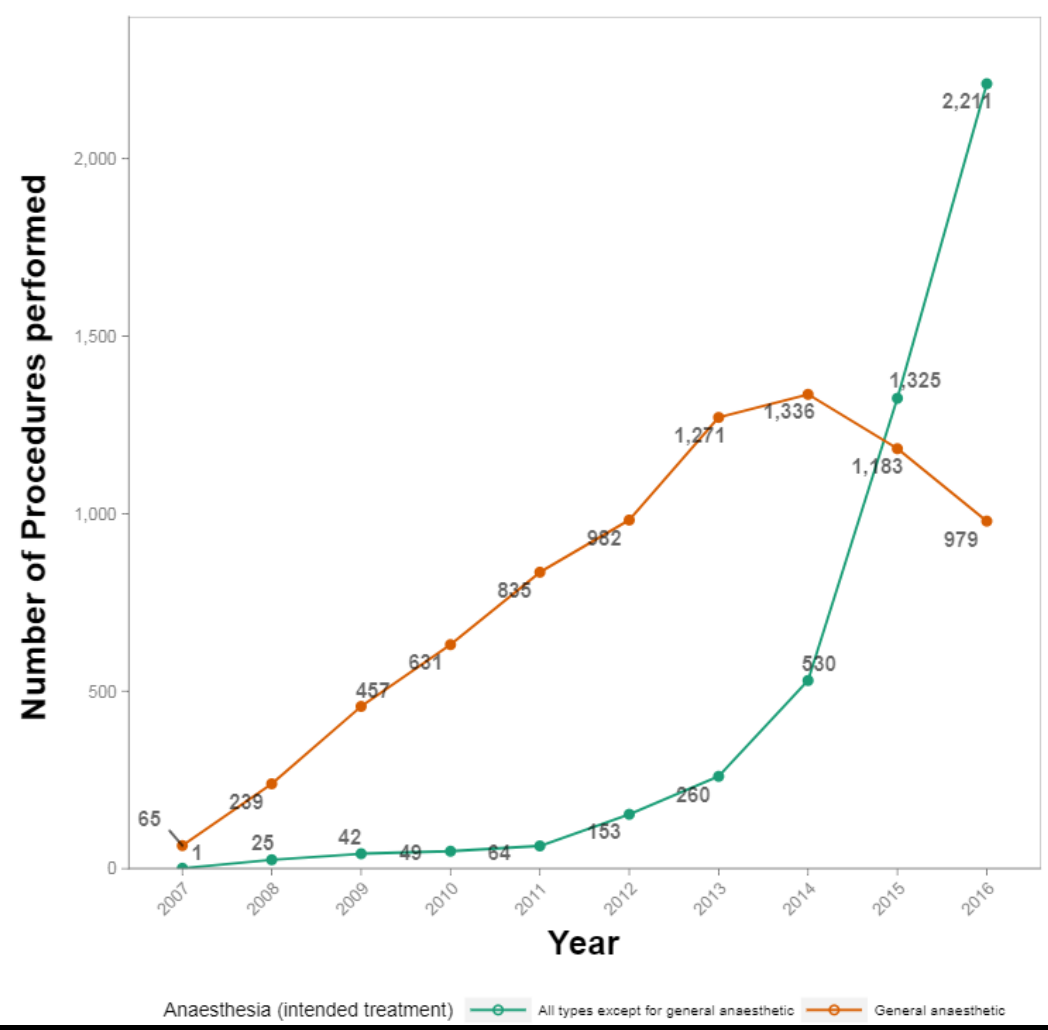
P=0.24

P<0.001 (TA)  
P<0.01 (DA)

# Number of Procedures performed by Year Grouped by Cerebral circulation protection device(s) used TOTAL UK From 2007 to 2016

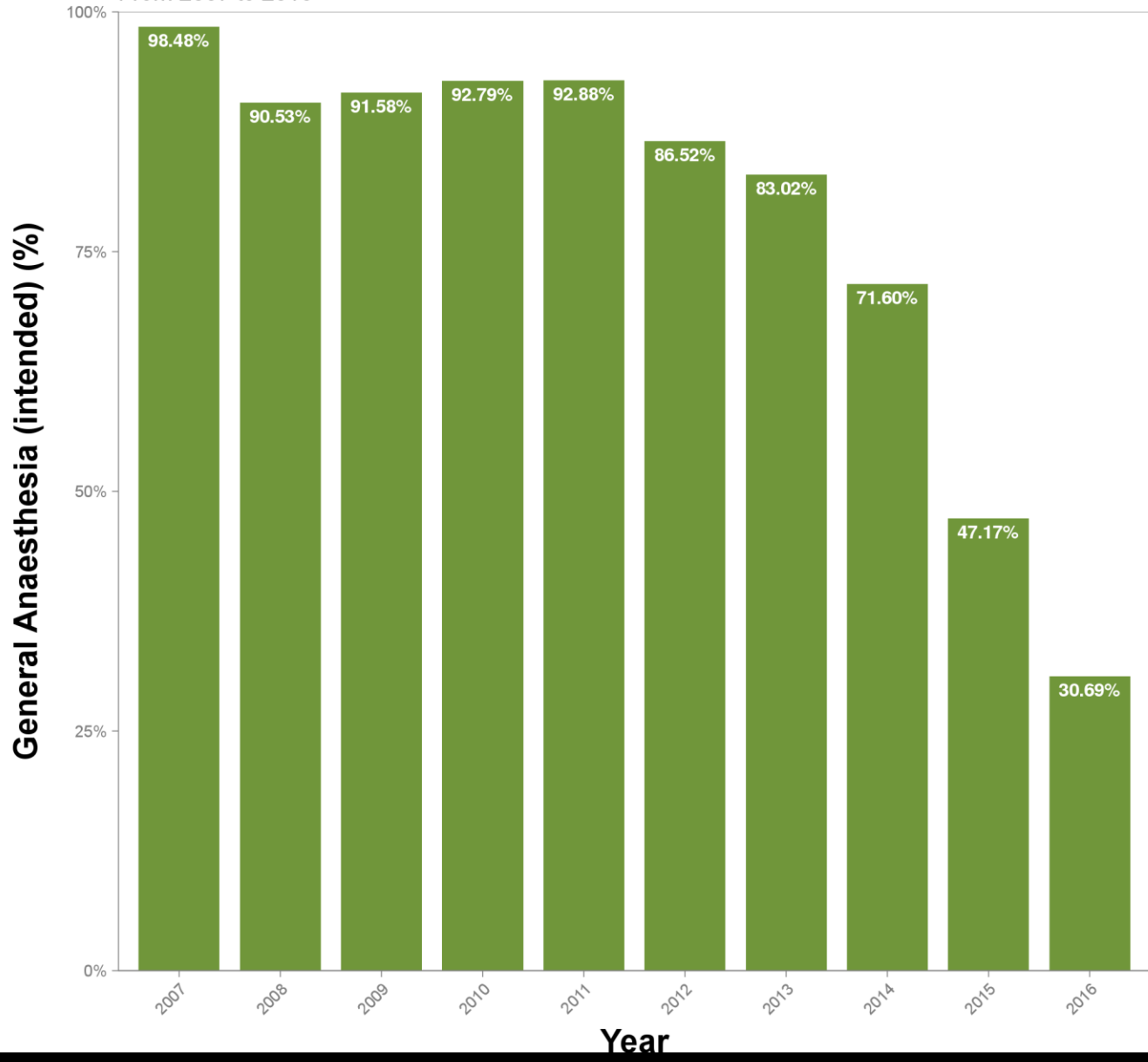


# Number of Procedures performed by Year Grouped by Anaesthesia (intended treatment) TOTAL UK From 2007 to 2016



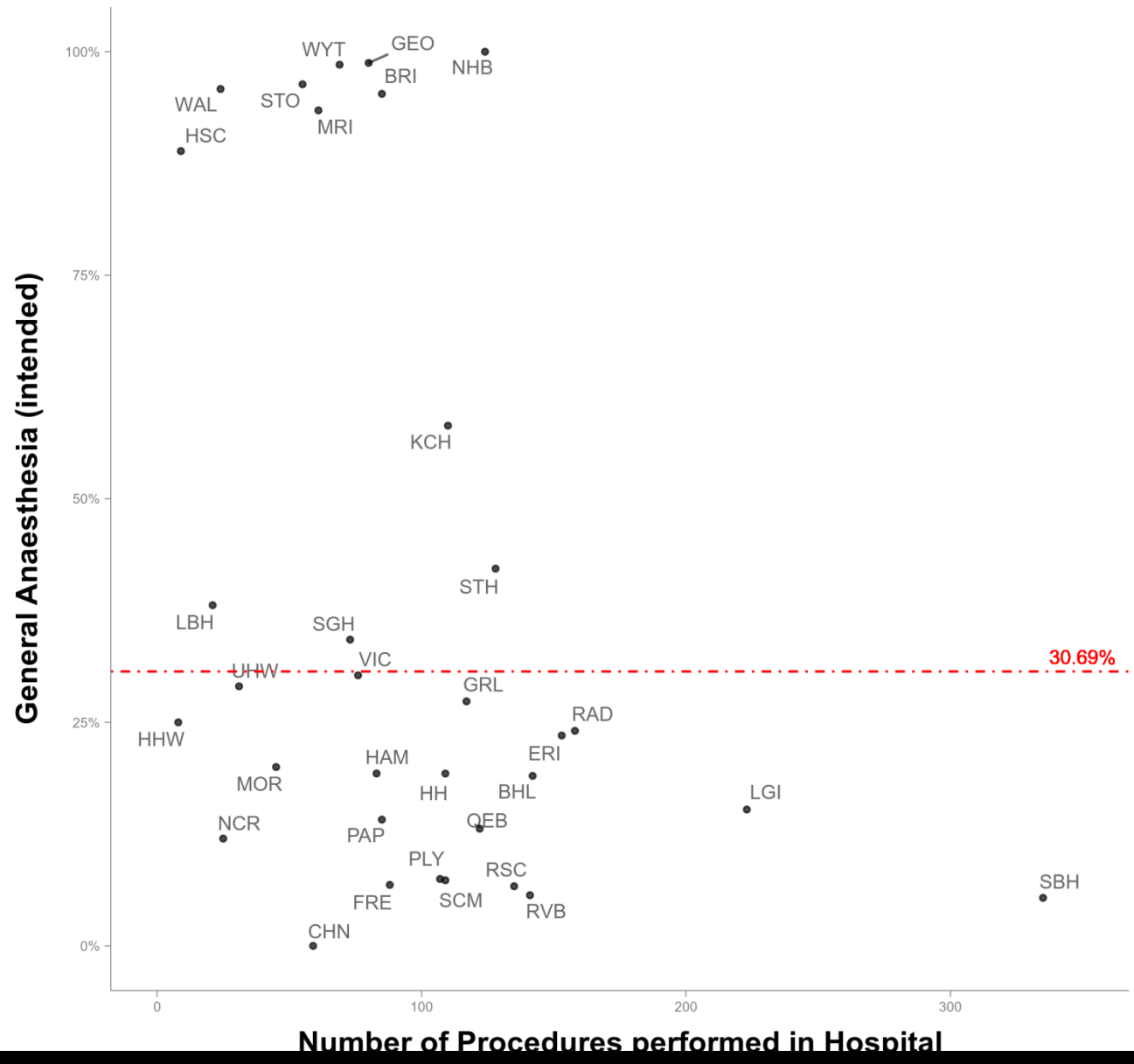
### General Anaesthesia (intended) (%) by Year

TOTAL UK  
From 2007 to 2016

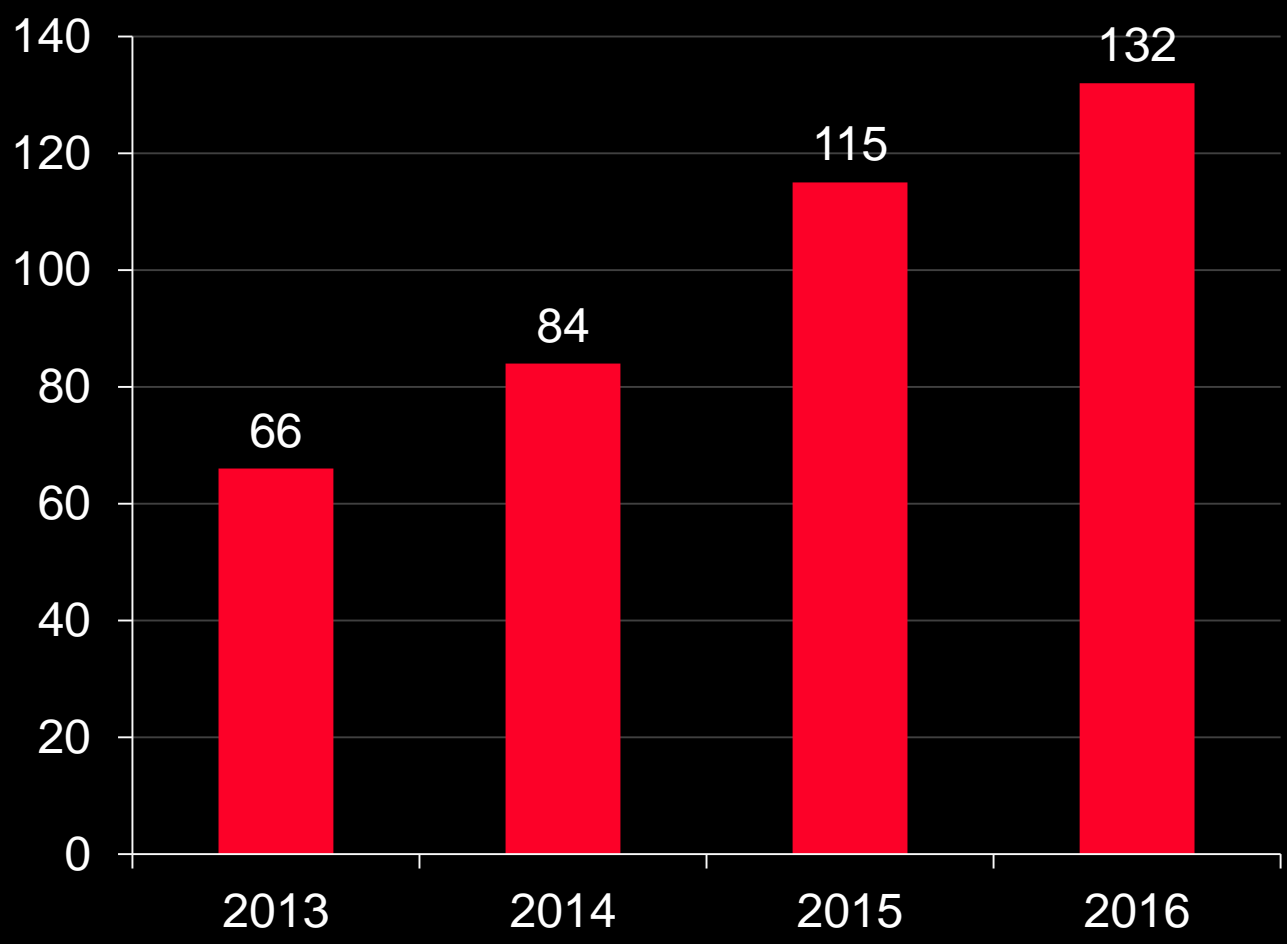


# General Anaesthesia (intended) (%) by Number of Procedures performed in Hospital

From 2016 to 2016

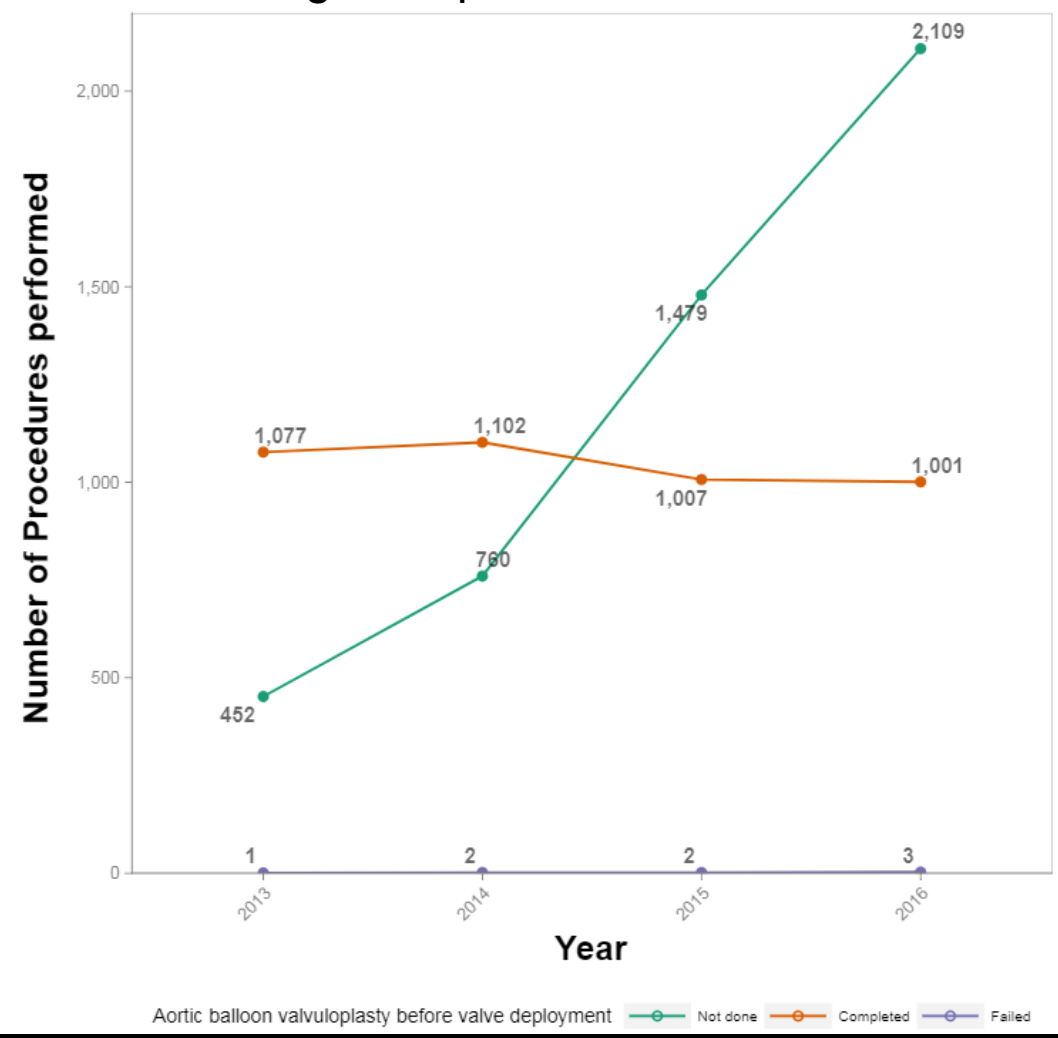


# TAVI for Aortic Bioprosthetic failure



Number of Procedures performed by Year  
Grouped by Aortic balloon valvuloplasty before valve deployment  
TOTAL UK  
From 2007 to 2016

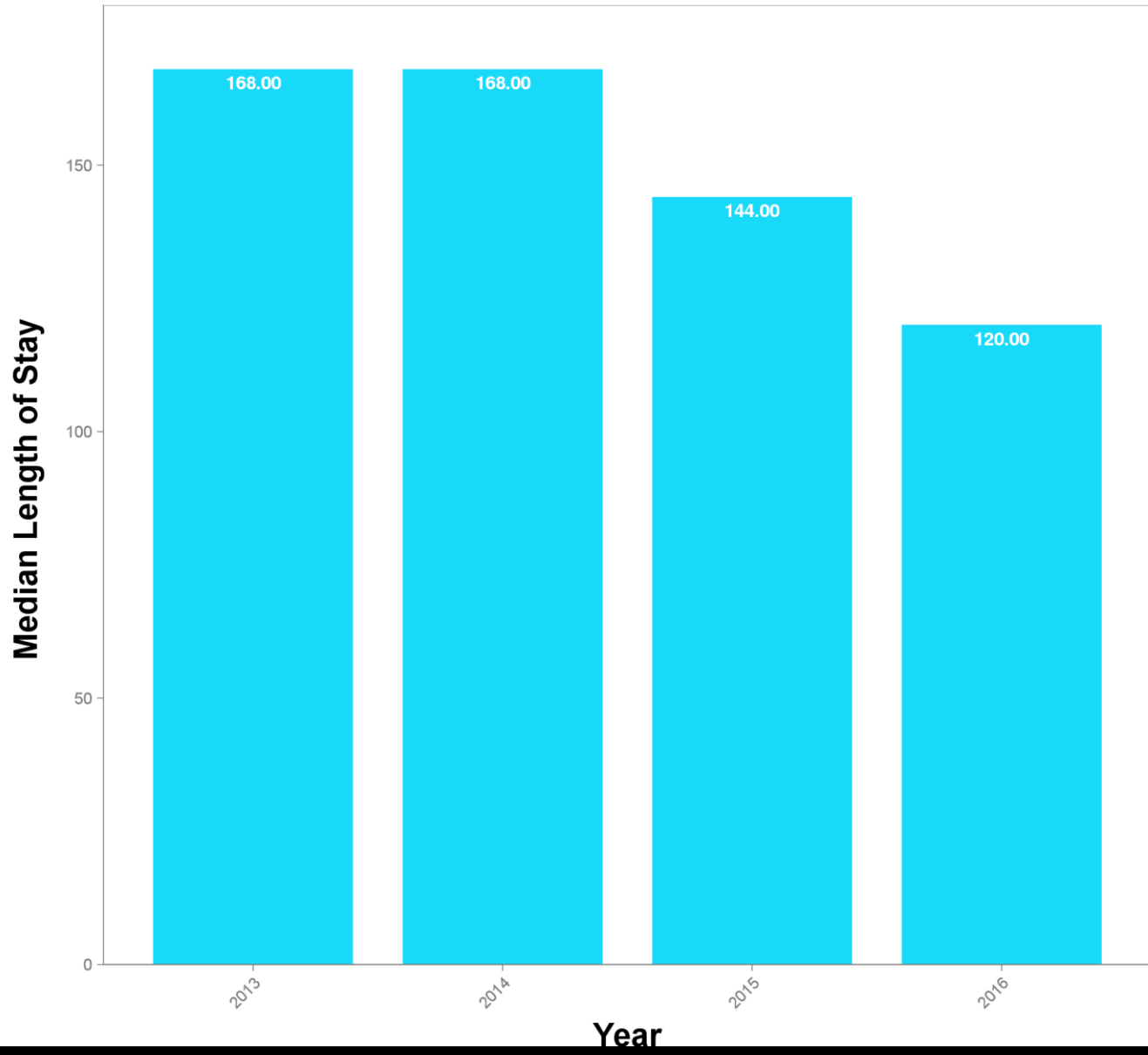
### Pre-dilatation of AV During TAVI procedure



### Median Length of Stay by Year

TOTAL UK  
From 2013 to 2016

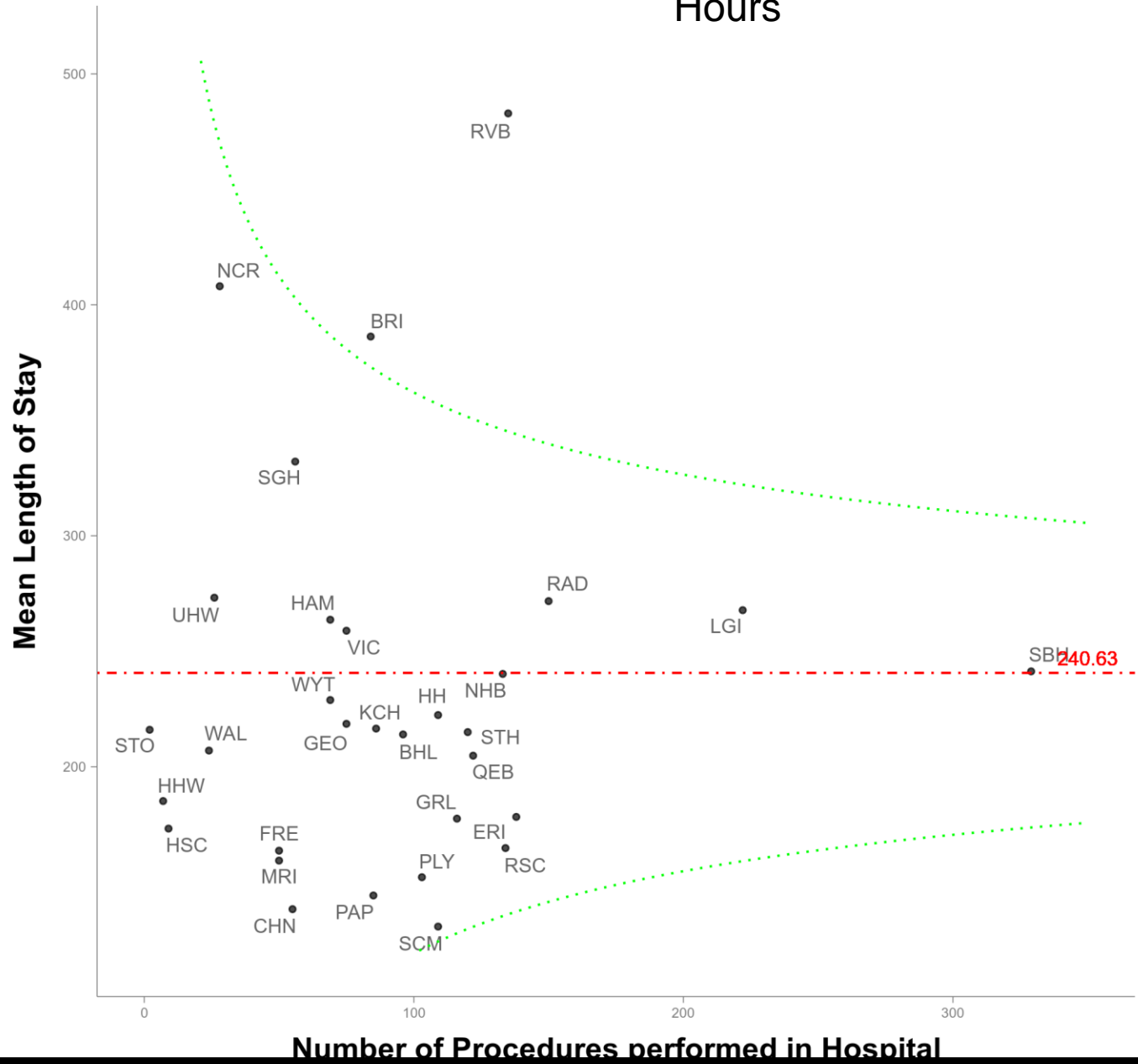
Hours



# Mean Length of Stay by Number of Procedures performed in Hospital

From 2016 to 2016

Hours

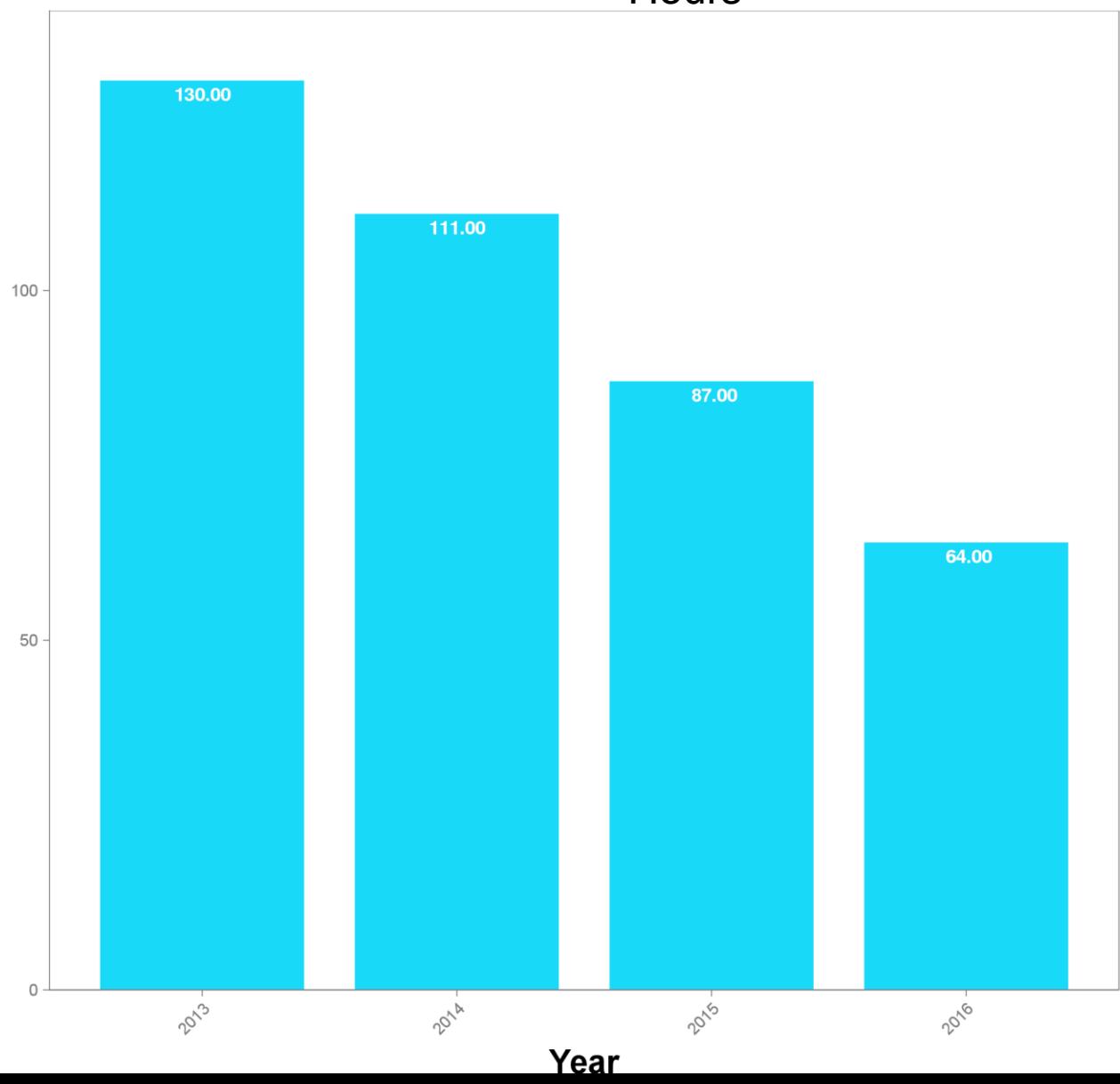


# Median Procedure to Discharge by Year

TOTAL UK  
From 2013 to 2016

Hours

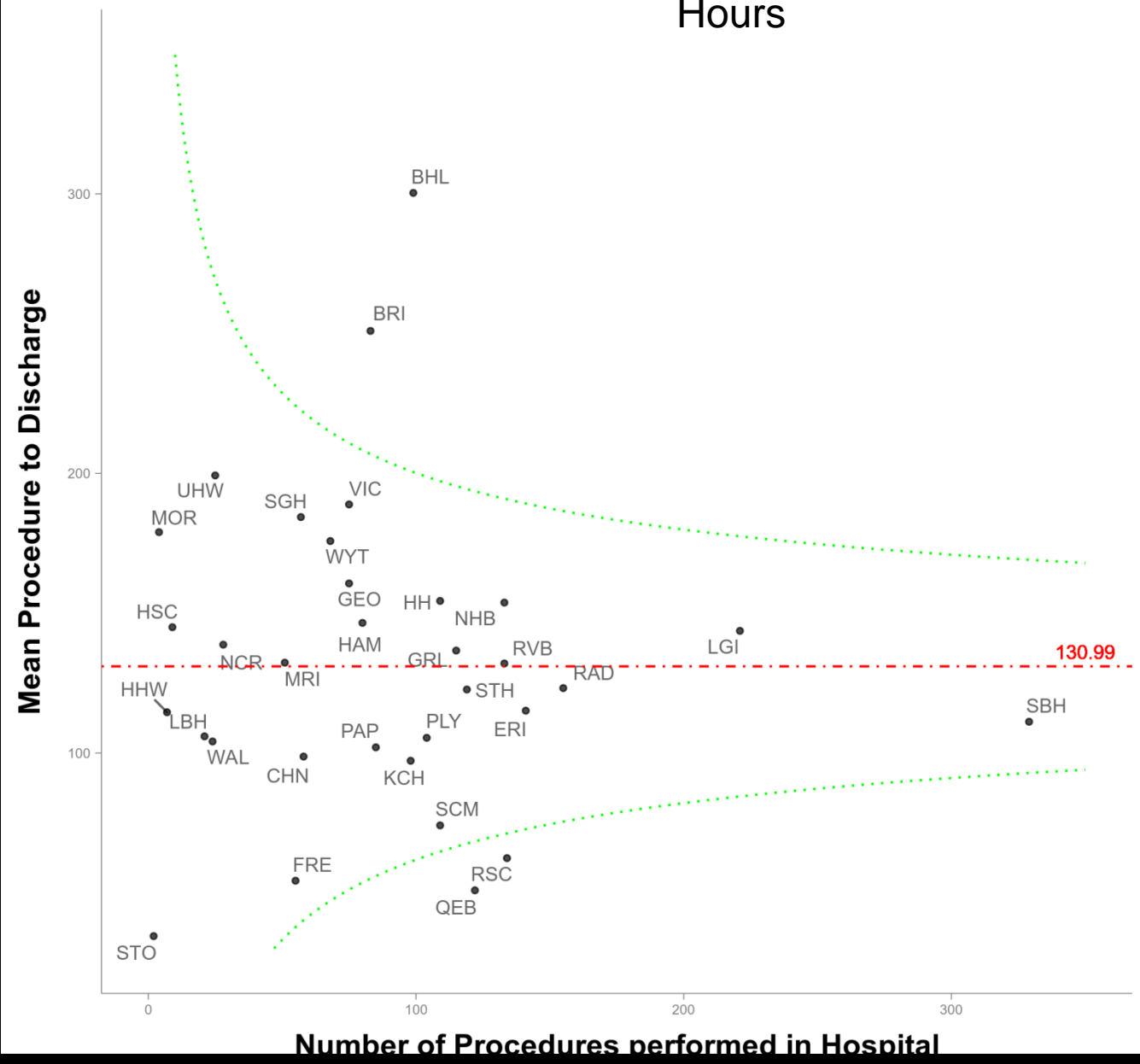
Median Procedure to Discharge



# Mean Procedure to Discharge by Number of Procedures performed in Hospital

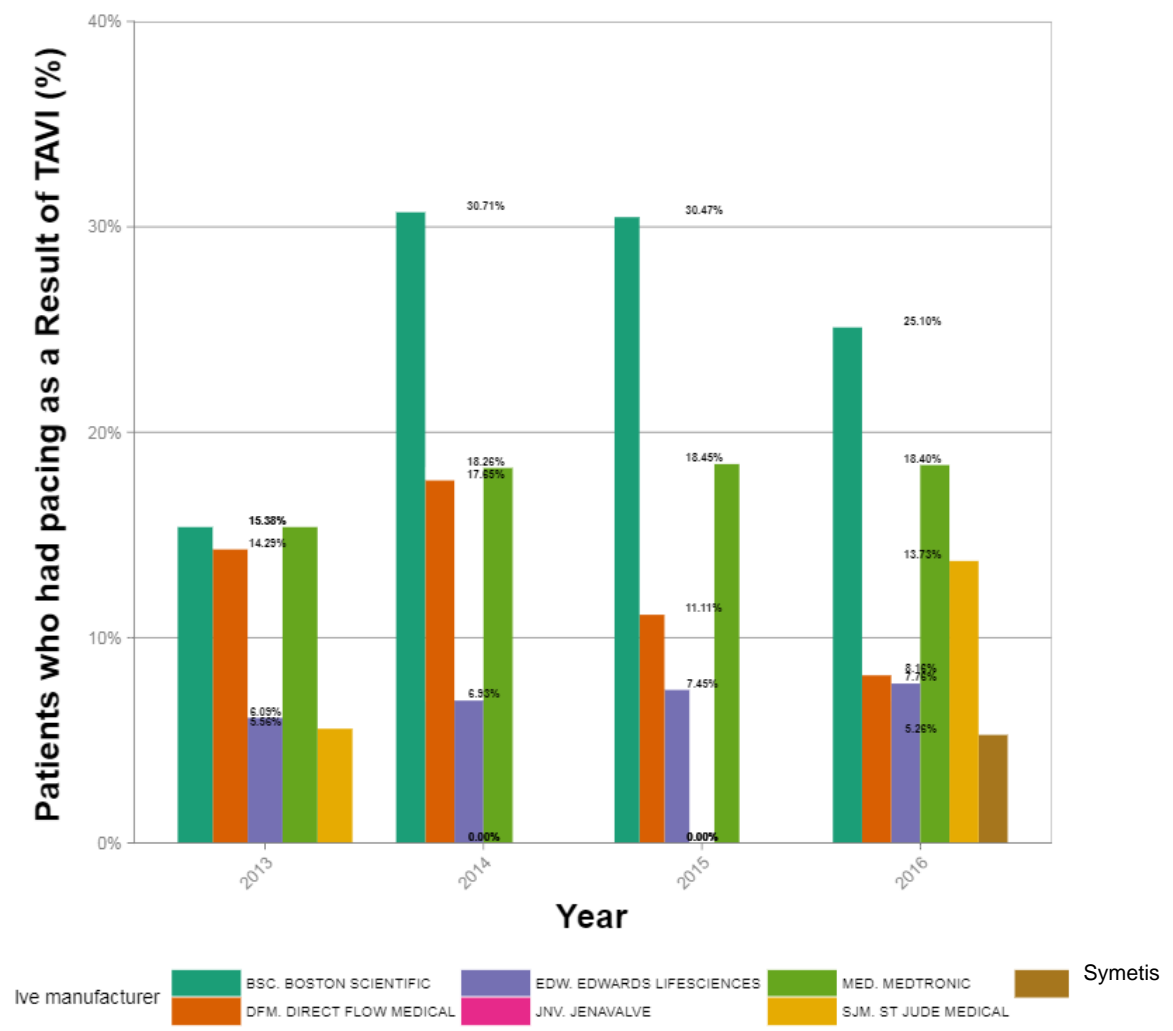
From 2016 to 2016

## Hours



# Outcomes

# Patients who had pacing as a Result of TAVI (%) by Year Grouped by Valve manufacturer TOTAL UK From 2013 to 2016

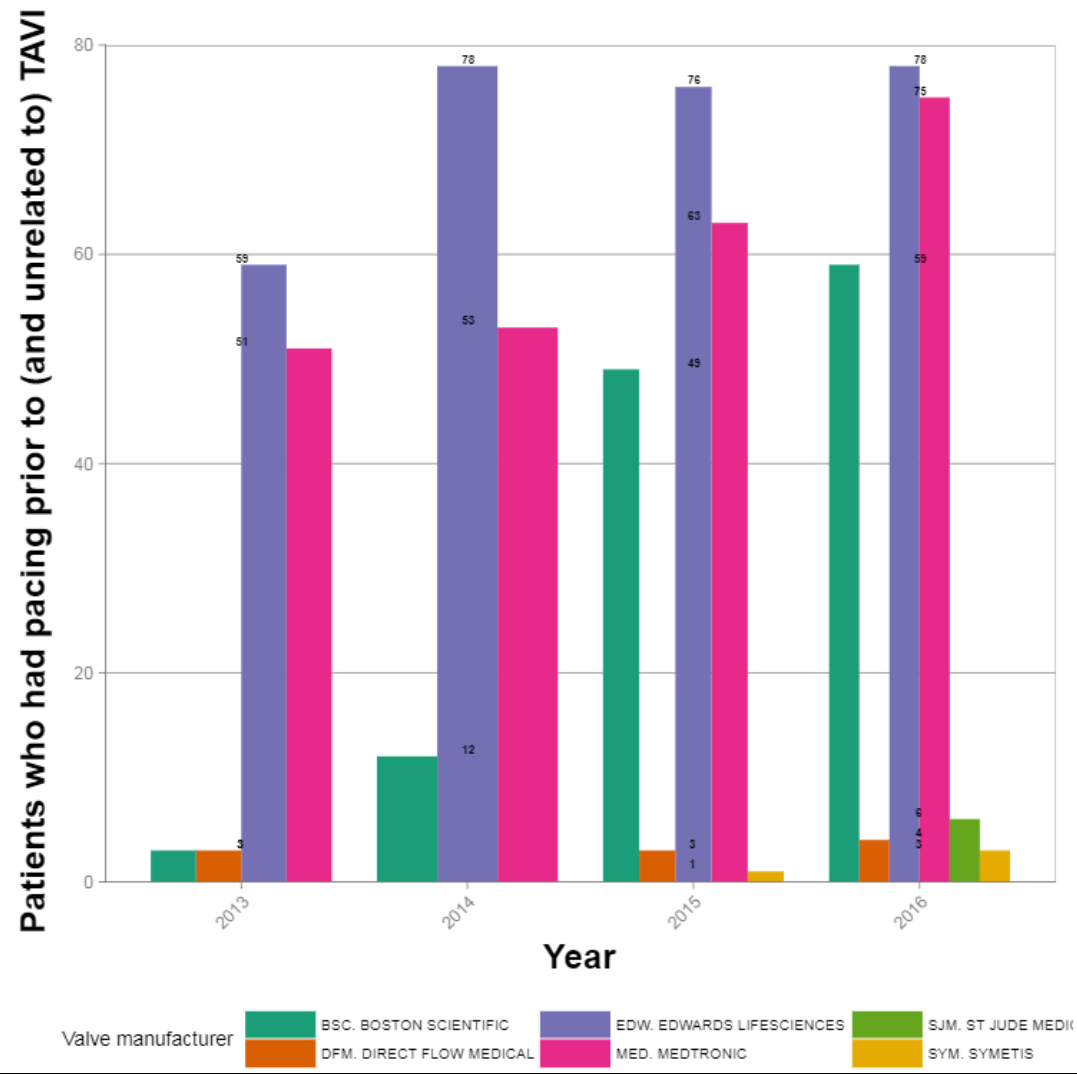


# Patients who had pacing prior to (and unrelated to) TAVI by Year

## Grouped by Valve manufacturer

### TOTAL UK

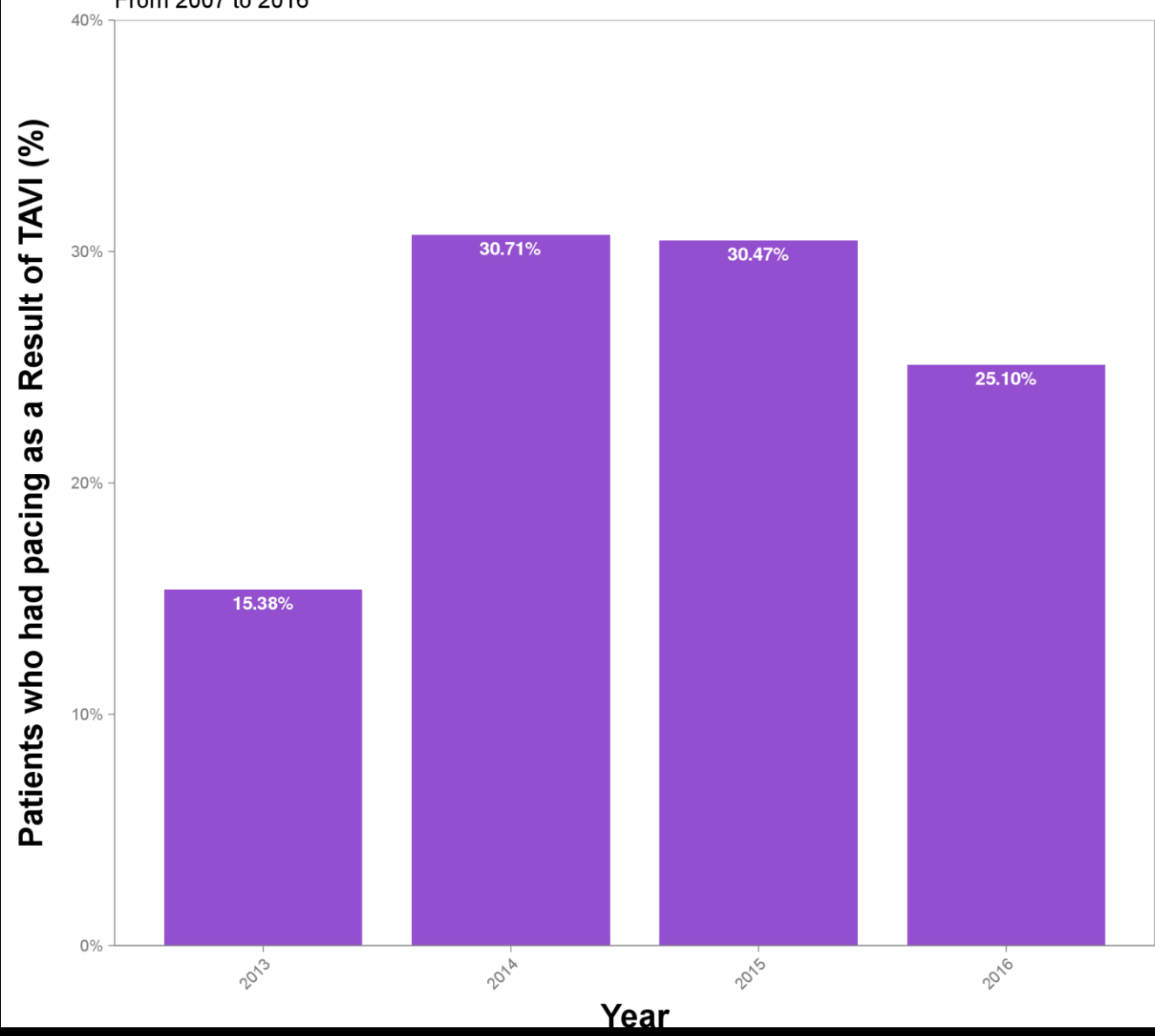
#### From 2013 to 2016



# Patients who had pacing as a Result of TAVI (%) by Year Filtered by Valve manufacturer =

## Boston

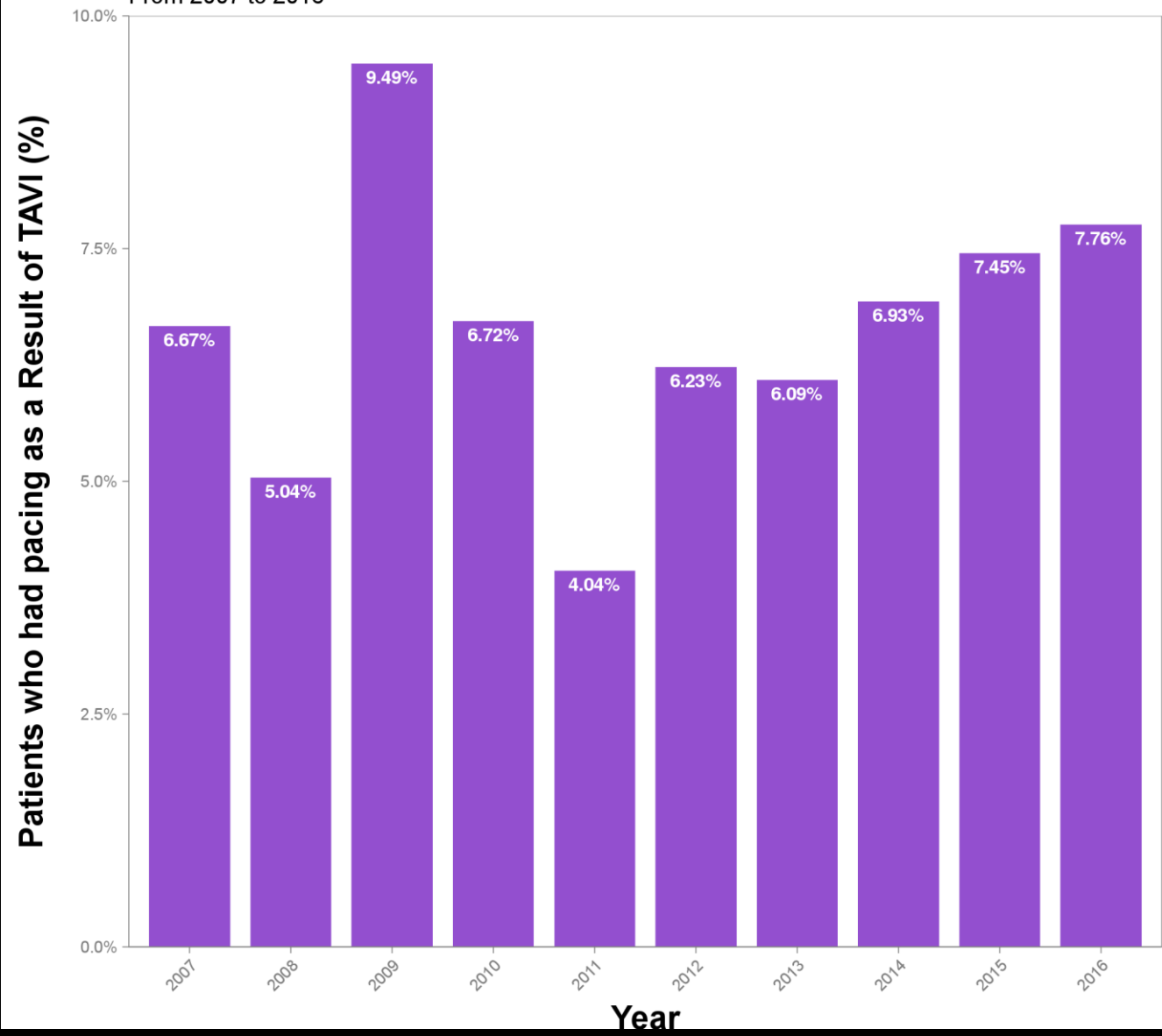
TOTAL UK  
From 2007 to 2016



# Patients who had pacing as a Result of TAVI (%) by Year Filtered by Valve manufacturer =

## Edwards

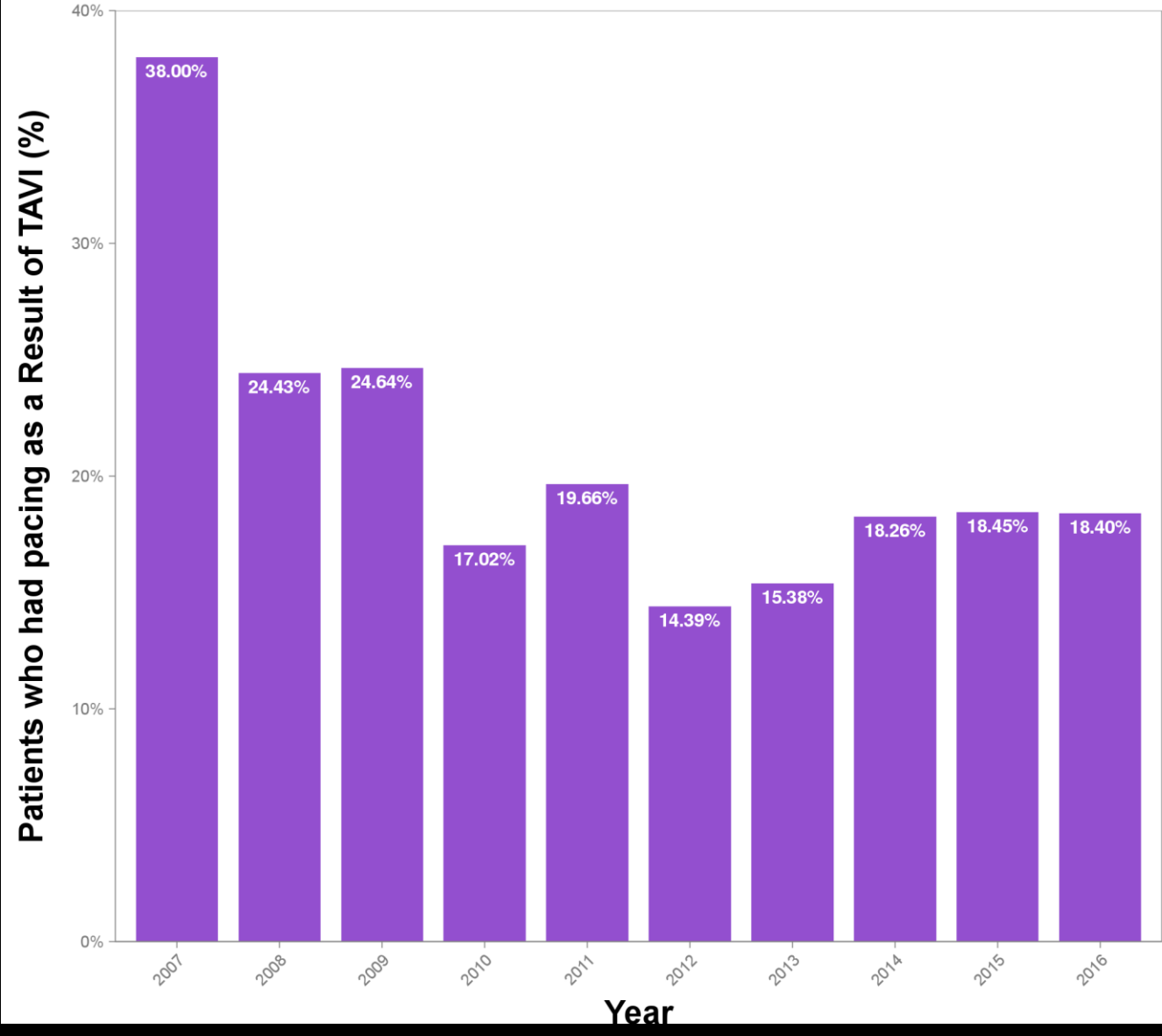
TOTAL UK  
From 2007 to 2016



# Patients who had pacing as a Result of TAVI (%) by Year Filtered by Valve manufacturer =

TOTAL UK  
From 2007 to 2016

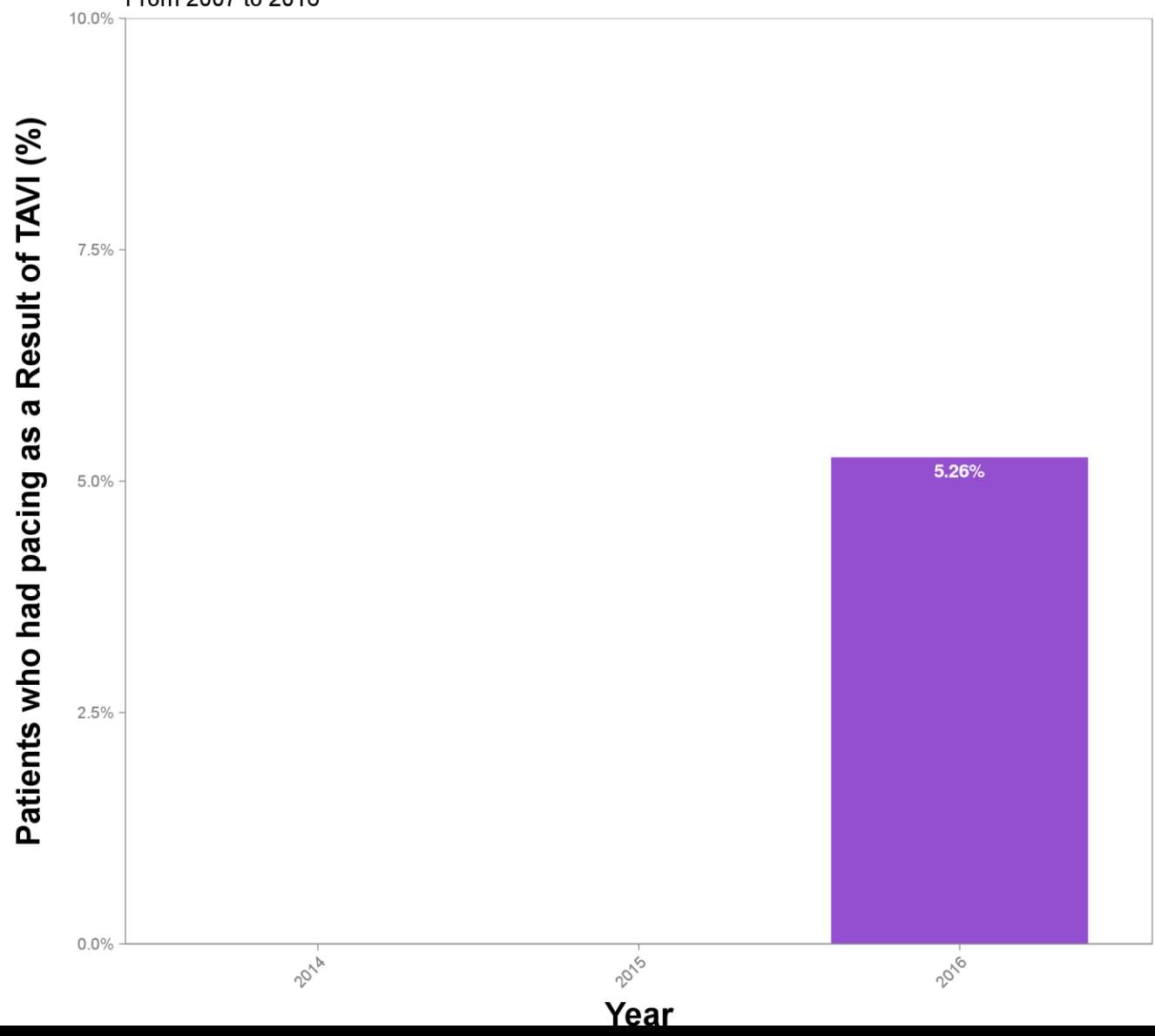
## Medtronic



# Patients who had pacing as a Result of TAVI (%) by Year Filtered by Valve manufacturer =

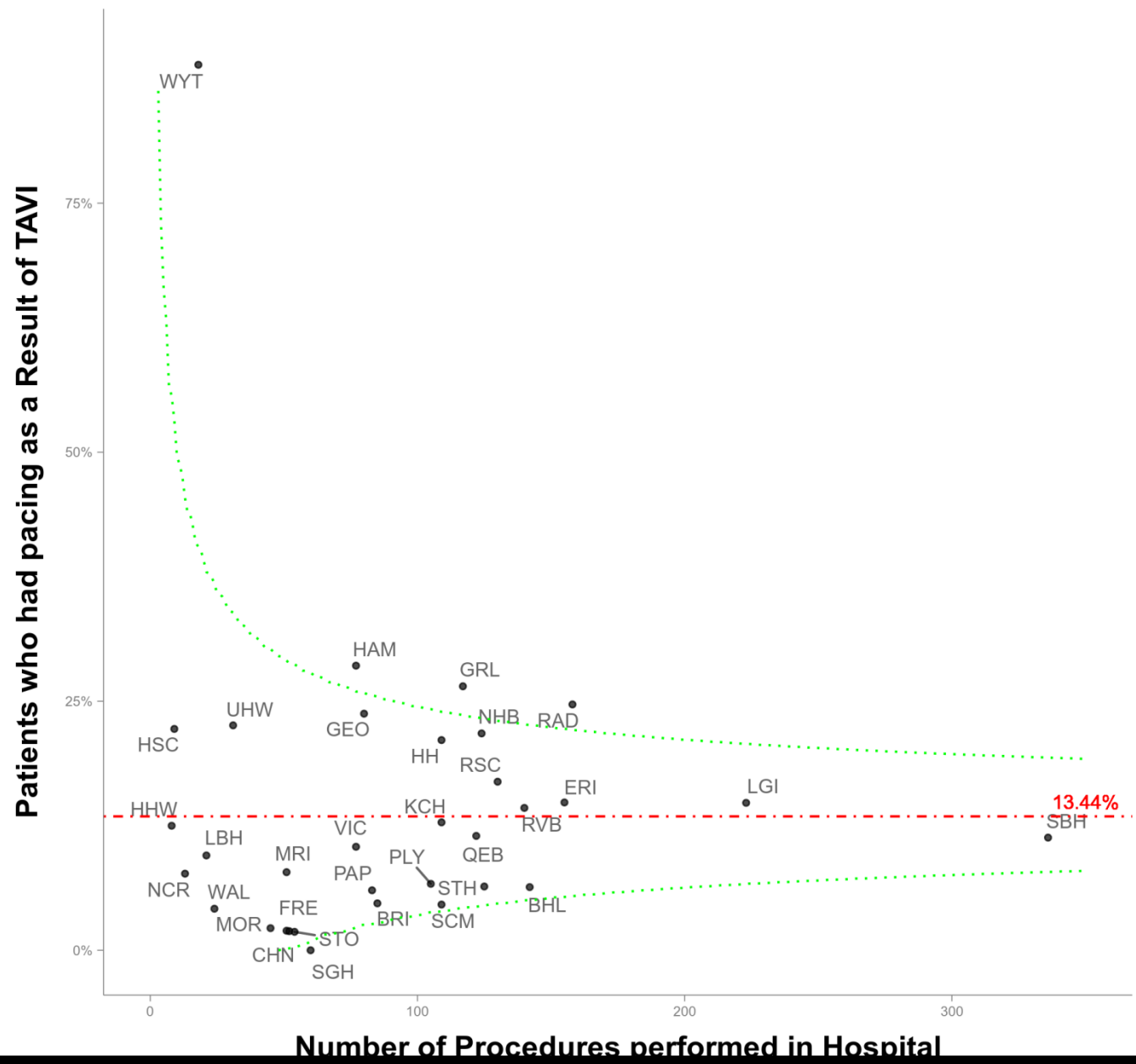
## Symetis

TOTAL UK  
From 2007 to 2016



# Patients who had pacing as a Result of TAVI (%) by Number of Procedures per Hospital

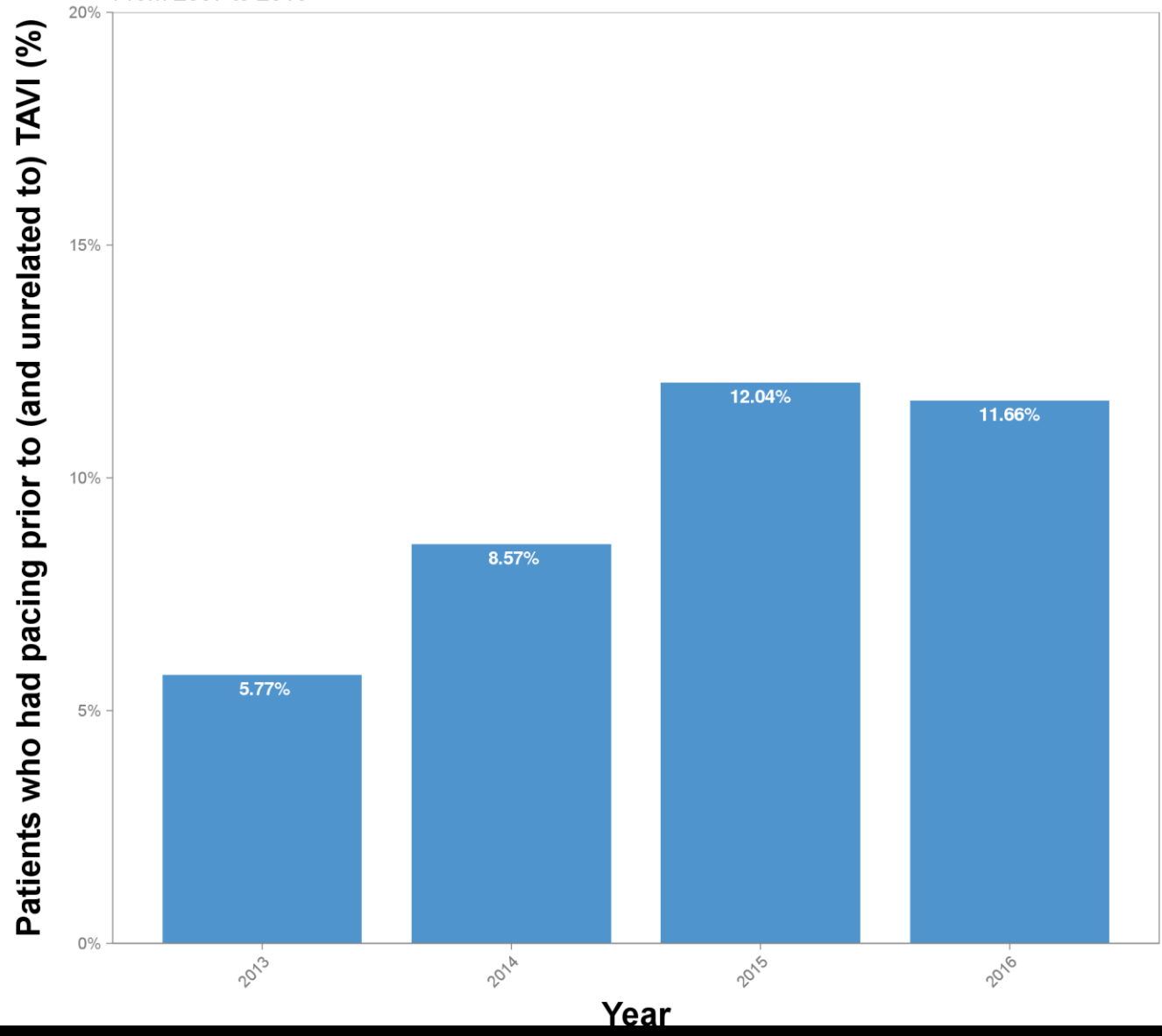
From 2016 to 2016



# Patients who had pacing prior to (and unrelated to) TAVI (%) by Year Filtered by Valve manufacturer =

TOTAL UK  
From 2007 to 2016

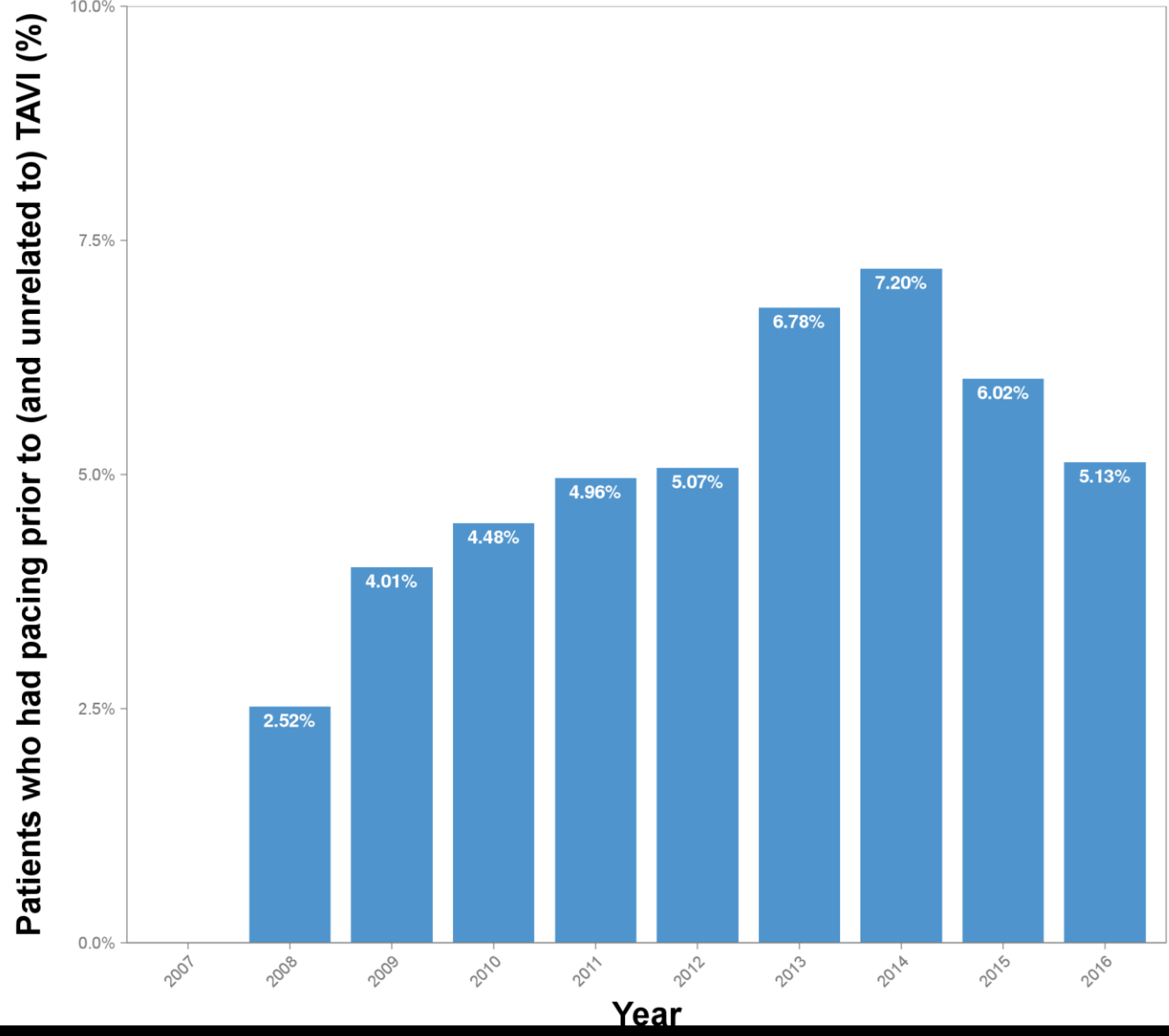
## Boston



# Patients who had pacing prior to (and unrelated to) TAVI (%) by Year Filtered by Valve manufacturer =

TOTAL UK  
From 2007 to 2016

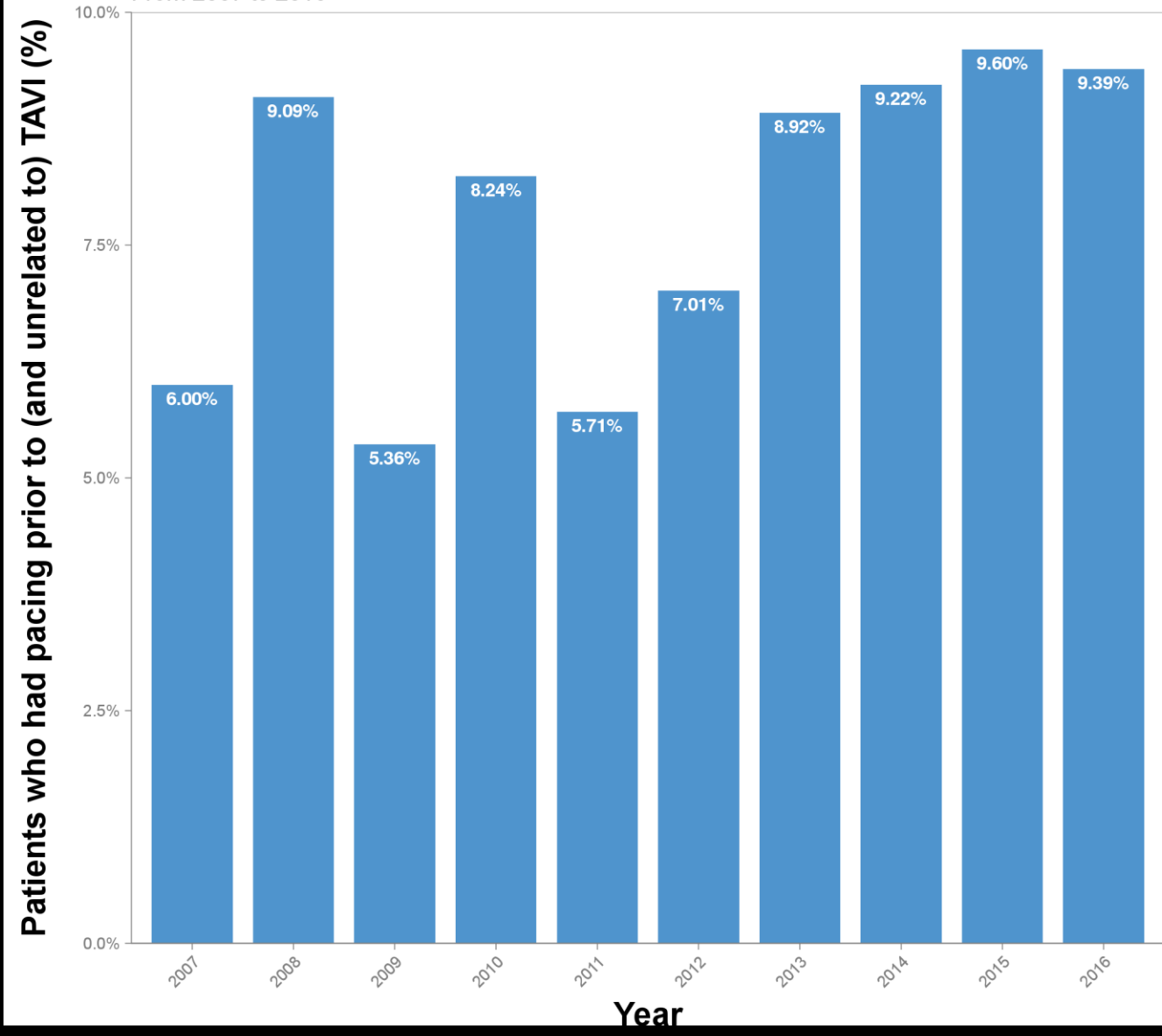
## Edwards



# Patients who had pacing prior to (and unrelated to) TAVI (%) by Year Filtered by Valve manufacturer =

TOTAL UK  
From 2007 to 2016

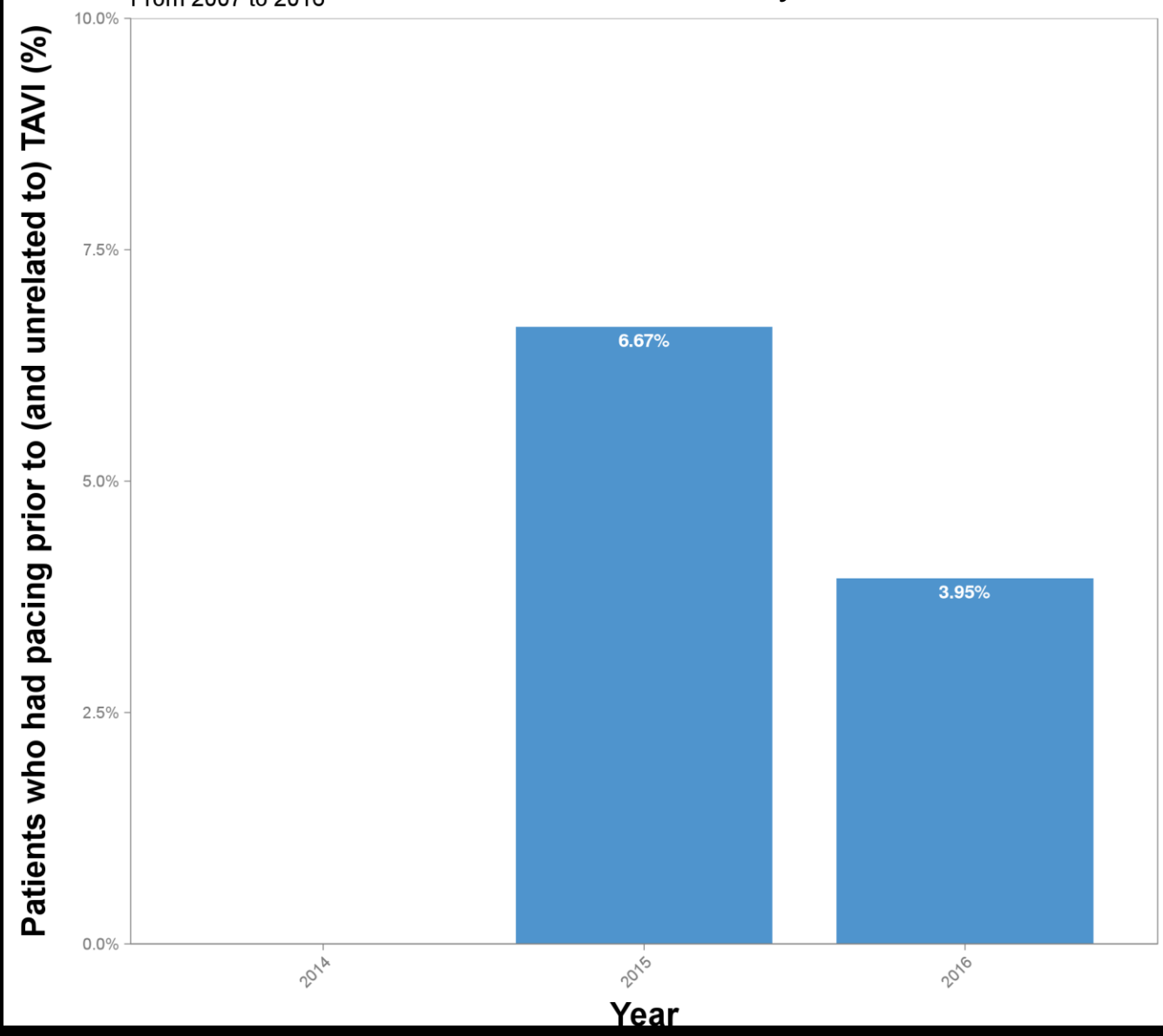
## Medtronic



# Patients who had pacing prior to (and unrelated to) TAVI (%) by Year Filtered by Valve manufacturer =

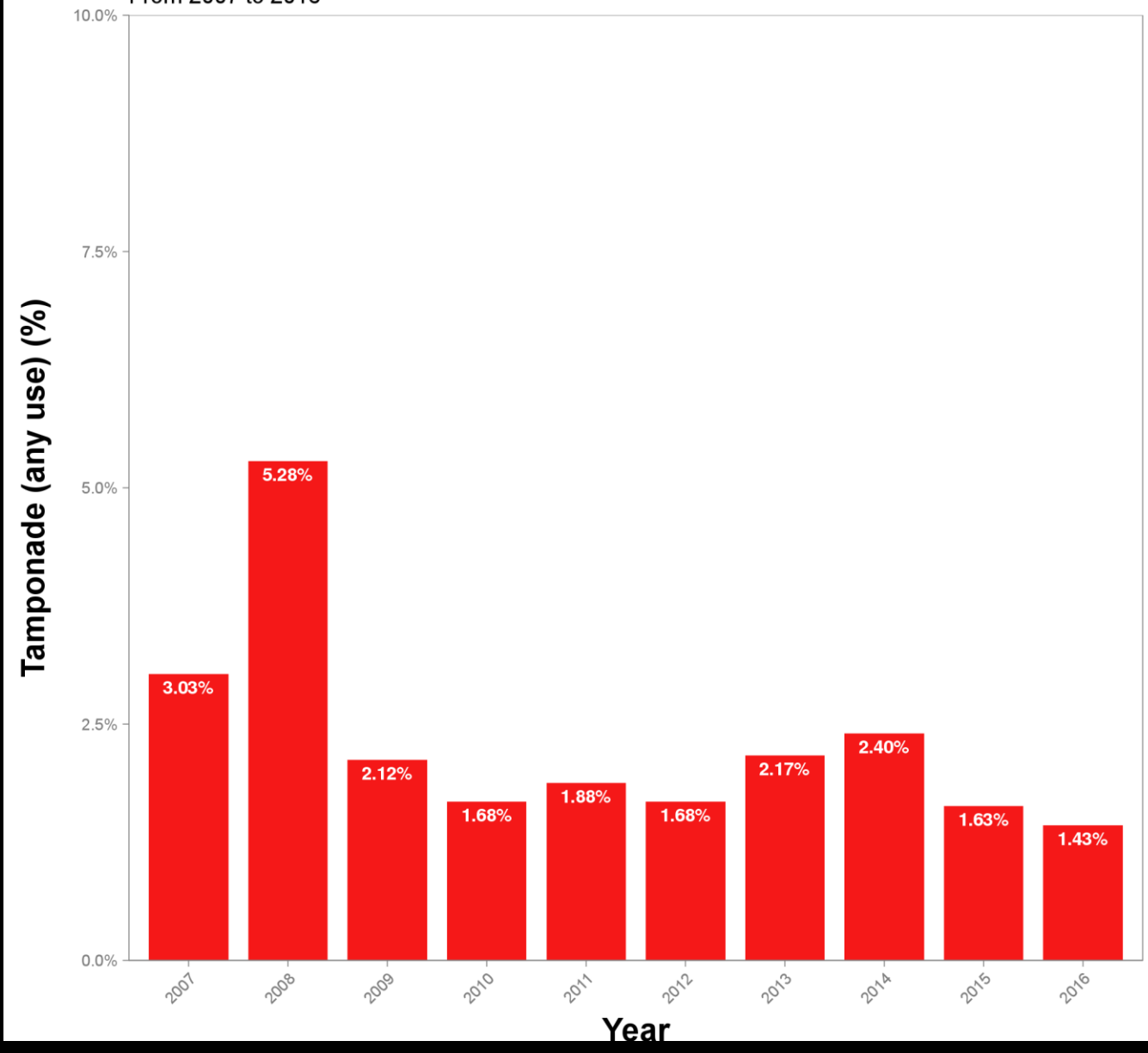
TOTAL UK  
From 2007 to 2016

## Symetis



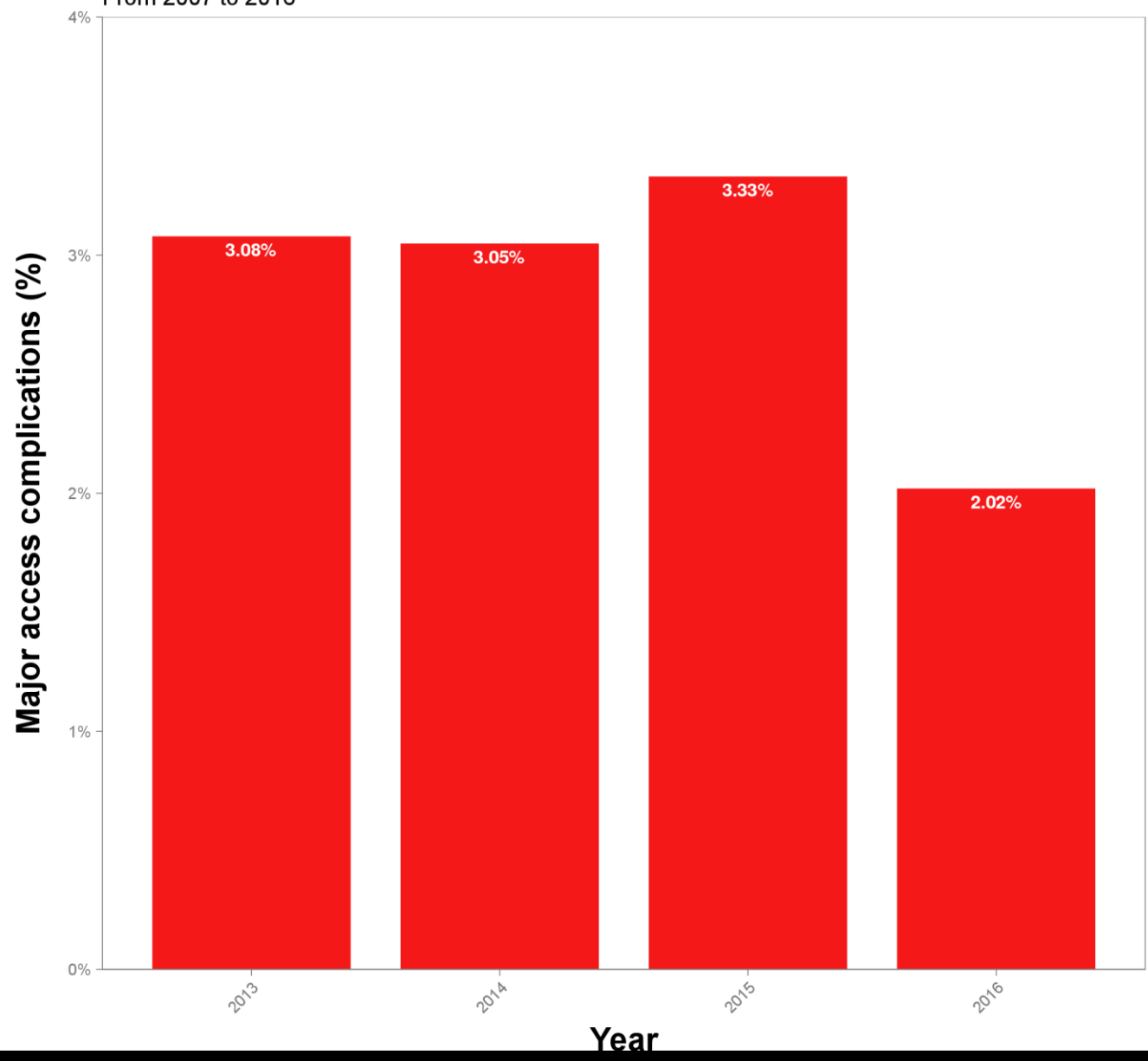
# Tamponade

TOTAL UK  
From 2007 to 2016



### Major access complications (%) by Year

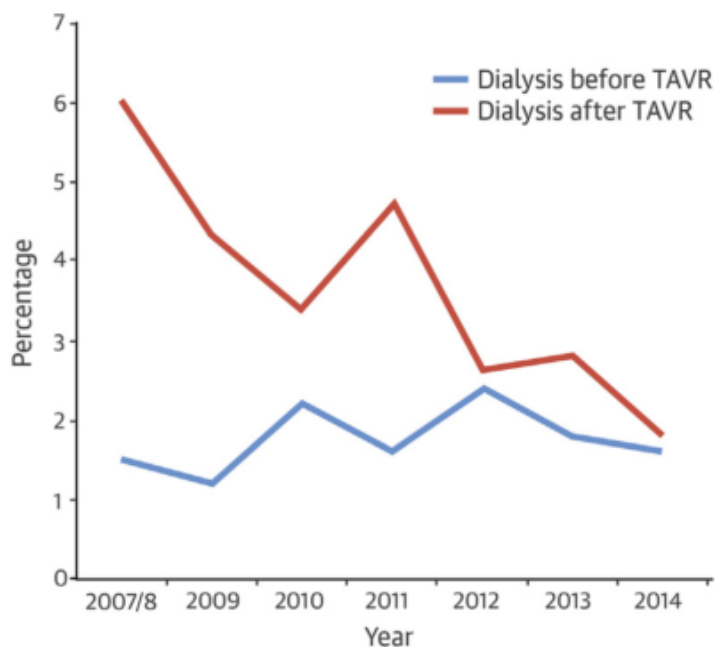
TOTAL UK  
From 2007 to 2016



# Survival v Dialysis

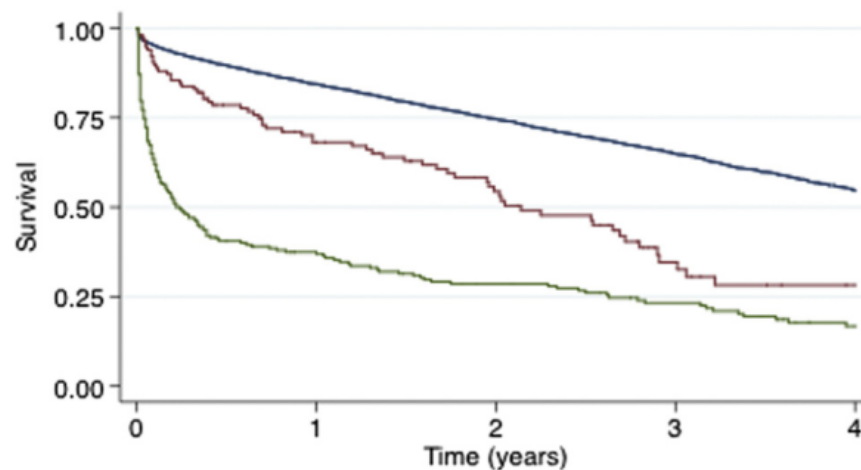
Ferro CJ JACC Int 2017

**FIGURE 1** Percentage of Patients on Dialysis Before TAVR and With New Requirement for Dialysis After TAVR (2007 to 2014)



The proportion of patients on dialysis undergoing transcatheter aortic valve replacement (TAVR) has remained constant over the study time period whereas the proportion of patients requiring dialysis for the first time after the procedure has declined.

**FIGURE 2** Kaplan-Meier Curves for All-Cause Cumulative Survival



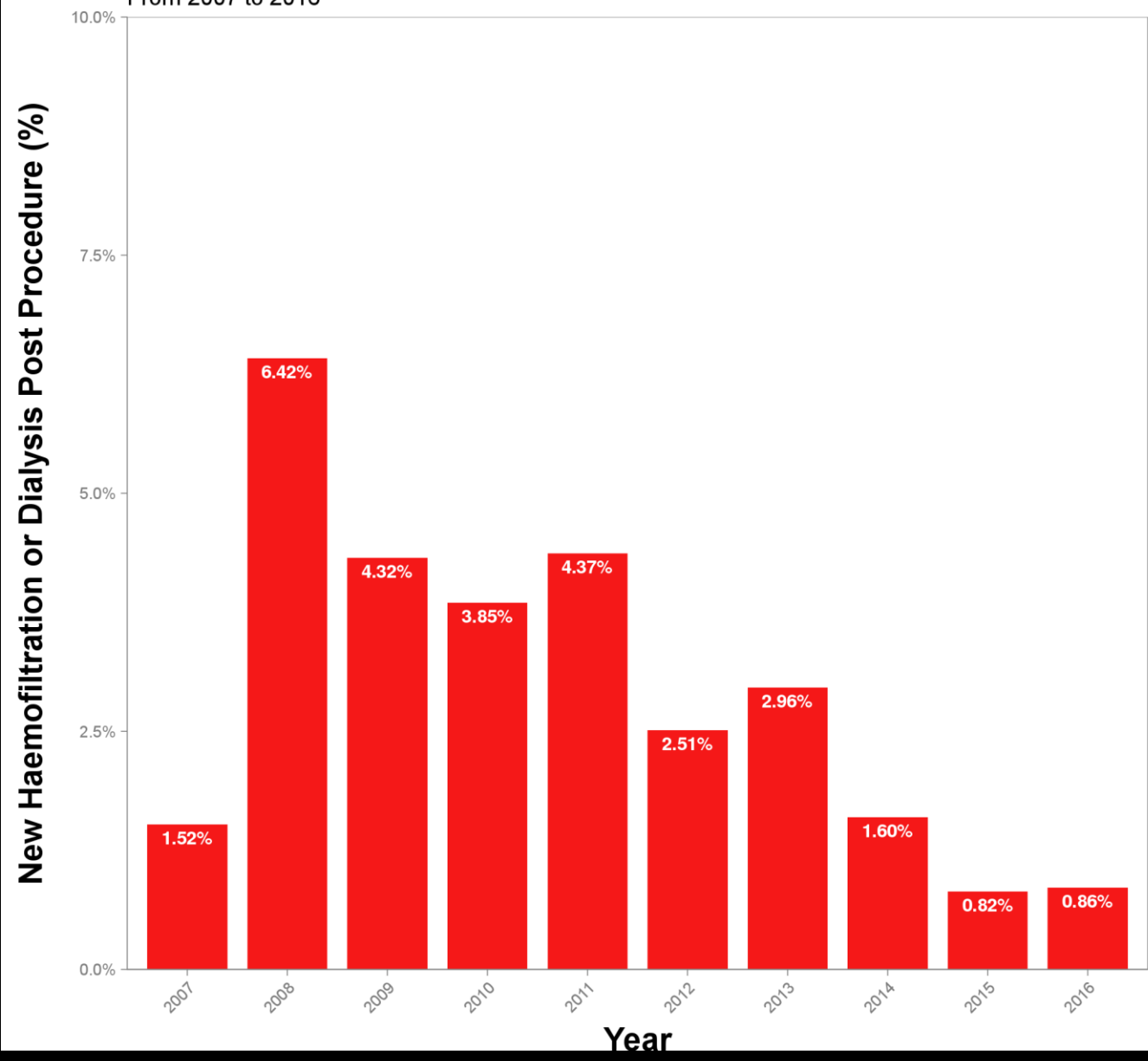
Number at risk	0	1	2	3	4
No dialysis	6145	4210	2750	1889	1009
Dialysis before	117	69	41	17	9
Dialysis after	202	68	46	31	16



Study patients are divided according to the need for dialysis either before or after transcatheter aortic valve replacement (global log-rank test  $p < 0.001$ ). Patients requiring dialysis after transcatheter aortic valve replacement had a higher mortality than both patients already on dialysis (pairwise log-rank test  $p < 0.001$ ) and those with no dialysis requirement (pairwise log-rank test  $p < 0.001$ ).

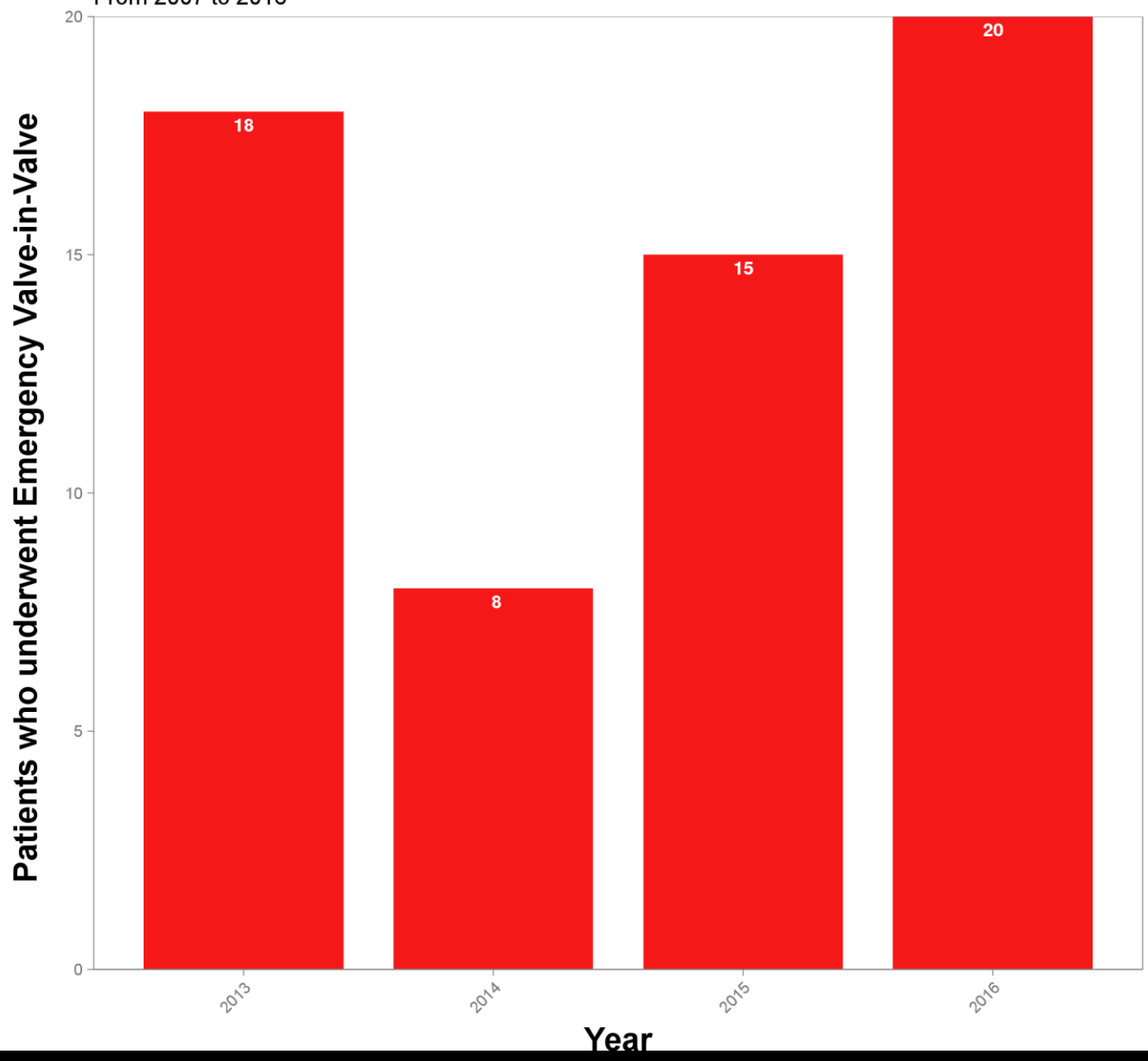
### New Haemofiltration or Dialysis Post Procedure (%) by Year

TOTAL UK  
From 2007 to 2016



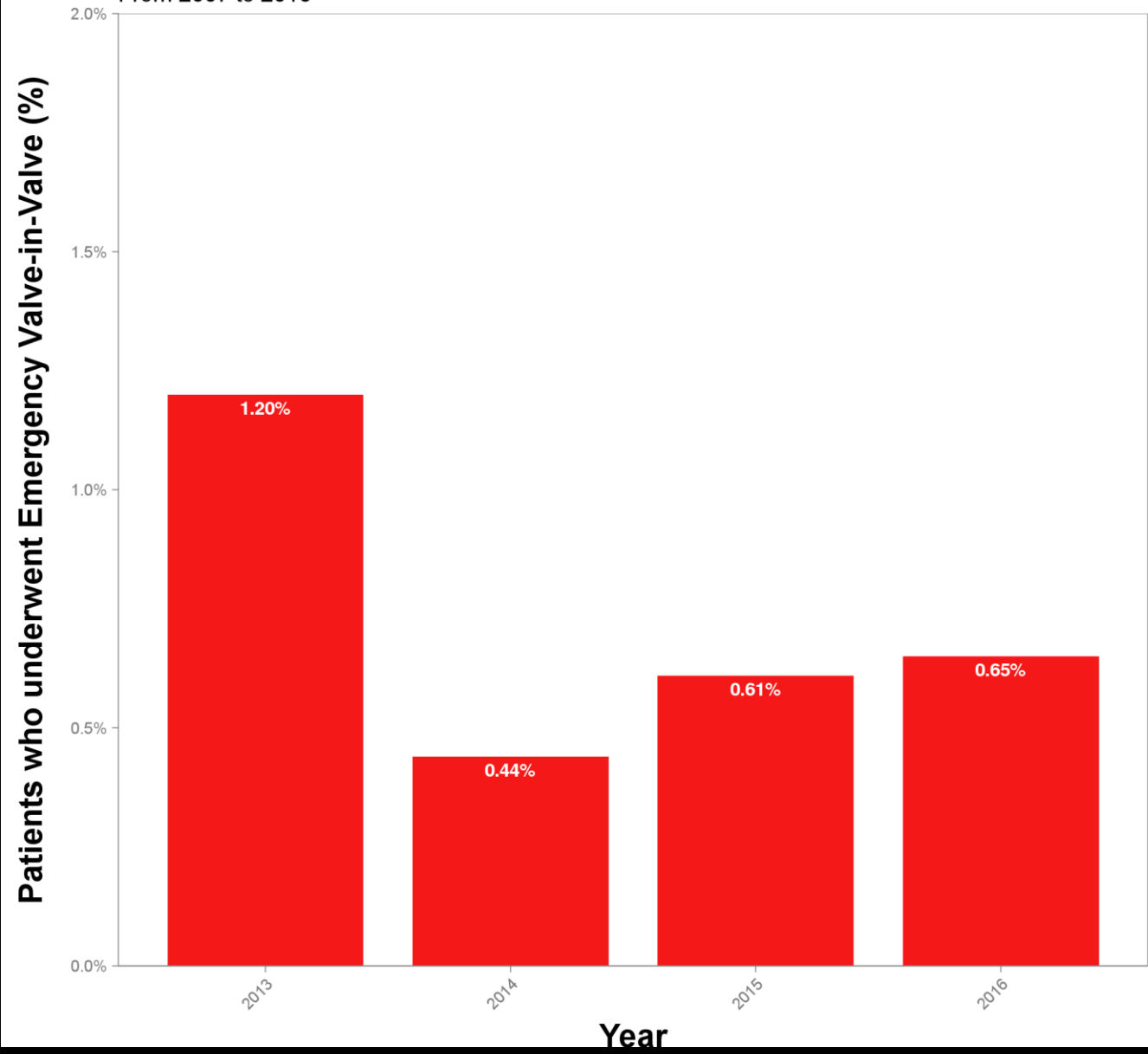
### Patients who underwent Emergency Valve-in-Valve by Year

TOTAL UK  
From 2007 to 2016



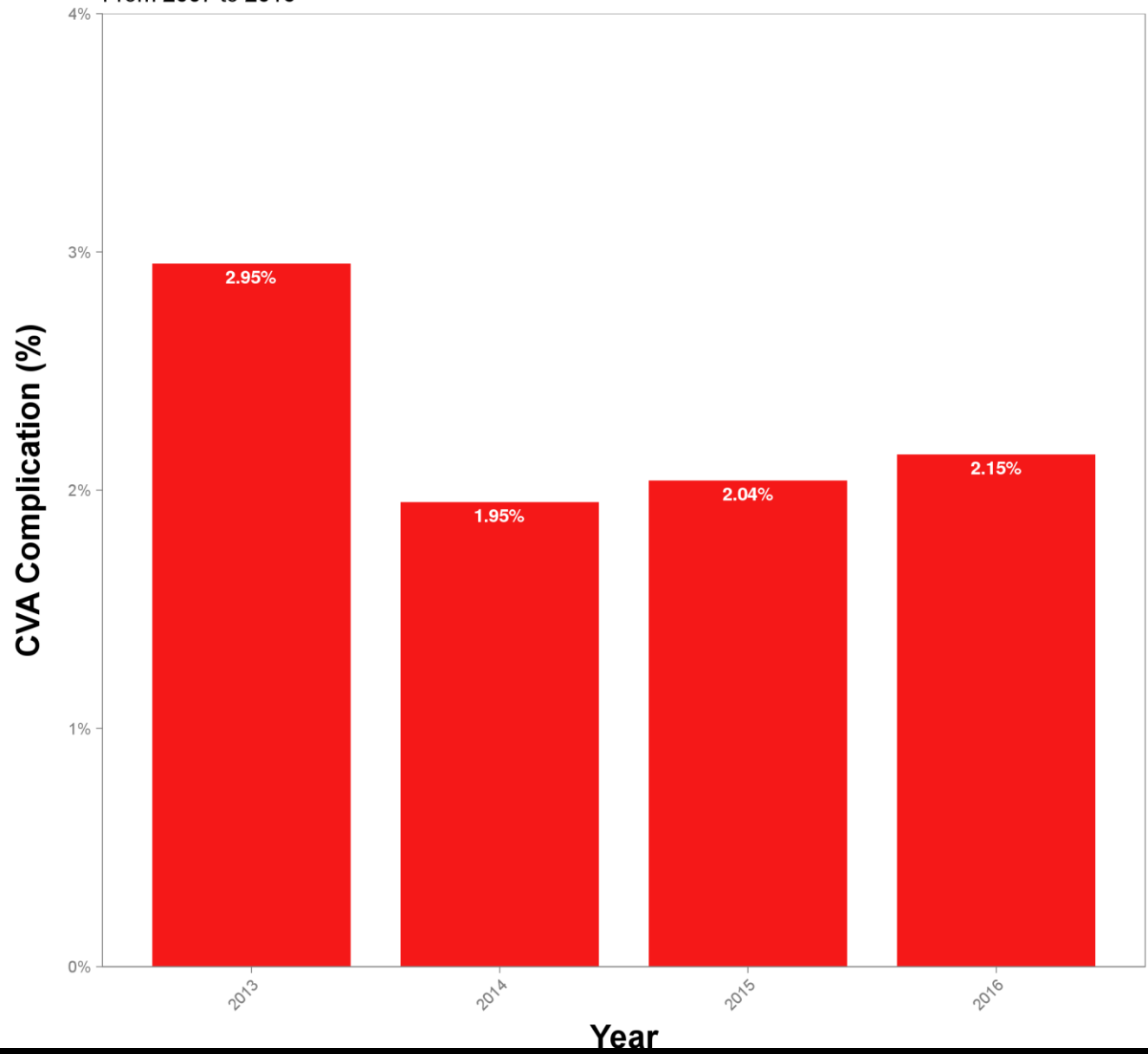
# Patients who underwent Emergency Valve-in-Valve (%) by Year

TOTAL UK  
From 2007 to 2016



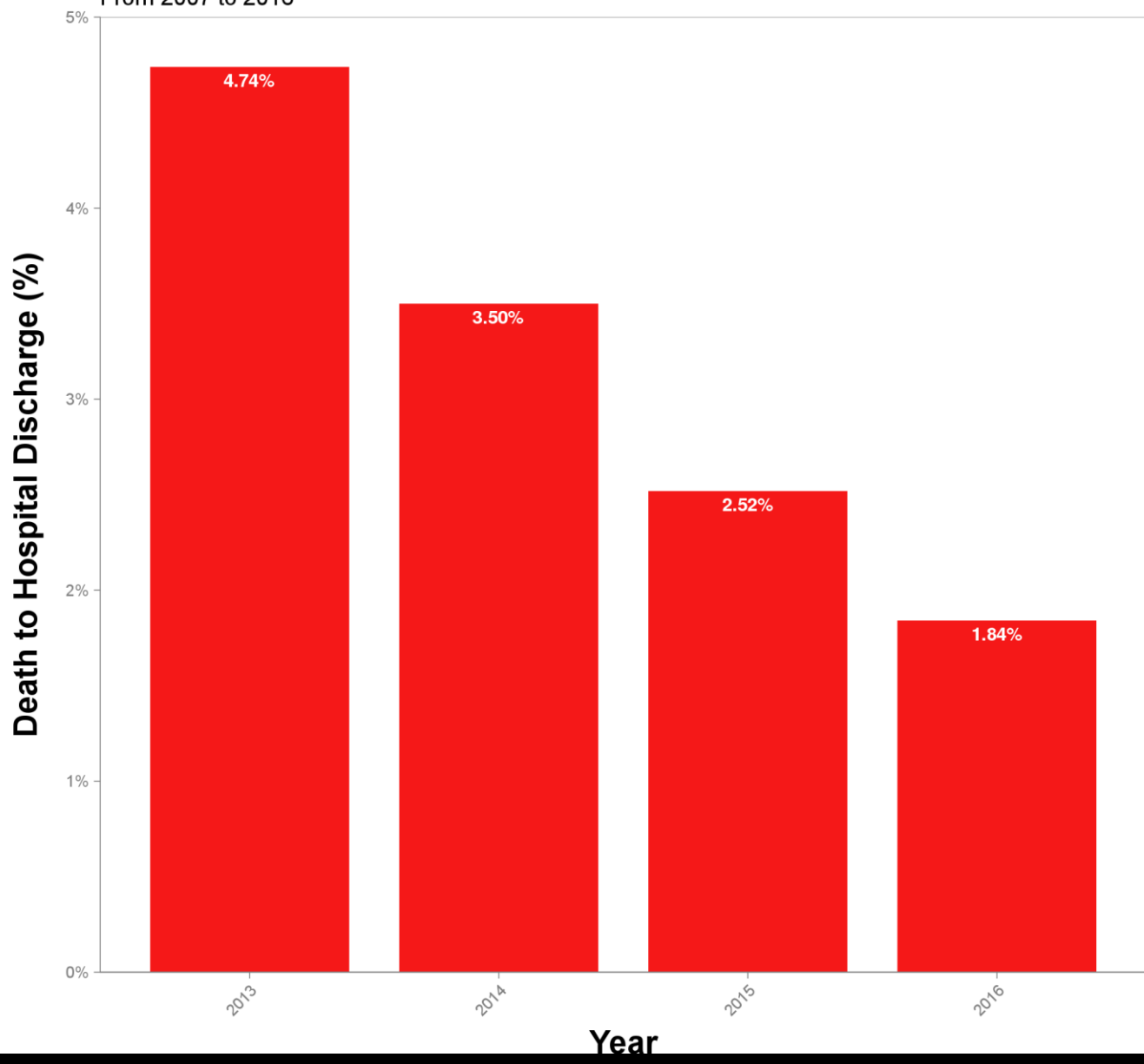
### CVA Complication (%) by Year

TOTAL UK  
From 2007 to 2016



### Death to Hospital Discharge (%) by Year

TOTAL UK  
From 2007 to 2016



# Risk Prediction Models

Martin GP, AHJ 2016;184:97-105

	Calibration	AUC
German AV	0.44	0.59
FRANCE-2	0.69	0.62
OBSERVANT	0.39	0.57
ACC-TAVI	0.67	0.64
LES	0.35	0.57
ESII	0.40	0.59
STS	0.56	0.60

# Prediction Model with Frailty

## 30-day Mortality after TAVI in the United Kingdom

(data extracted May 2017)

Martin G et al. Heart in press

**Table 3:** Variables and coefficients included in the final multivariable UK-TAVI CPM.

Variable*	Coefficient (SE)	OR (95% CI)
Intercept	-3.3633 (0.2370)	N/A
Mean-centred Age	0.0095 (0.0086)	1.010 (0.993, 1.027)
Female	0.1051 (0.1183)	1.111 (0.880, 1.401)
Mean-centred BMI	-0.0286 (0.0119)	0.972 (0.949, 0.995)
Mean-centred BMI Squared	0.0013 (0.0000)	1.001 (1.000, 1.003)
Glomerular Filtration Rate per 5 unit increase	-0.0386 (0.014)	0.962 (0.936, 0.989)
Pulmonary disease	0.2375 (0.1275)	1.268 (0.988, 1.628)
Sinus pre-operative heart rhythm	-0.1950 (0.1213)	0.823 (0.649, 1.044)
Prior BAV	0.2594 (0.1651)	1.296 (0.938, 1.791)
Critical pre-operative status	0.6273 (0.2815)	1.873 (1.079, 3.251)
Poor Mobility	0.1865 (0.2376)	1.205 (0.756, 1.920)
CSHA Frailty	0.235 (0.2091)	1.265 (0.840, 1.906)
KATZ<6	0.1776 (0.2839)	1.459 (0.836, 2.545)
PA Systolic pressure > 60mmHg	0.2283 (0.1575)	1.257 (0.923, 1.711)
Non-elective procedure	0.3840 (0.1615)	1.468 (1.070, 2.015)
Non-transfemoral access	0.6871 (0.1250)	1.988 (1.556, 2.540)

Abbreviations: BAV: Balloon aortic valvuloplasty, BMI: Body mass index, OR: Odds ratio, SE:

standard error

Frailty phenotype:

Vulnerability to physiological stressors

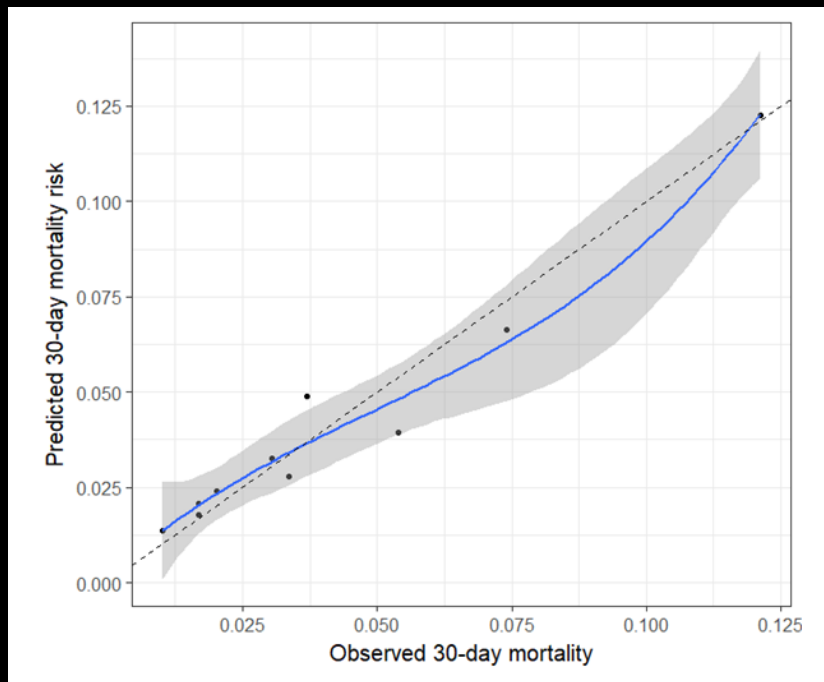
Age associated decline in resilience & reserve.

Commonly manifests as slowness, weakness, reduced activity, low energy levels and unintended weight loss.

# Prediction Model with Frailty

## 30-day Mortality after TAVI in the United Kingdom

Martin G et al. Heart in press



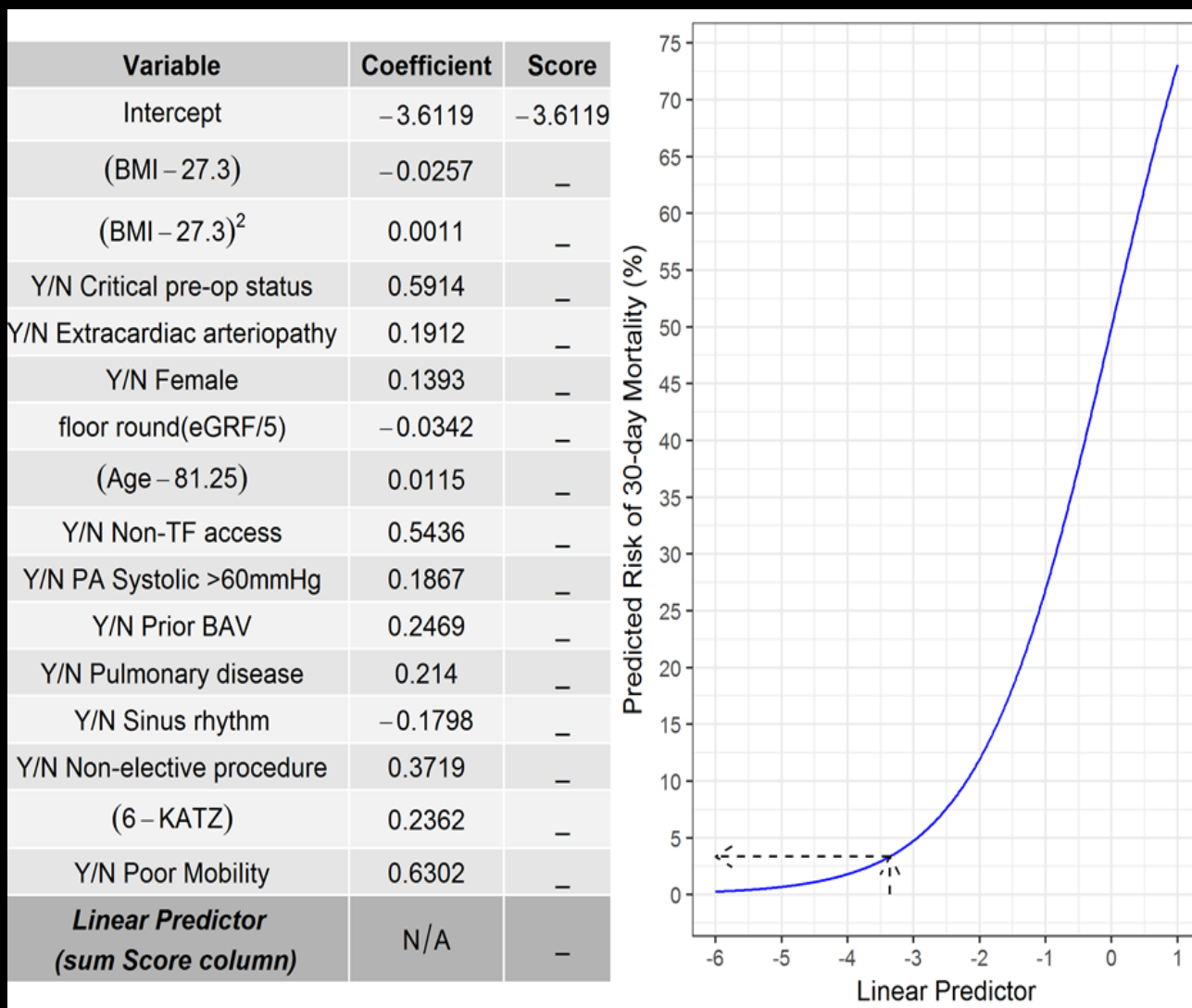
Validation	Calibration Intercept (95% CI)	Calibration Slope (95% CI)	AUC (95% CI)
Apparent	0.00 (-0.18, 0.18)	1.00 (0.76, 1.24)	0.70 (0.65, 0.75)
Internal*	0.02 (-0.17, 0.20)	0.79 (0.55, 1.03)	0.66 (0.61, 0.71)

# Prediction Model with Frailty

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(data extracted May 2017)

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# Prediction Model with Frailty

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Strong calibration




Only moderate discrimination

Better for risk-adjusted outcomes between centres than in predicting risk for individual patients being offered TAVI

# TAVI risk calculator

<https://www.bcis.org.uk/resources/tavi-risk-calculator/>

### TAVI 30 day Mortality Calculator

Calculation result
Risk factor definitions
Acknowledgements
Terms and Conditions

## Predicted 30 Day Mortality

### Following TAVI

# 2.8 %

[BMI = 28.67 ]

This model can only provide an estimate of the mortality risk. The precision of the estimate will be less good for cases that involve a combination of factors that is less frequently encountered

The model has not been validated for clinical decision support

**Age (years)**  
89

**Sex**  
 Female  
 Male

**Height (m)**  
1.5

**Weight (Kg)**  
60

**Glomerular Filtration Rate (calculated eGFR) mL/min/1.73 m2**  
30

**Pulmonary disease**  
No

**Extracardiac arteriopathy**  
No

**Sinus rhythm**  
Yes

**Prior balloon aortic valvuloplasty**  
No

**Critical pre-operative status**  
No

**Poor mobility**  
No




**KATZ Index**  
6

**Pulmonary artery pressure > 60mmHg**  
Yes

**Elective procedure**  
Yes

**Transfemoral access**  
Yes

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No

**Sinus rhythm**  
Yes

**Prior balloon aortic valvuloplasty**  
No

**Critical pre-operative status**  
No

**Poor mobility**  
No

**KATZ Index**

**Pulmonary disease:** Chronic Obstructive Airways Disease / Emphysema: Patient requires medication (inhalers, aminophylline or steroids) for chronic pulmonary disease or FEV1 less than 75% predicted value. Venous pO2 < 60mmHg, pCO2 > 50mmHg. Asthma. Intermittent or allergic reversible airways disease treated with bronchodilators or steroids, or other significant pulmonary disease

**Extracardiac arteriopathy:** History or evidence of aneurysm or occlusive peripheral vascular disease or carotid disease, including aortic aneurysm, previous aorto-iliac or peripheral vascular surgery, or reduced or absent peripheral pulses and/or angiographic stenosis of more than 50%. Include femoral or carotid bruits as evidence of peripheral vascular disease.

**Critical pre-operative status:** Any of the following options: ventricular tachycardia or ventricular fibrillation or aborted sudden death, preoperative cardiac massage, preoperative ventilation before anaesthetic room, preoperative inotropes or IABP, preoperative acute renal failure (anuria or oliguria <10ml/hr)

**Poor mobility:** severe impairment of mobility secondary to musculoskeletal or neurological dysfunction

**KATZ:** Index 0 to 6

#### Katz Index of Independence in Activities of Daily Living

ACTIVITIES (POINTS 1 OR 0)	INDEPENDENCE: (1 POINT) NO supervision, direction or personal assistance	DEPENDENCE: (0 POINTS) WITH supervision, direction, personal assistance or total care
<b>BATHING</b>  POINTS: _____	(1 POINT) Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity.	(0 POINTS) Needs help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing.
<b>DRESSING</b>  POINTS: _____	(1 POINT) Gets clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	(0 POINTS) Needs help with dressing self or needs to be completely dressed.
<b>TOILETING</b>	(1 POINT) Goes to toilet, gets on and off, arranges clothes, cleans genital area	(0 POINTS) Needs help transferring to the toilet, cleaning self or uses bedpan or

# Acknowledgments

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