



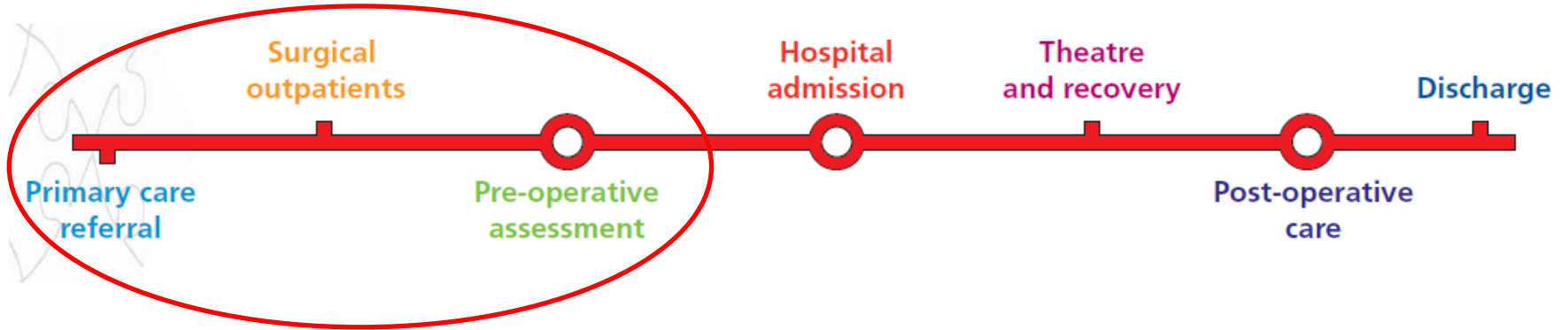
# Peri-operative Management of Poorly Controlled Diabetes and the Limitations of HbA<sub>1c</sub>

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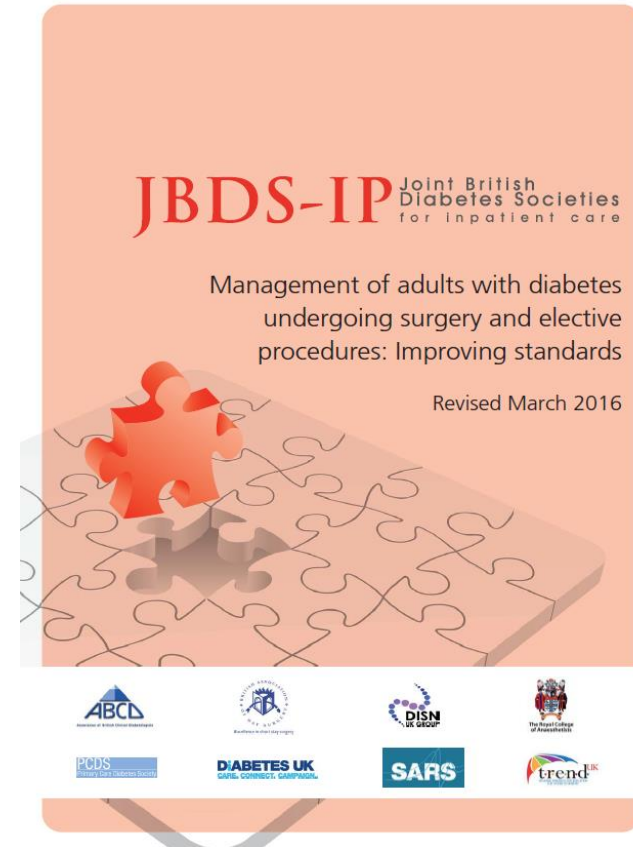
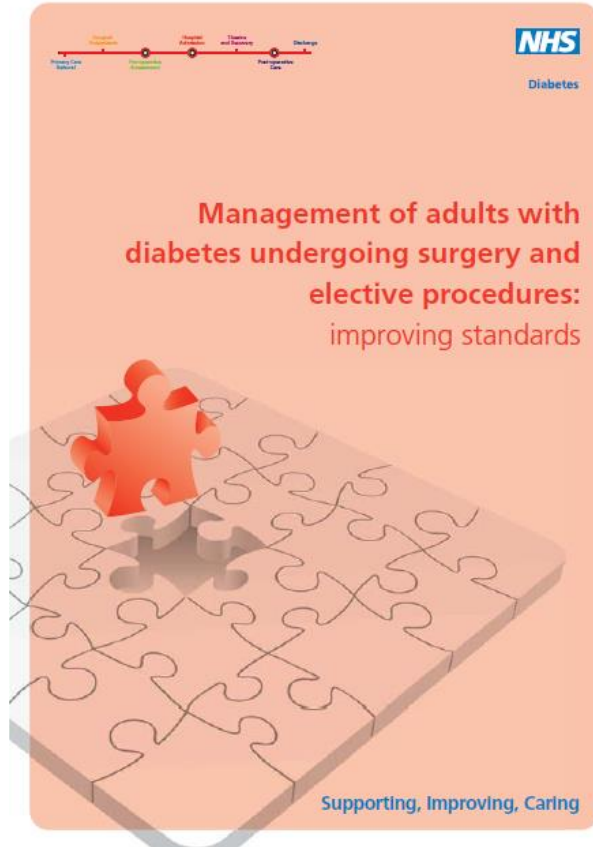
# The Patient Journey



# Guidance

In 2011  
Along Came  
This.....

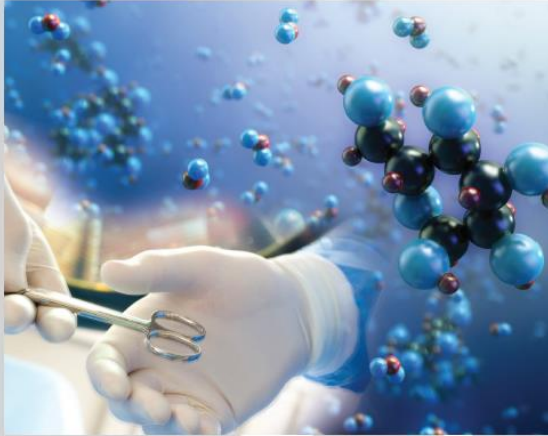
Revised in  
2016.....



[https://abcd.care/sites/abcd.care/files/resources/Surgical\\_guidelines\\_2015\\_full\\_FINAL\\_amended\\_Mar\\_2016.pdf](https://abcd.care/sites/abcd.care/files/resources/Surgical_guidelines_2015_full_FINAL_amended_Mar_2016.pdf)

## Highs and Lows

A review of the quality of care provided to patients over the age of 16 who had diabetes and underwent a surgical procedure

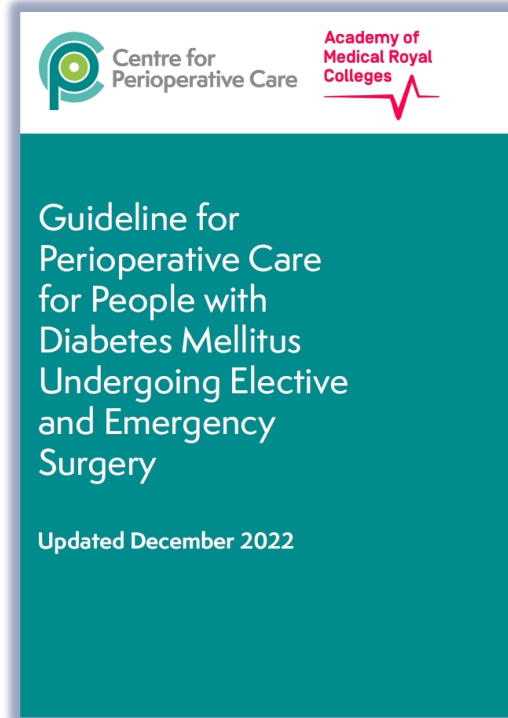


# National Confidential Enquiry into Patient Outcome and Death – NCEPOD Report 2018

# Factors Leading to Poor Outcomes

- Failure to identify patients with diabetes or hyperglycaemia
- Lack of institutional guidelines for the management of hyperglycaemia
- Poor knowledge of diabetes amongst staff delivering care
- Complex polypharmacy and insulin prescribing errors

# Updated in December 2022





# Referrals from Primary Care

- Minimum dataset required in the referral

## BOX 5

### Minimum data required from GP when referring a patient for surgery/procedures (Appendix 12)

- Duration and type of diabetes
- Place of usual diabetes care (primary or secondary)
- Other co-morbidities
- Treatment
  - For diabetes oral agents/ insulin doses and frequency
  - For other co-morbidities
- Complications
  - At risk foot
  - Renal impairment
  - Cardiac disease
- Relevant measures (measured within the previous 3 months)
  - BMI
  - BP
  - HbA<sub>1c</sub>
  - eGFR



# Delay

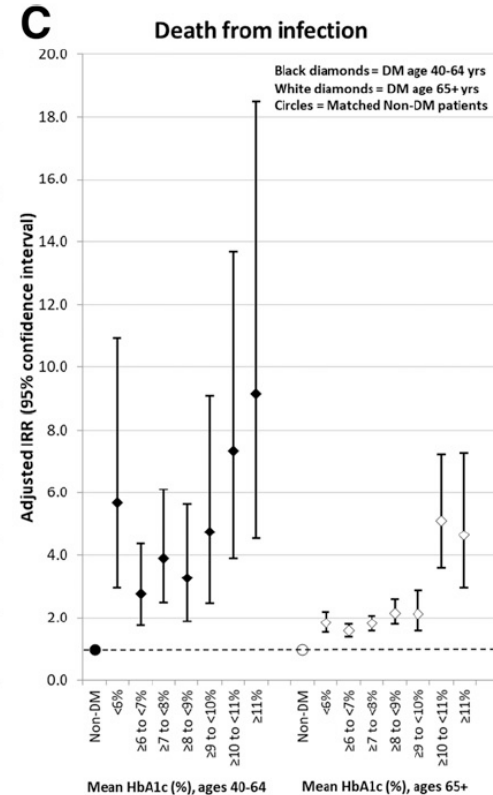
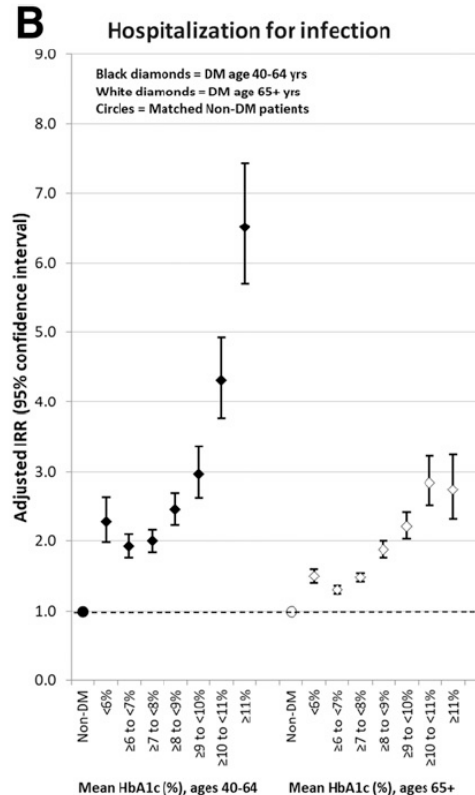
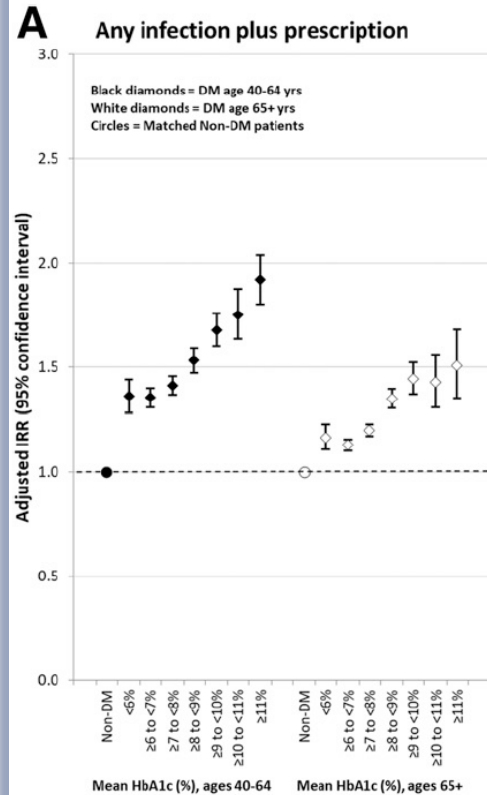
- In your institution, what is the delay between
  - The GP referring to the surgeon and them being seen
  - The surgeon seeing them and saying ‘you need a procedure’ to the time they have their procedure?
- Why not use those times to optimise their diabetes?

# Do Peri-Operative High Glucose Levels Cause Harm?

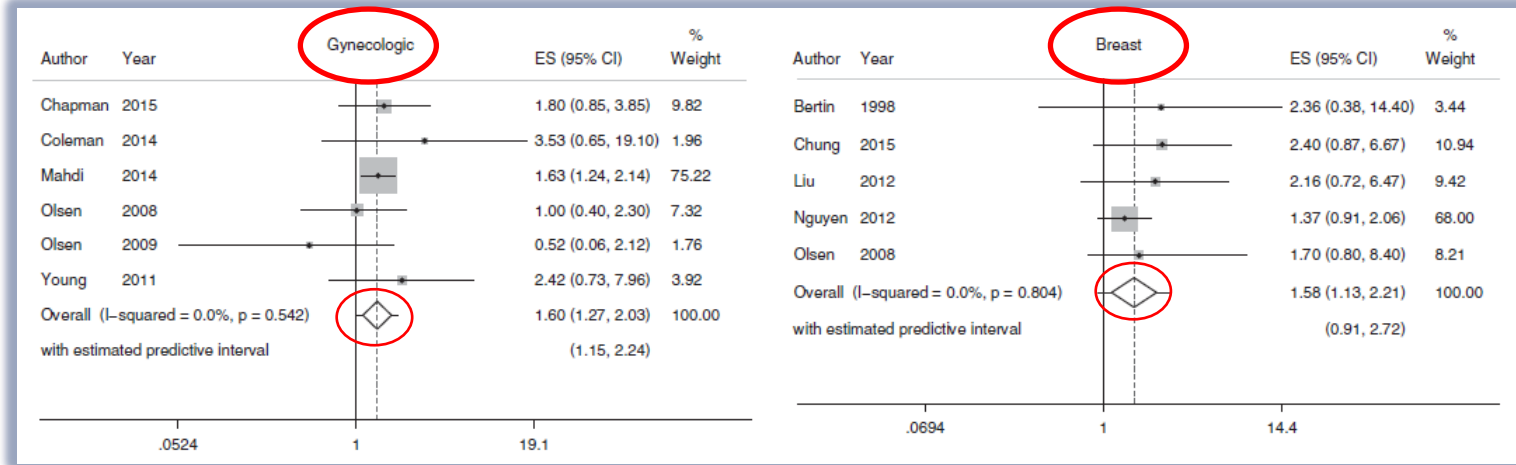
- High pre-operative glucose or HbA1c has been related to adverse outcomes following
  - spinal
  - vascular / endovascular
  - colorectal
  - cardiac
  - trauma
  - mastectomies
  - emergency
  - foot and ankle
  - neurosurgery
  - transplant
  - HBP
  - cholecystectomy
  - cardiac
  - burns

Walid MS et al J Hosp Med 2010;5:E10-E14  
O'Sullivan CJ et al Euro J of Vasc Endovasc Surg 2006;32:188-197  
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Shapey IM et al Diab Obes Metab 2021;23(1):49-57  
Shanahan J et al JAMA Network Open 2023;6(3):e236318

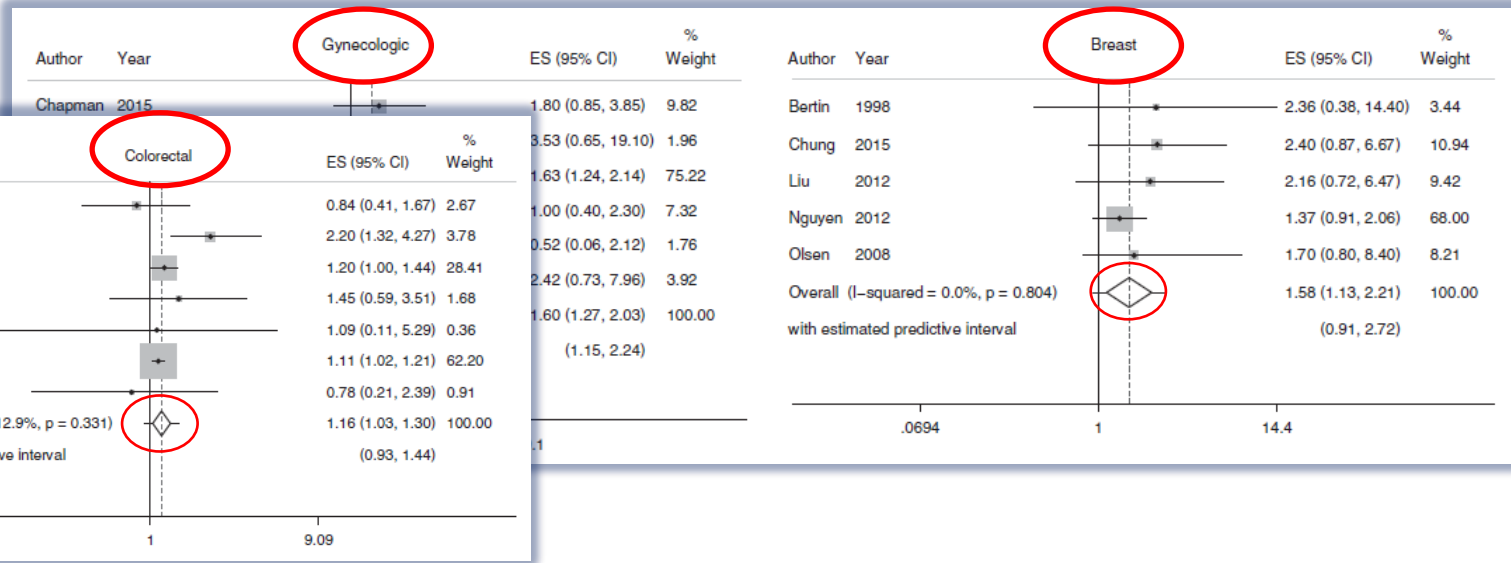
# Infections



# Glucose and SSI – A Variety of Specialities



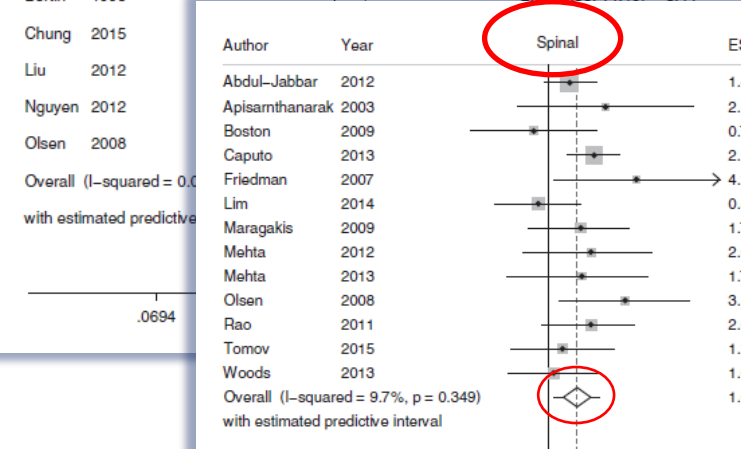
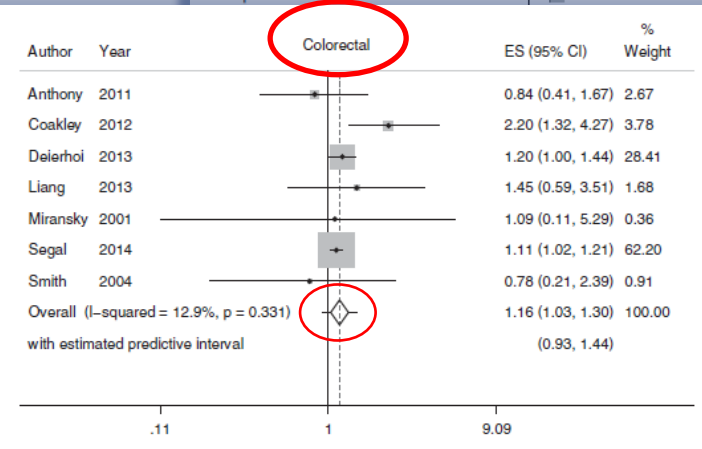
# Glucose and SSI – A Variety of Specialities



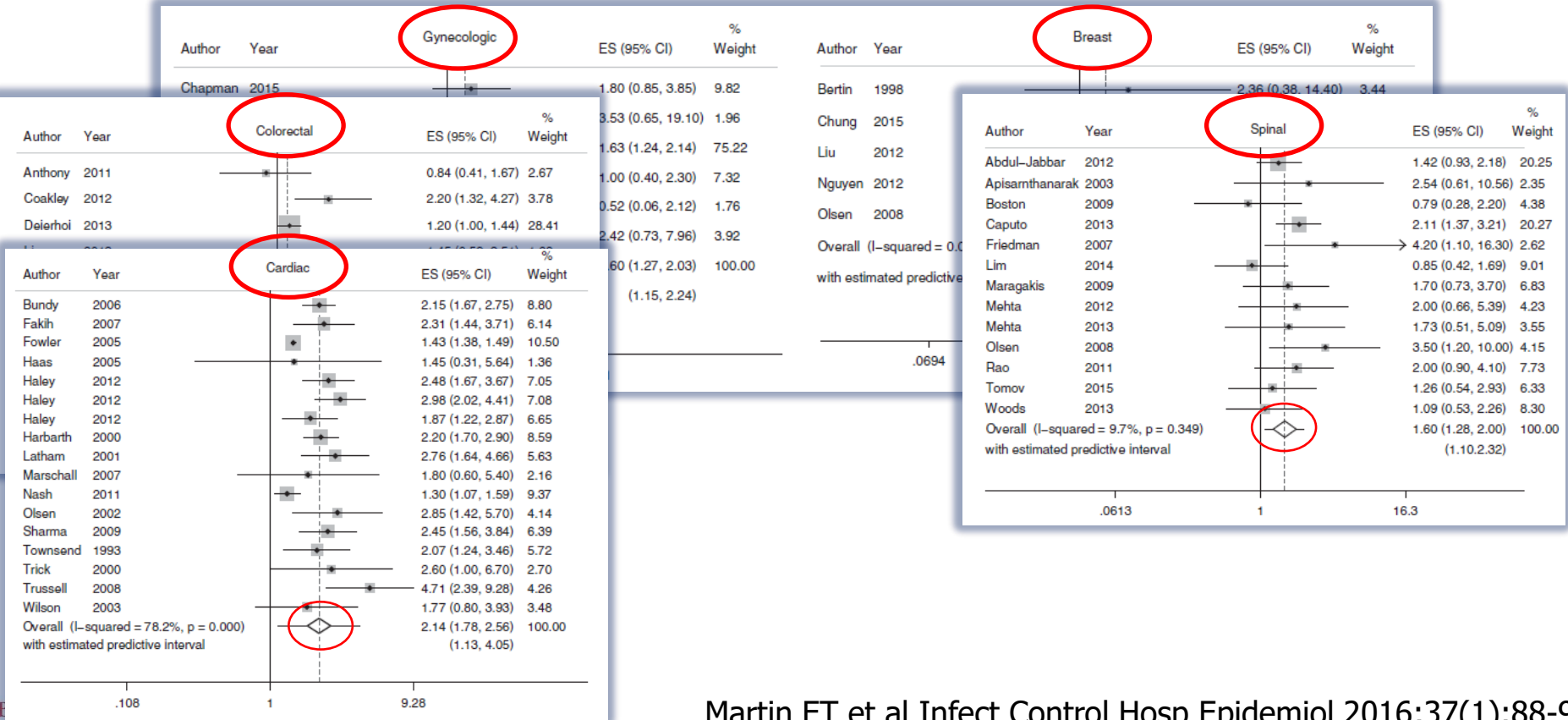
# Glucose and SSI – A Variety of Specialities

Author	Year	Gynecologic	ES (95% CI)	% Weight
Chapman	2015		1.80 (0.85, 3.85)	9.82

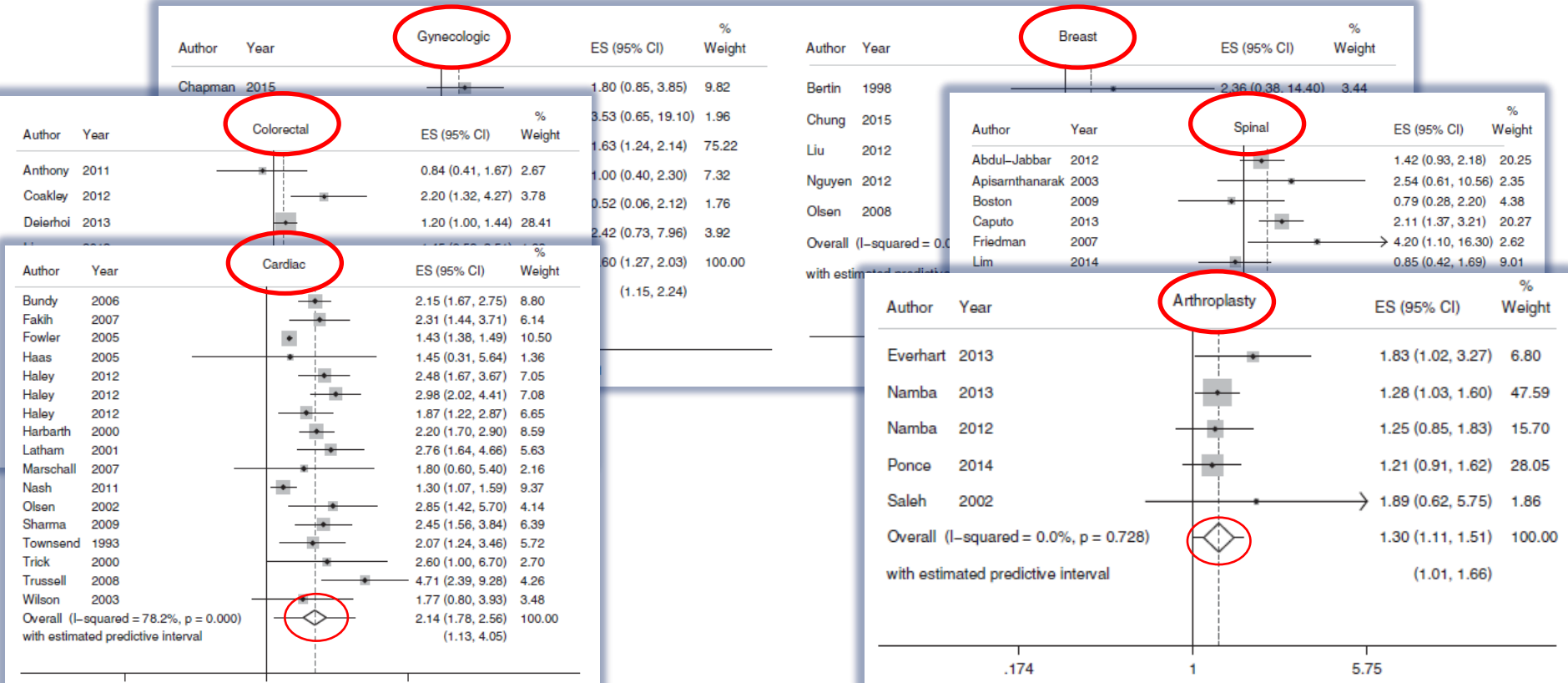
Author	Year	Breast	ES (95% CI)	% Weight
Bertin	1998		2.36 (0.38, 14.40)	3.44



# Glucose and SSI – A Variety of Specialities

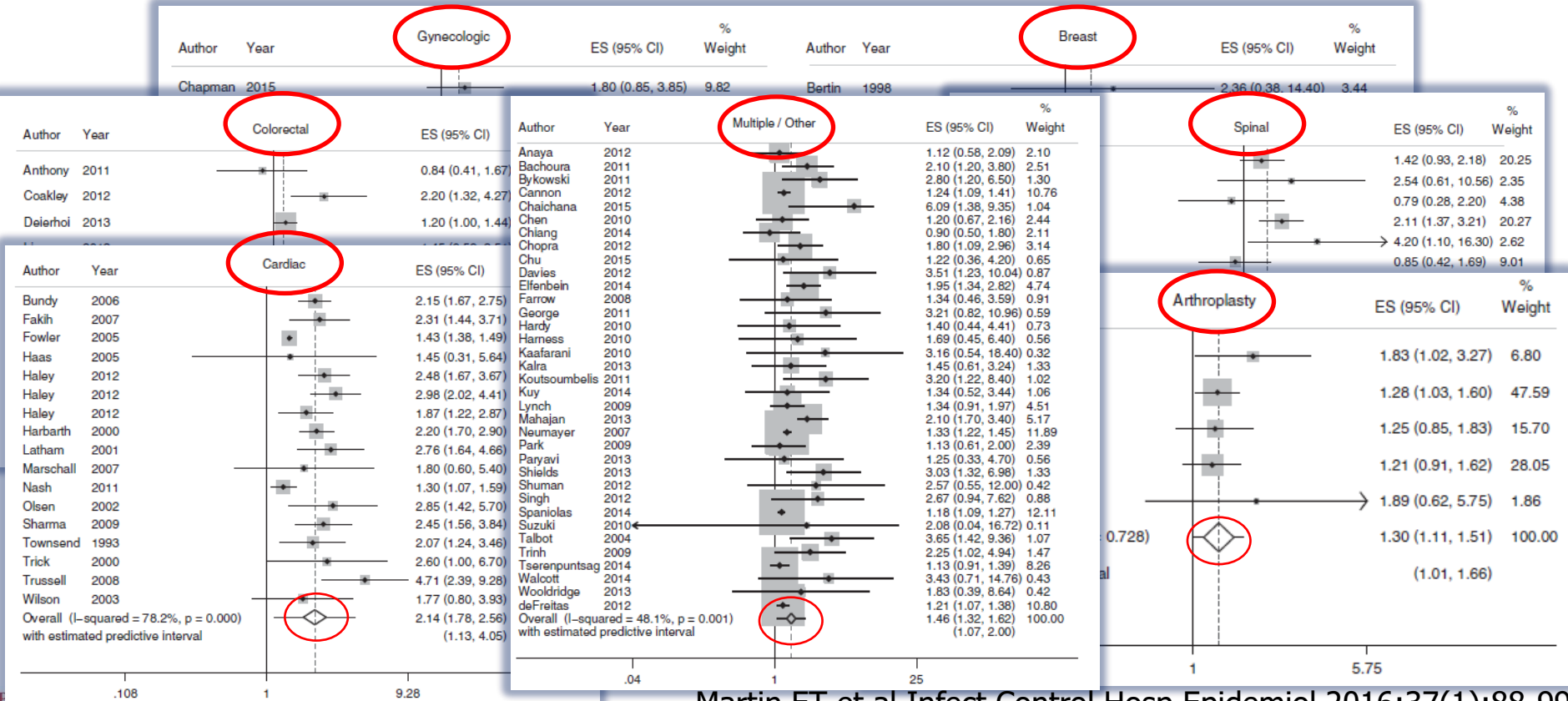


# Glucose and SSI – A Variety of Specialities





# Glucose and SSI – A Variety of Specialities



# More Observational Data

- Observational data from 55 US hospitals over 5 years looked at the outcomes of 18,278 patients 11,633 of whom who had a BG measured pre op, on day 1 post op or day 2 post op
- 55.4 ± 15.3 years
- 65.7% women

# Outcomes

**TABLE 2.** Adjusted Multivariate Logistic Regression Analysis on the Effect of Perioperative Hyperglycemia (>180 mg/dL at Any Point on the Day of Surgery, Postoperative Day 1, or Postoperative Day 2) on Outcomes Presented as Odds Ratio and 95% Confidence Intervals (Within Parenthesis)

	Composite Infections (n = 491)	Deaths (n = 48)	Reoperative Interventions (n = 257)	Anastomotic Failures (n = 43)	Myocardial Infarctions (n = 13)
Hyperglycemia	2.0 (1.63–2.44)	2.71 (1.72–4.28)	1.8 (1.41–2.3)	2.43 (1.38–4.28)	1.15 (0.43–3.1)

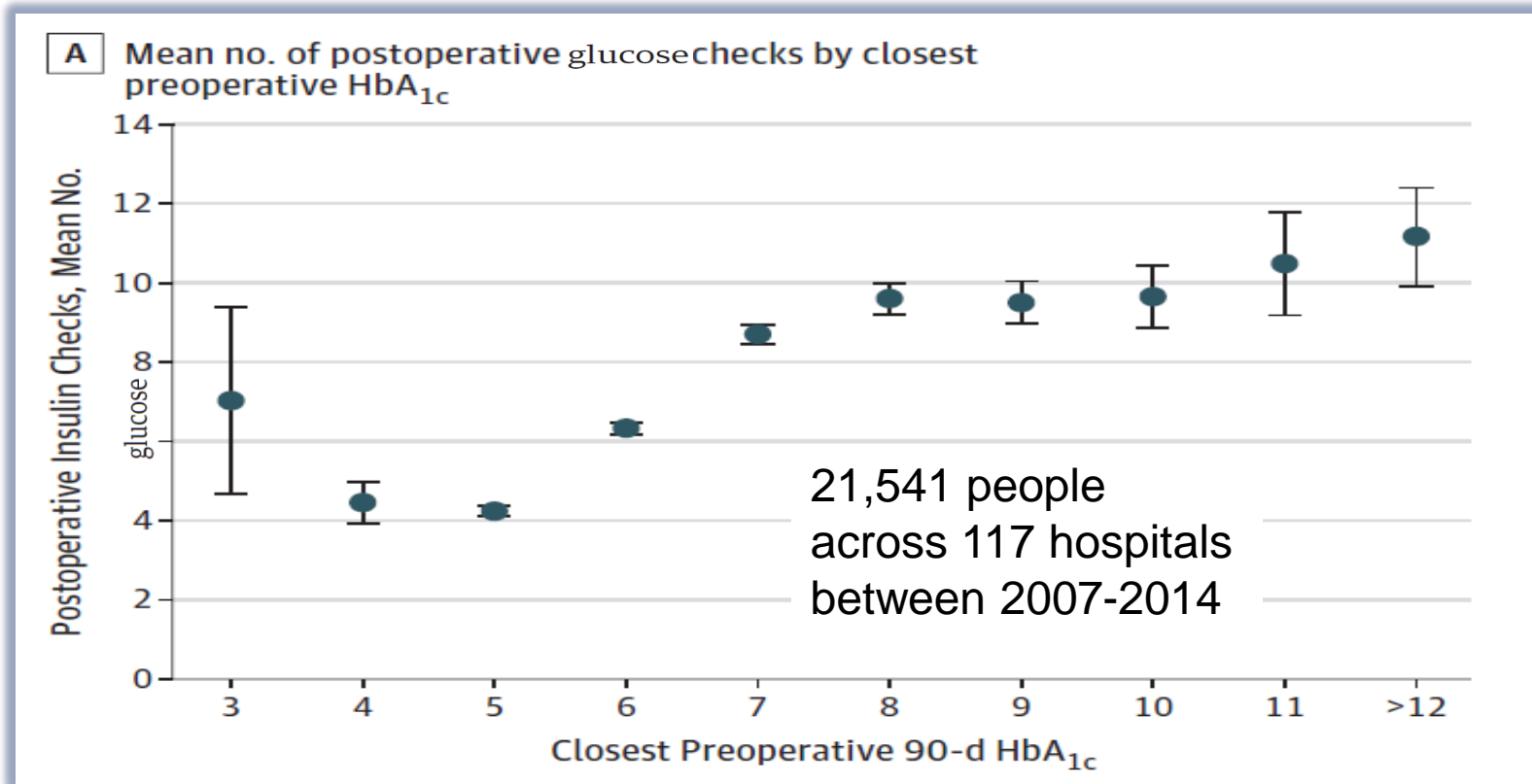
High glucose levels were associated with poor outcomes

## Diabetes<sup>§</sup>

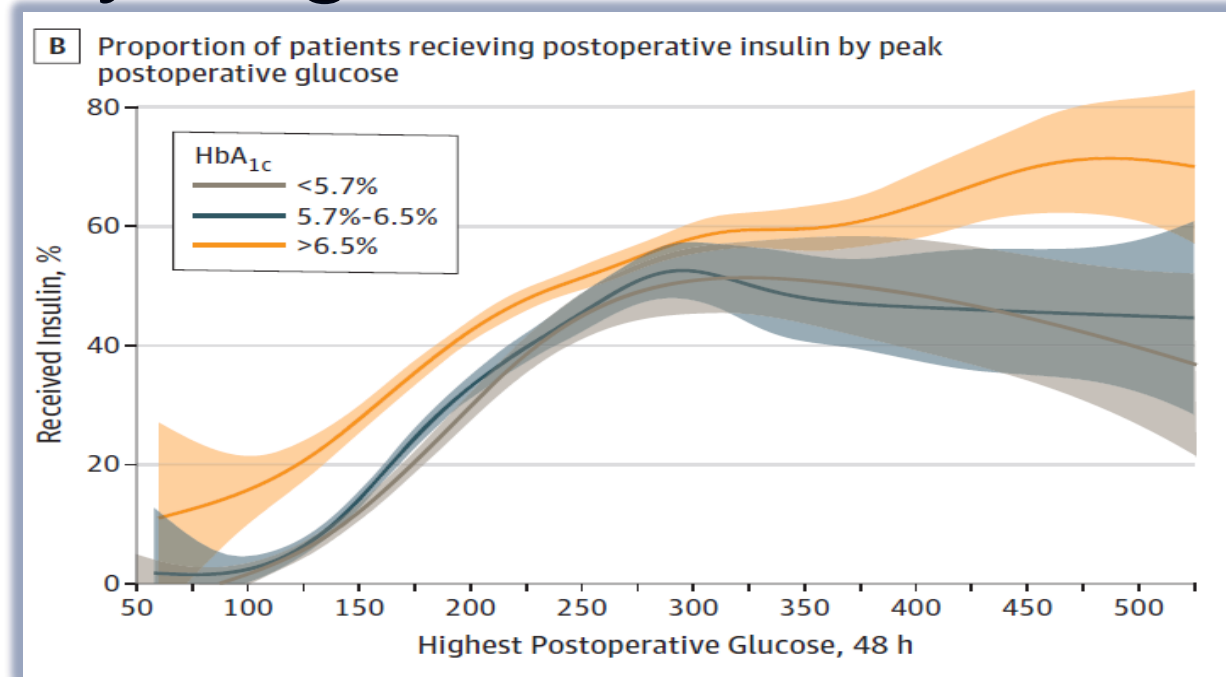
Noninsulin-dependent	0.51 (0.37–0.69)	0.48 (0.25–0.93)	0.63 (0.44–0.9)	0.45 (0.21–0.99)	0.77 (0.15–4.08)
Insulin-dependent	0.52 (0.35–0.76)	0.78 (0.36–1.68)	0.54 (0.35–0.85)	0.49 (0.18–1.32)	1.66 (0.26–10.71)

But – **knowing** that someone had diabetes was protective (?increased vigilance)

# Probably



# The Highest Pre-op HbA1c Were Most Likely to go onto Insulin Post-op



# Confirmed Elsewhere

- 3217 people on a cardiac ITU

	All (n = 3217)	Non-DM (n = 1811)	DM (n = 1406)	P-value
Average BG checks/day, median (IQR)	6.0 (3.3, 12.0)	4.8 (3.0, 9.9)	7.7 (5.0, 16.0)	<0.01

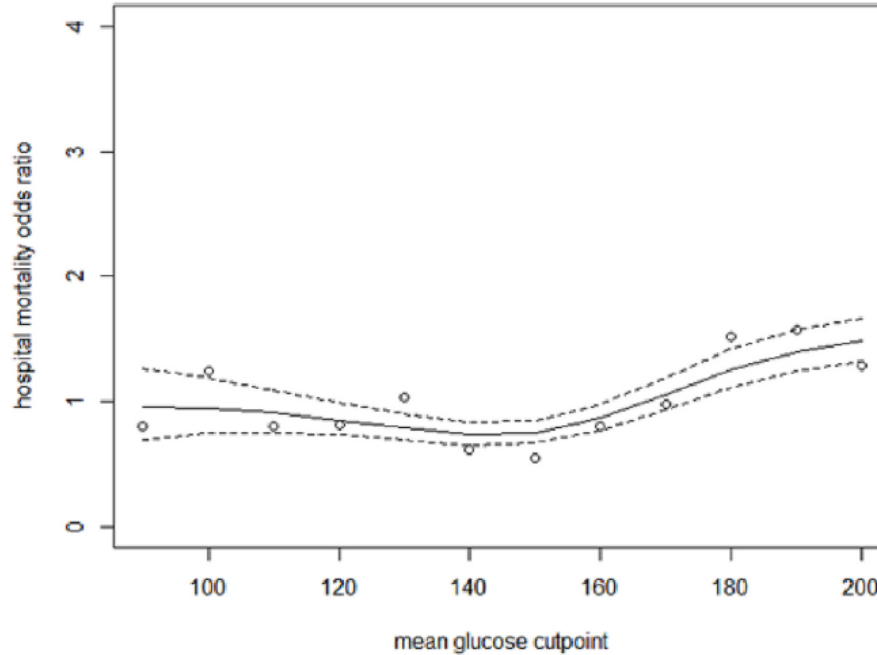
Baseline demographics for average blood glucose quartiles patients with diabetes.

	Q1 (BG 52–129) (n = 352)	Q2 (BG 129.1–159.8) (n = 351)	Q3 (BG 159.9–197.6) (n = 352)	Q4 (BG 197.7–969) (n = 351)	P-value
Average BG checks/day, median (IQR)	6.0 (3.6, 11.3)	7.0 (4.7, 16.9)	9.2 (6.0, 22.3)	8.6 (6.2, 13.9)	<0.01

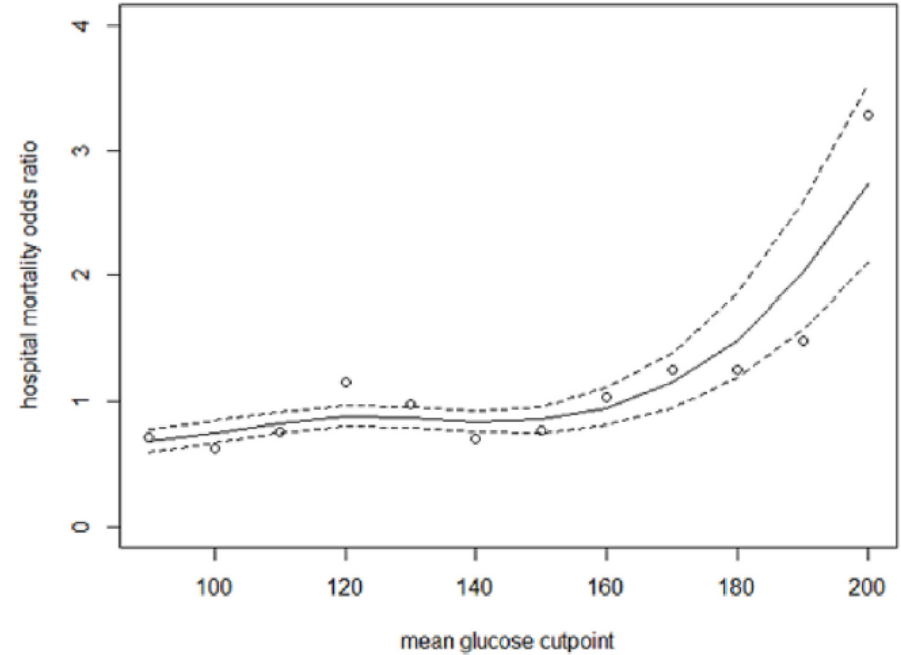
Baseline demographics for average blood glucose quartiles patients without diabetes.

	Q1 (BG 67.5–104.6) (n = 453)	Q2 (BG 104.7–116.2) (n = 453)	Q3 (BG 116.3–132.4) (n = 452)	Q4 (BG 132.5–415.5) (n = 453)	P-value
Average BG checks/day, median (IQR)	3.1 (2.0, 6.3)	4.2 (2.7, 8.3)	5.1 (3.0, 11.9)	6.9 (3.9, 16.0)	<0.01

# Mortality

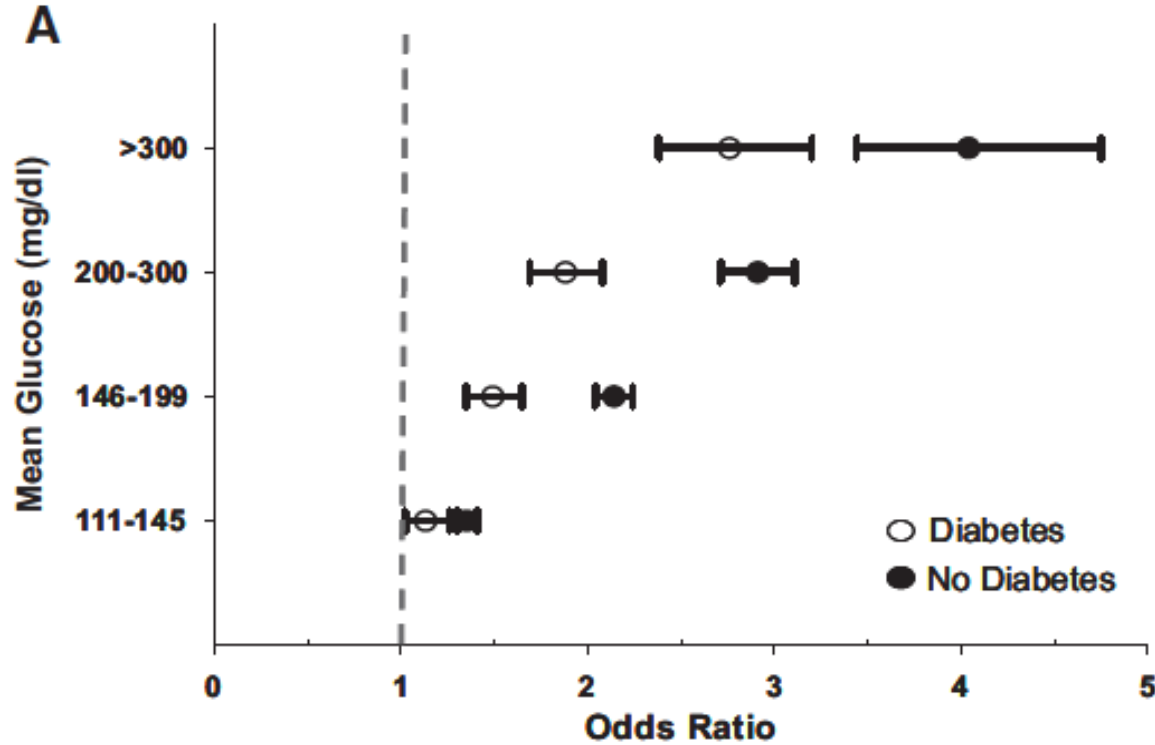


With diabetes



Without diabetes

# ITU





# There is a Trend Emerging

- Those who had **not been identified as having diabetes** or those who developed post-operative hyperglycaemia had the worst outcomes
- It's all about what happens before they get to theatre

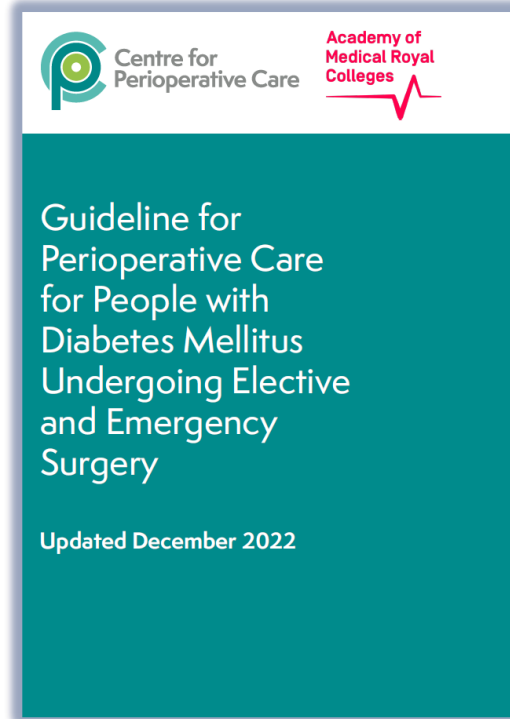
# Barriers to Post-Op Glycaemic Control

- Knowledge of glycaemic targets
- Belief about consequences of hyper / hypoglycaemia
- Available resources
- Adaptability of insulin regimens
- Skills to initiate insulin

# Disadvantages of HbA1c?

- It takes 3 months to reach a steady state – if things are more urgent, don't rely on it
- Use capillary / lab glucose values and try to ensure they remain between 6-10mmol/l in the peri-operative period
- Ideally by pharmacological manipulation of their existing medication, but otherwise using a VRIII (if they are NBM for >2 meals)

# Practical Advice?



# Non-Insulin Agents

Diabetes medication	Day prior to admission	Timing of surgery	
		Patient for am surgery	Patient for pm surgery
<b>Acarbose</b>	Take as normal	Omit morning dose if not eating	Give morning dose if eating
<b>Meglitinide</b> (repaglinide or nateglinide)	Take as normal	Omit morning dose if not eating	Give morning dose if eating
<b>Metformin</b> (AND eGFR >60 ml/min/1.73m <sup>2</sup> OR procedure not requiring use of contrast media <sup>1,2</sup> )	Take as normal	If taken once or twice a day – take as normal If taken three times per day, omit lunchtime dose	If taken once or twice a day – take as normal If taken three times per day, do not take lunchtime dose
<b>Sulphonylurea</b> (eg glibenclamide, gliclazide, glipizide, glimiperide)	Take as normal	Omit on morning of surgery If taken twice daily, take evening dose if eating	Do not take on day of surgery
<b>Pioglitazone</b>	Take as normal	Take as normal	Take as normal
<b>DPP4 inhibitor</b> (eg sitagliptin, vildagliptin, saxagliptin, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal
<b>GLP-1 Receptor Agonist</b> (eg exenatide, liraglutide, lixisenatide, dulaglutide, semaglutide) Daily/Weekly administration	Take as normal	Take as normal	Take as normal
<b>SGLT-2 inhibitors</b> (eg dapagliflozin, canagliflozin, empagliflozin, ertugliflozin)	Omit on day before surgery	Omit on day of surgery	Omit on day of surgery

# Insulin

	Insulins	Example medications	Day prior to admission	Patient for am surgery	Patient for pm surgery
Long acting insulin	Once daily long acting (morning)	Abasaglar® Humulin I® Insulatard® Insuman Basal® Lantus® Levemir® Semglee® Tresiba® Toujeo® Xultophy®	No dose adjustment necessary	Give 80% of dose and blood glucose to be checked on admission	Give 80% of dose and blood glucose to be checked on admission
	Once daily long acting (lunchtime)	As above	Give 80% of dose	Restart insulin at normal dose when eating and drinking starts	Restart insulin at normal dose when eating and drinking starts
	Once daily long acting (evening)	As above	Give 80% of dose	No dose adjustment necessary	No dose adjustment necessary
	Twice daily (long acting insulin)	As above	Morning dose will need to stay the same evening dose will need to be 80%	Morning dose will need to be 80% and blood glucose to be checked on admission  The evening dose will remain unchanged	Morning dose will need to be 80% and blood glucose to be checked on admission  The evening dose will remain unchanged

# Insulin

	Insulins	Example medications	Day prior to admission	Patient for am surgery	Patient for pm surgery
Premixed insulin prepared by manufacturers	Twice daily (premixed insulin)	Humulin M3 <sup>®</sup> Humalog Mix 25 <sup>®</sup> Humalog Mix 50 <sup>®</sup> Hypurin Porcine 30/70 Mix <sup>®</sup> ) Insuman Comb 15 <sup>®</sup> Insuman Comb 25 <sup>®</sup> Insuman Comb 50 <sup>®</sup> Novomix 30 <sup>®</sup>	No dose adjustment necessary	Halve usual morning dose. Blood glucose to be checked on admission Resume usual insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin	Halve usual morning dose. Blood glucose to be checked on admission Resume usual insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin
	Three times per day (premixed insulin)	As above	No dose adjustment necessary	Halve usual morning dose. Blood glucose to be checked on admission  Omit lunchtime dose  Resume normal insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin	Halve usual morning dose. Blood glucose will be checked on admission  Omit lunchtime dose  Resume normal insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin

# Insulin

	Insulins	Example medications	Day prior to admission	Patient for am surgery	Patient for pm surgery
Self-mixed insulin prepared by patient/carer	Twice daily (two different types of insulin combined by the person with diabetes into one injection)	Short acting: Actrapid® Apidra® Fiasp® Humalog® Humulin S® Hypurin® Porcine Neutral Insuman Rapid® Lyumjev® NovoRapid® AND intermediate acting: Humulin I® Hypurin® Porcine Isophane Insulatard®	No dose adjustment necessary	Calculate the total dose of both morning insulins and give half of this total dose as intermediate acting insulin only, in the morning  Blood glucose to be checked on admission  Resume usual insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin	Calculate the total dose of both morning insulins and give half of this total dose as intermediate acting insulin only, in the morning  Blood glucose to be checked on admission  Resume usual insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin



# Insulin

	Insulins	Example medications	Day prior to admission	Patient for am surgery	Patient for pm surgery
Short acting insulin	Short acting insulin with meals (two to four doses a day)	Actrapid Apidra® Fiasp® Humalog® Humulin S® Hypurin® Porcine Neutral Insuman Rapid® Lyumjev® NovoRapid®	No dose adjustment necessary	Omit morning dose if no breakfast is eaten Blood glucose to be checked on admission  Omit lunchtime dose if not eating and drinking normally  Resume normal insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin	Take your usual morning insulin dose with your breakfast  Omit lunchtime dose if not eating Blood glucose to be checked on admission  Resume normal insulin with evening meal if eating a normal meal. If eating a half/small meal give half usual dose. If not eating give basal only component of the usual mixed insulin
Resume taking usual insulin the morning after surgery (procedure). However, blood glucose levels may be higher than usual for a day or so.					
Variable rate intravenous insulin infusions	Dose of long-acting insulin should be 80%  Short acting, Intermediate and Pre-mixed Insulins should be discontinued and replaced by a long-acting basal insulin at a dose of 0.2 units per kilogram  A return to the person's usual diabetes management should be made once they are eating and drinking normally. Adjustments may need to be made to insulin dose(s) as insulin requirements may change in the postoperative period – blood glucose levels should be monitored and advice sought from the specialist diabetes team if necessary				

# In Summary

- Diabetes and hyperglycaemia in people undergoing surgery is common
- Hyperglycaemia is associated with harm
- There are many practical guidelines available
- There is emerging evidence of benefit, try to aim for glucose concentrations of 6.0-10.0mmol/l (108-180mg/dl) where it is safe to do so



# Peri-operative Management of Poorly Controlled Diabetes and the Limitations of HbA<sub>1c</sub>

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