University of East Anglia

Norfolk and Norwich University Hospitals NHS
NHS Foundation Trust

Peri-operative Diabetes Control

JBDS-IP Joint British Diabetes Societies for Inpatient Care

Association of British Clinical Diabetologists

Endotext

Case 1

- 72-year-old man with a 12 year history of type 2 diabetes
- Presented with an acute abdomen to A&E

Medications

- Metformin 500mg bd
- Dapagliflozin 10mg od
- Sitagliptin 100mg od
- Ramipril 5mg bd
- Atorvastatin 40mg od

Investigations

- WBC 17.5 x 10^4
- CRP 245 mg/L
- eGFR 18 mL/min/1.73m^2
- Erect CXR – air under the diaphragm

- Last HbA1c done 8 months prior was 79mmol/mol

What action do you take?

Case 2

- 72-year-old man with a 12-year history of type 2 diabetes
- Presented with a 3-year history of an intermittent inguinal hernia
- See by the surgeon who lists him for an elective procedure

Medications

- Metformin 500mg bd
- Dapagliflozin 10mg od
- Sitagliptin 100mg od
- Ramipril 5mg bd
- Atorvastatin 40mg od

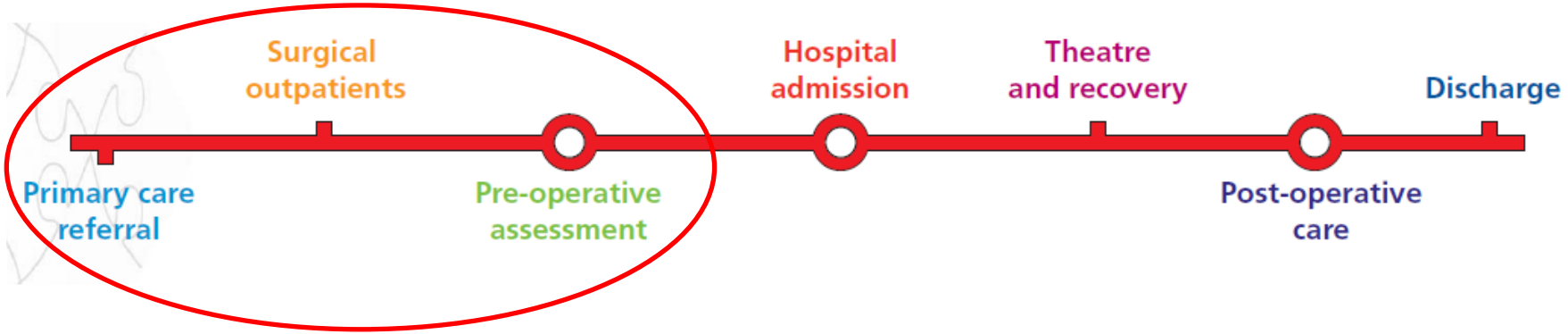
Investigations

- WBC 8.5 x 10^4
- CRP 15 mg/L
- eGFR 58 mL/min/1.73m^2

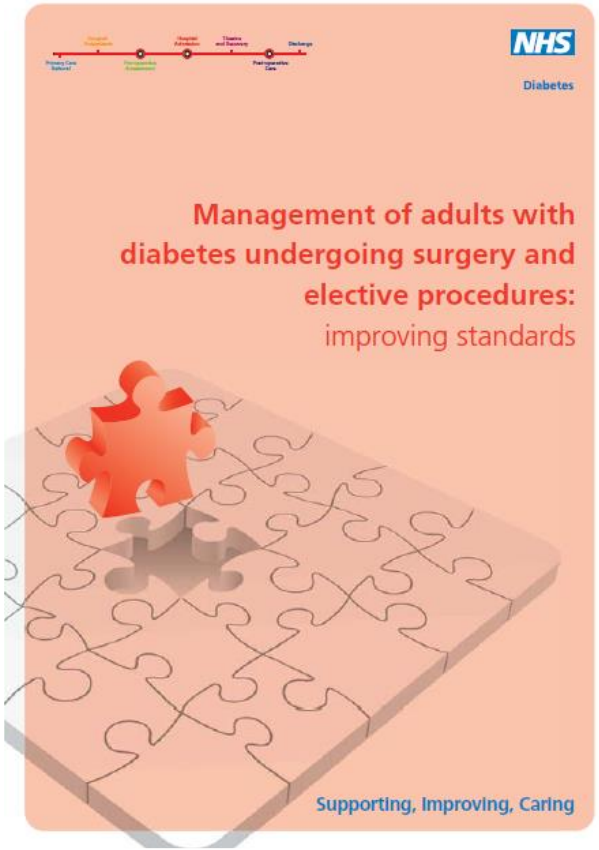
- Last HbA1c done 8 months prior was 79mmol/mol

What action do you take?

The Patient Journey

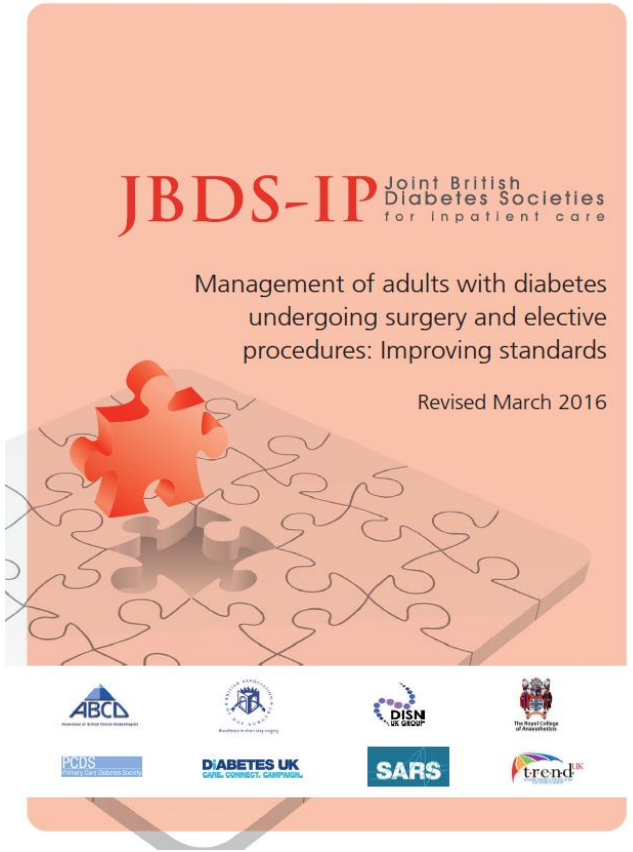


Guidance

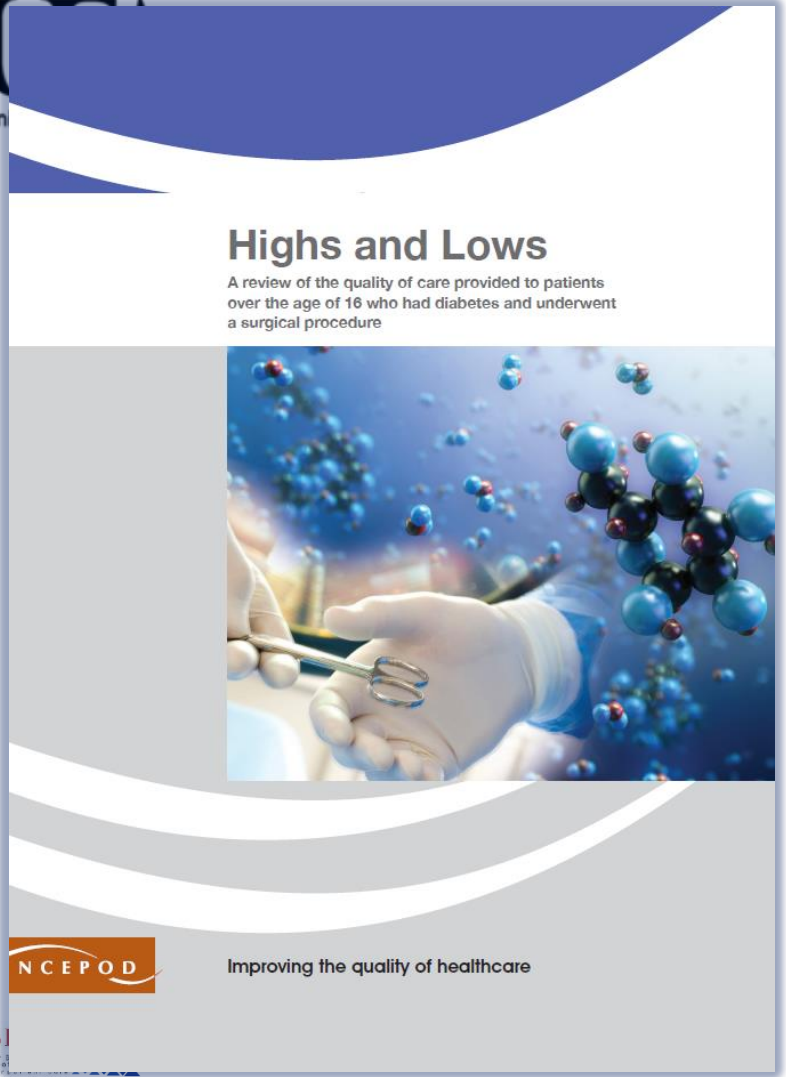


In 2011 Along Came This.....

Revised in 2016.....



https://abcd.care/sites/abcd.care/files/resources/Surgical_guidelines_2015_full_FINAL_amended_Mar_2016.pdf



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

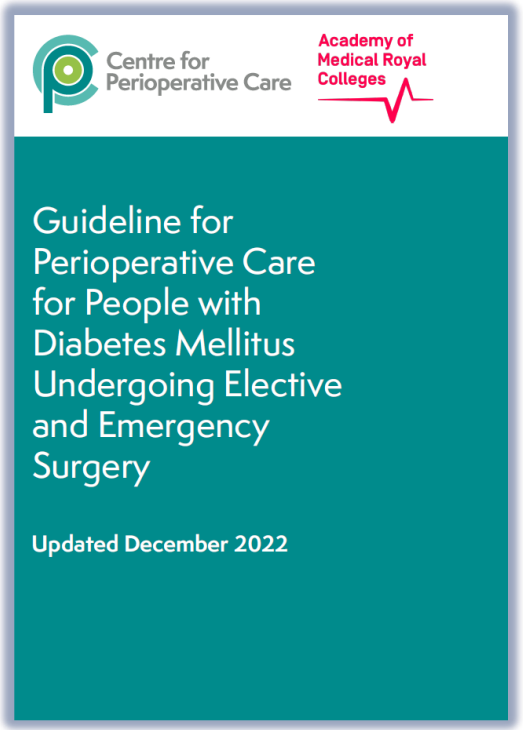
https://www.ncepod.org.uk/2018pd.html

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

https://www.ncepod.org.uk/2018pd.html

Updated in December 2022



https://cpoc.org.uk/sites/cpoc/files/documents/2022-12/CPOC-Diabetes-Guideline-Updated2022.pdf


Surgical outpatients
Hospital admission
Theatre and recovery
Discharge
Primary care referral
Pre-operative assessment
Post-operative care

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_{1c}
  - eGFR

https://abcd.care/sites/abcd.care/files/resources/Surgical_guidelines_2015_full_FINAL_amended_Mar_2016.pdf

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?

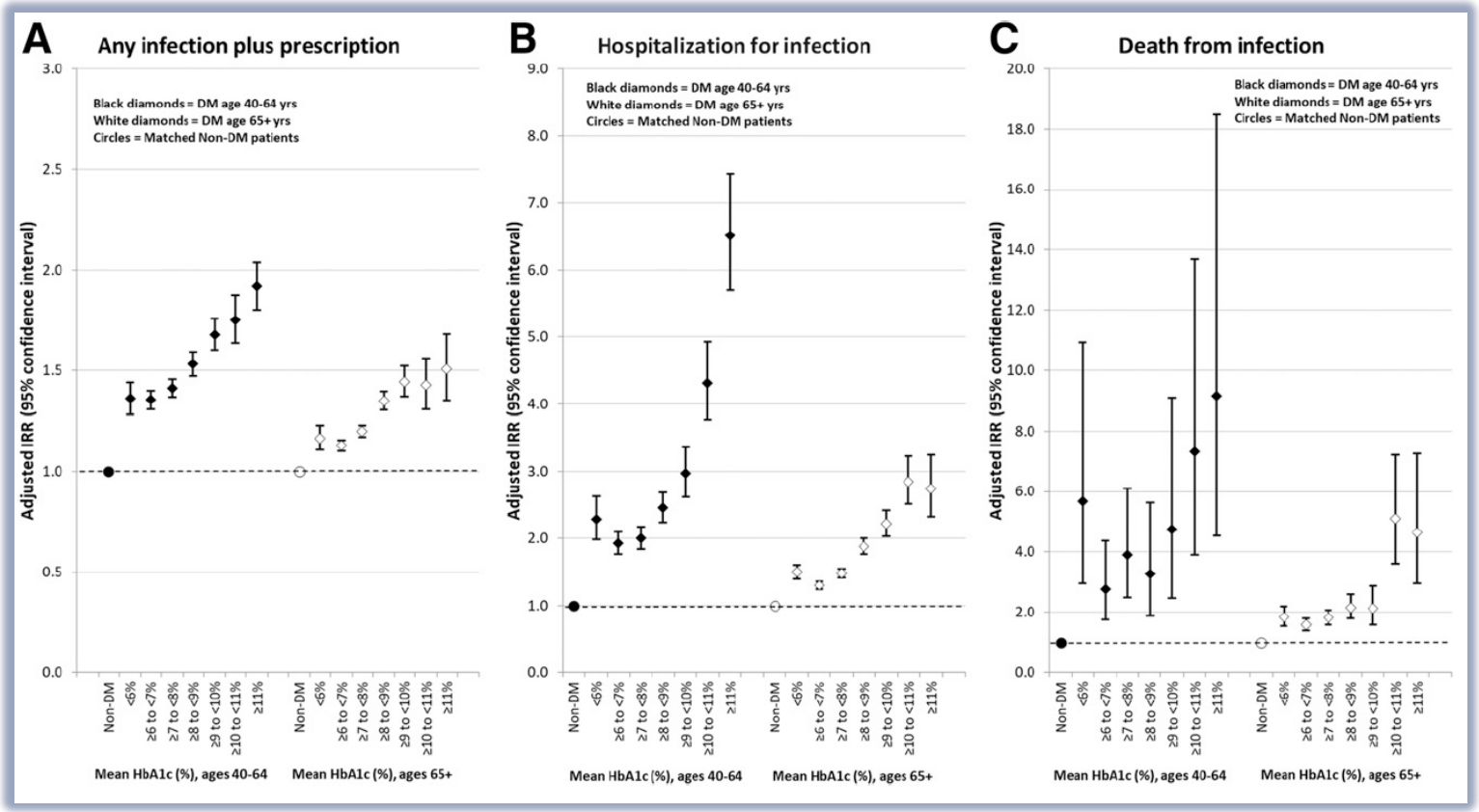
- Why not use those times to optimise their diabetes?

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
  - hernia
  - foot and ankle
  - neurosurgery
  - transplant
  - HBP
  - cholecystectomy
  - cardiac
  - burns

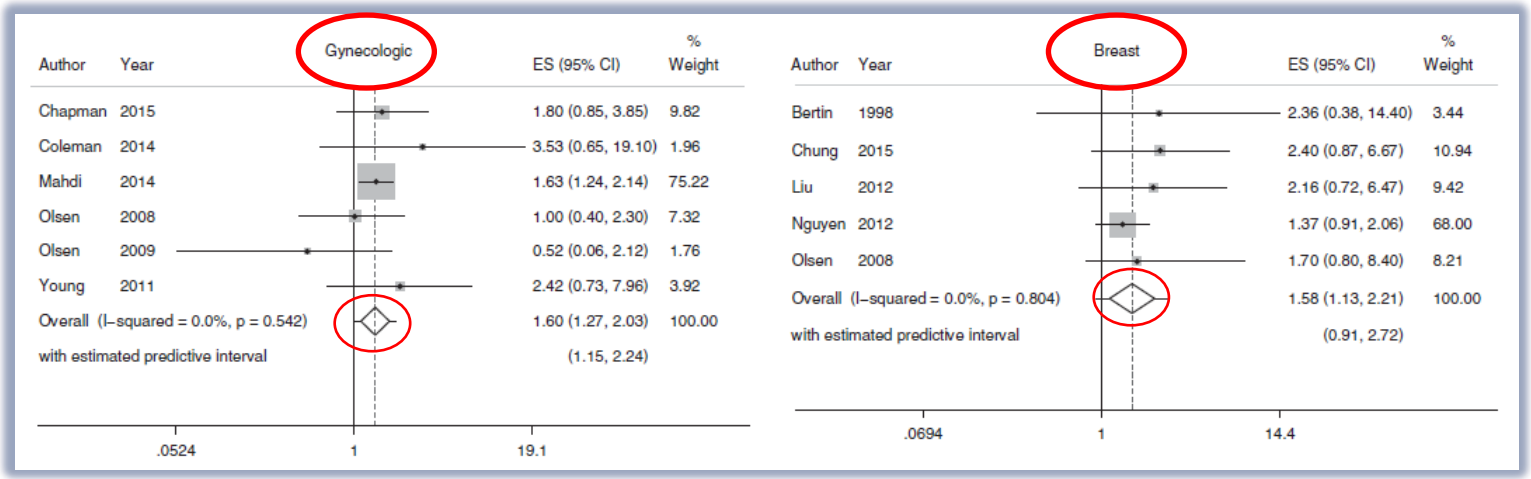
Walid MS et al J Hosp Med 2010;5:E10-E14
O'Sullivan CJ et al Euro J of Vasc Endovasc Surg 2006;32:188-197
Gustafsson UO et al Brit J Surg 2009;96:1358-1364
Halkos ME et al Ann of Thorac Surg 2008;86:1431-1437
Kreutziger J et al J Trauma 2009;67(4):704-8
Vilar-Compte et al Am J Infect Control 2008;36(3):192-198
Park C et al Transplantation 2009;87(7):1031-1036
Ambiru S et al J Hosp Infect 2008;68(3):230-233
Chuang SC et al J Formos Med Ass 2004;103(8):607-612
Shibuya N et al J Foot Ankle Surg 2013;52(2):207-211
Sadoskas D et al Foot Ankle Spec 2016;9(1):24-30
Domek N et al J Foot Ank Surg 2016;55(5):939-943
Jehan F et al J Trauma Acute Care Surg 2018;84(1):112-117
Younger AS et al Foot Ank Surg 2009;30(12):1177-1182
Dolp R et al Crit Care 2019;23(1):28
Cha J-J et Cardiovasc Diabetol 2020;19:97
Shapey IM et al Diab Obes Metab 2021;23(1):49-57
Shanahan J et al JAMA Network Open 2023;6(3):e236318

Infections



Critchley JA et al Diabetes Care 2018;41(10):2127-2135

Glucose and SSI – A Variety of Specialities



Martin ET et al Infect Control Hosp Epidemiol 2016;37(1):88-99

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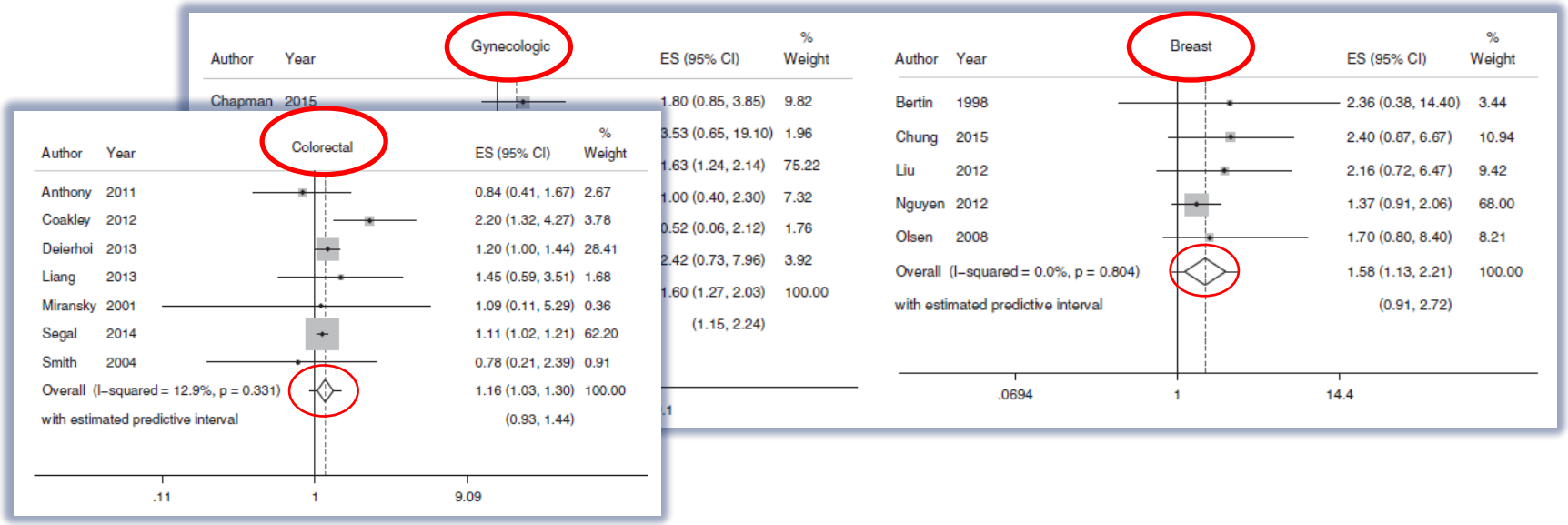

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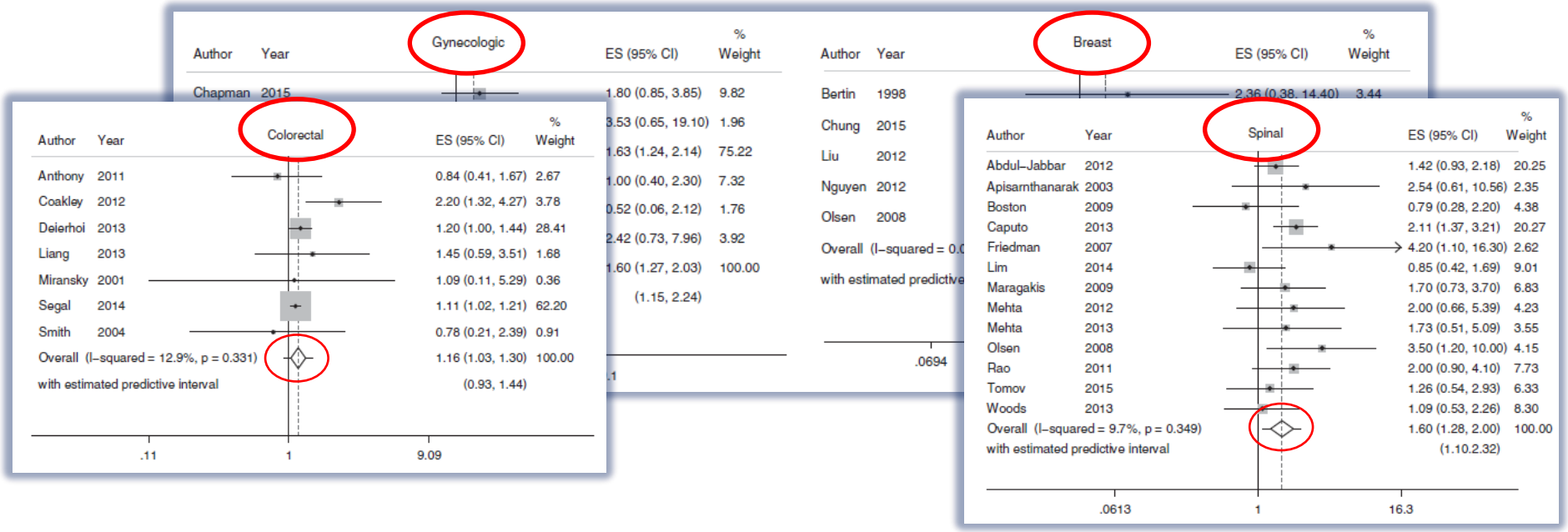

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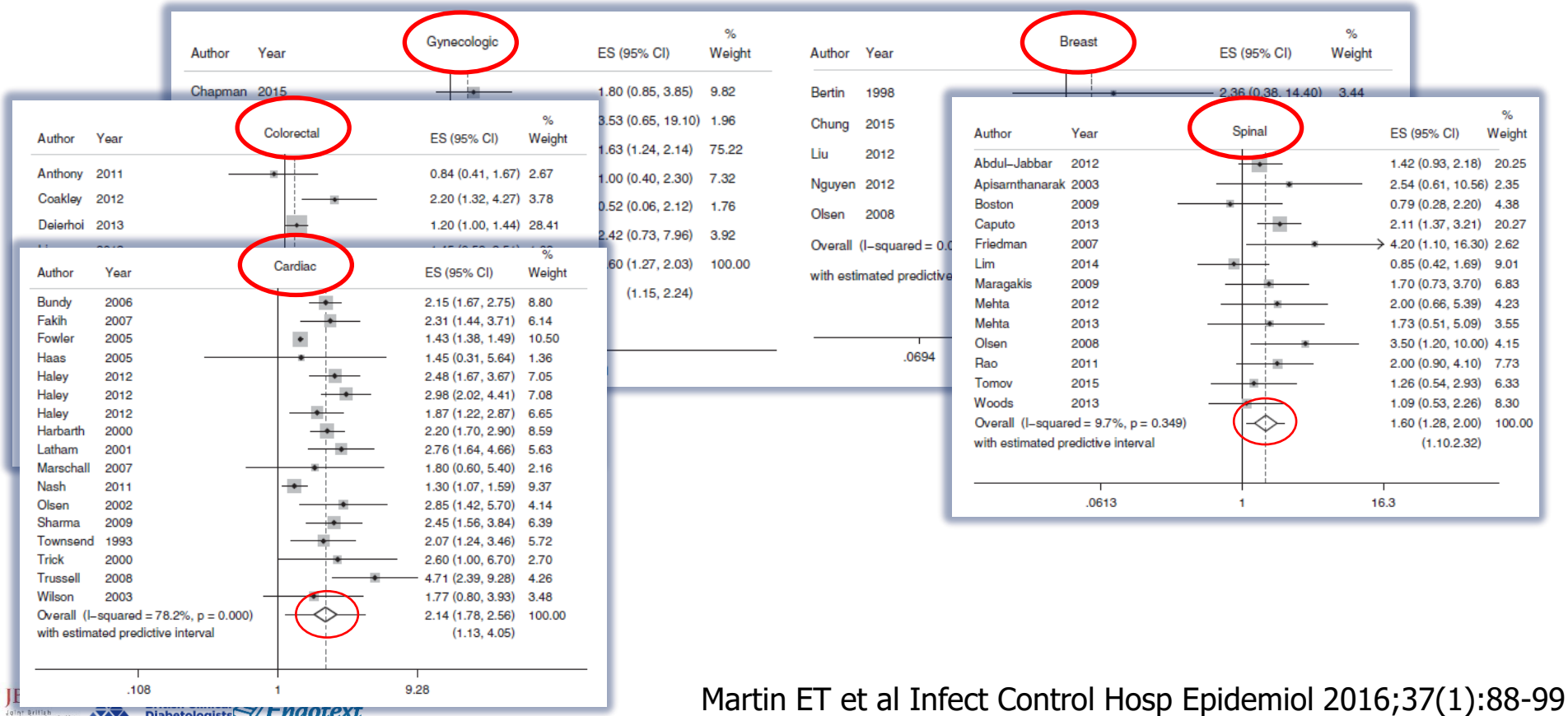

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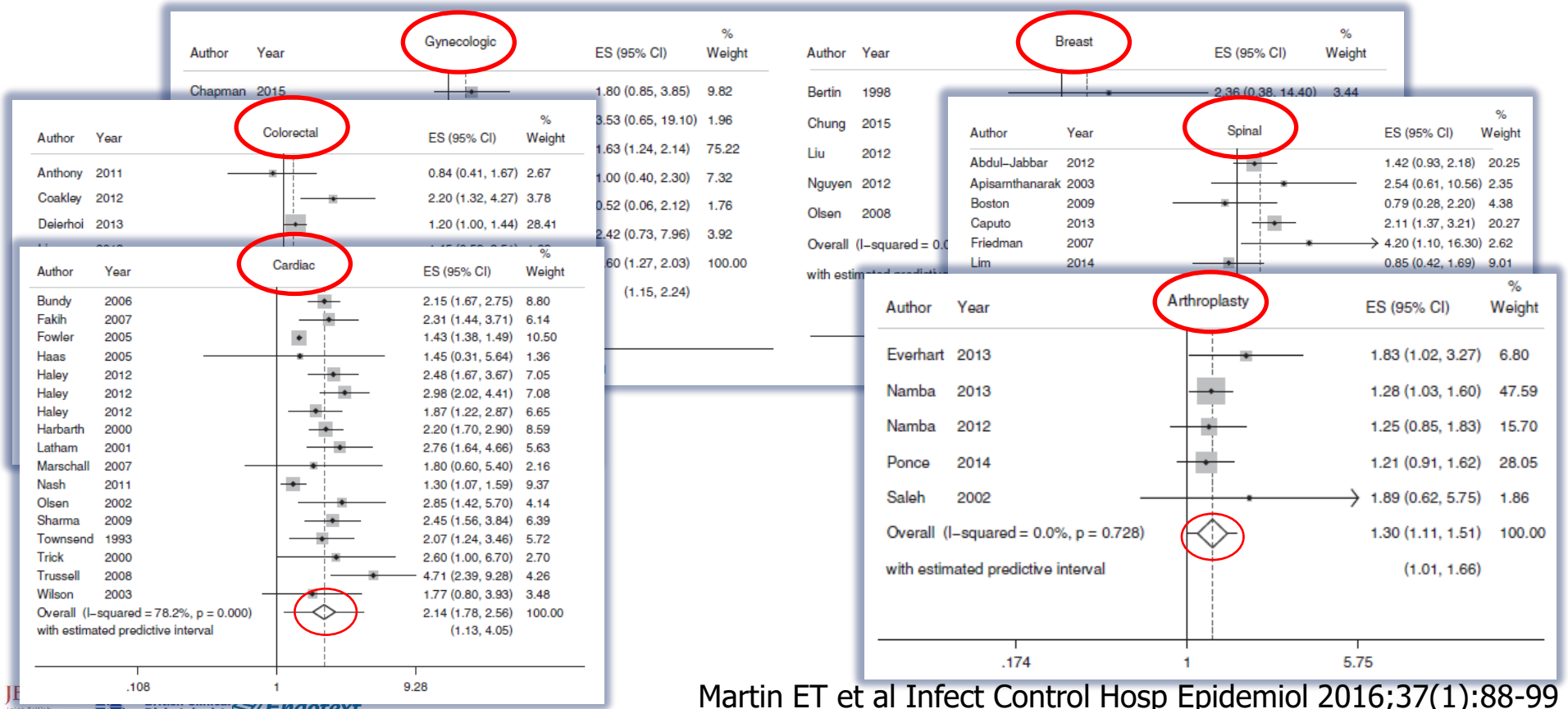

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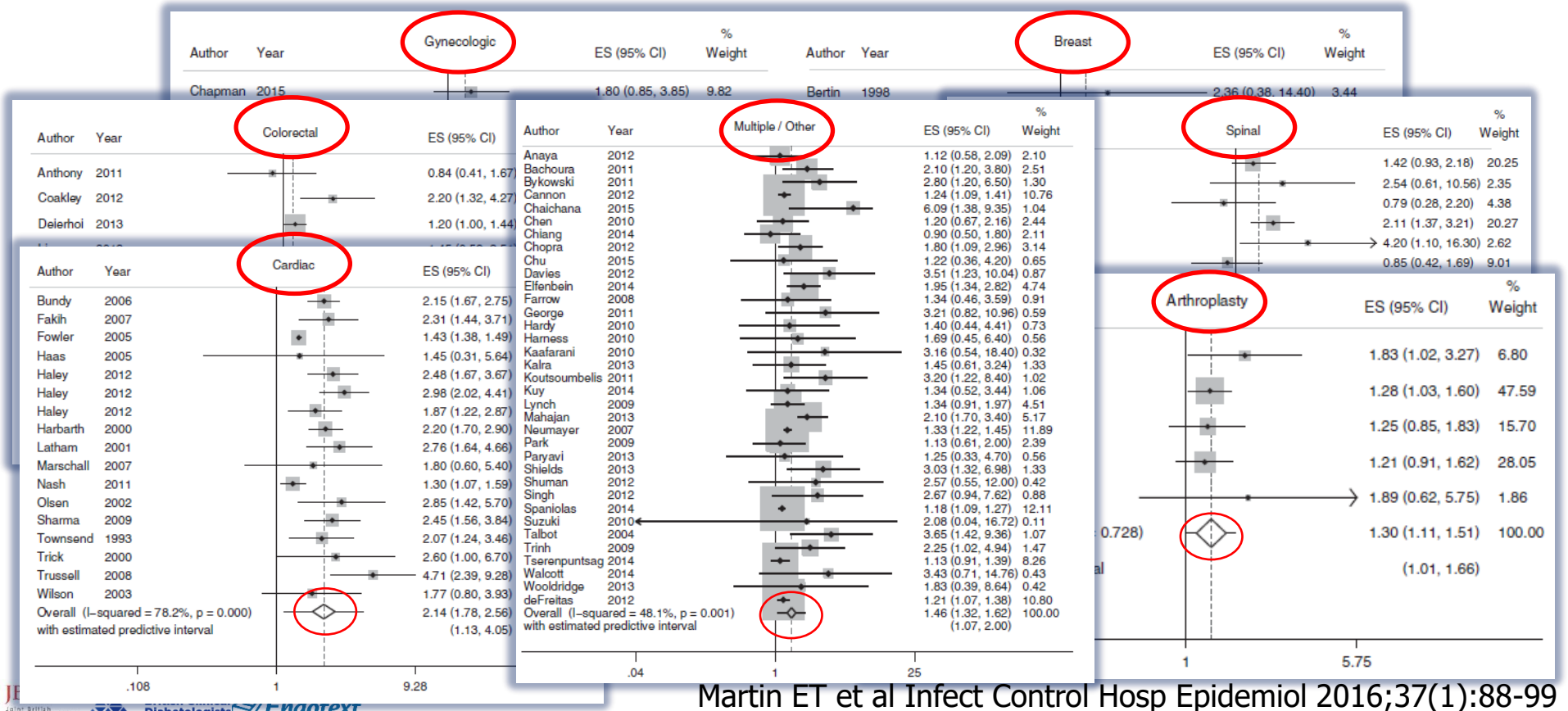


Martin ET et al Infect Control Hosp Epidemiol 2016;37(1):88-99

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

Kwon S et al Ann Surgery 2013;257(1):8-14

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)

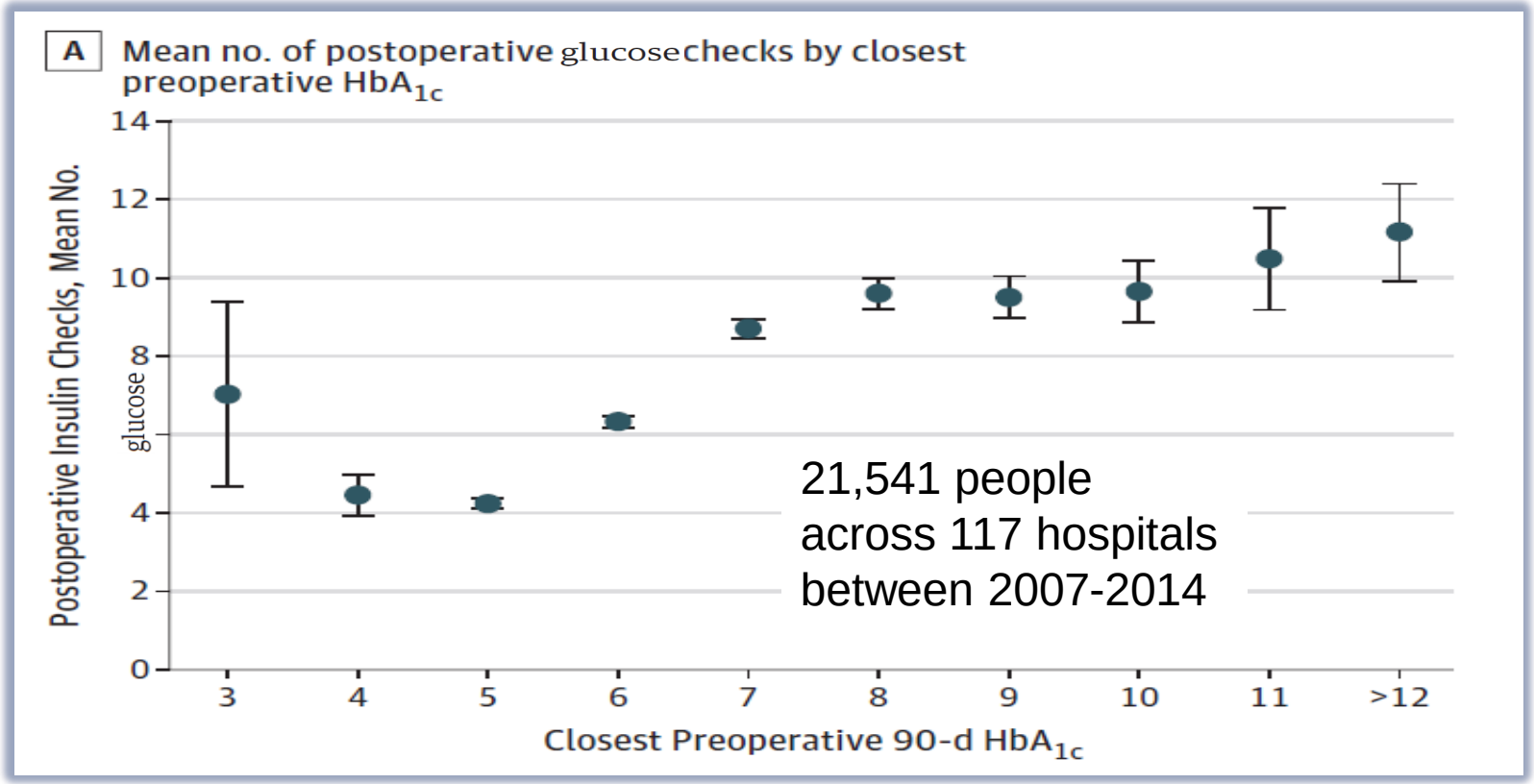
High glucose levels were associated with poor outcomes

Diabetes[§]					
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)

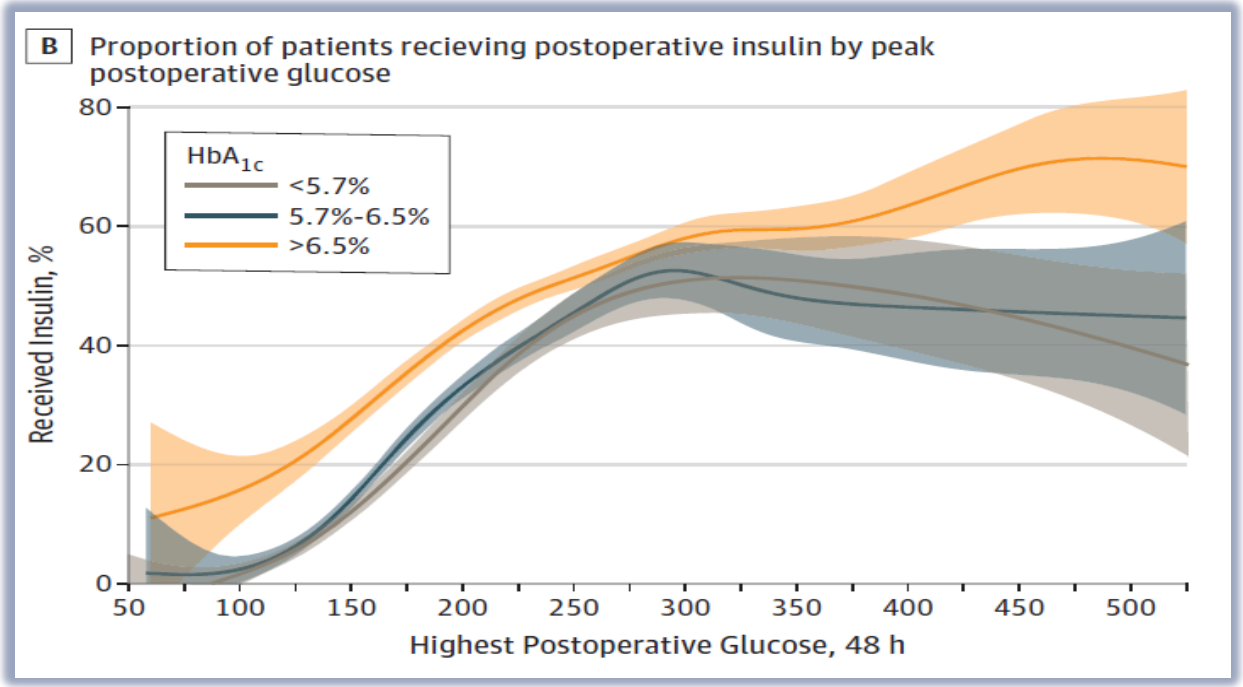
Kwon S et al Ann Surgery 2013;257(1):8-14

Probably



Jones CE et al JAMA Surg 2017;152(11):1031-1038

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



Jones CE et al JAMA Surg 2017;152(11):1031-1038

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.

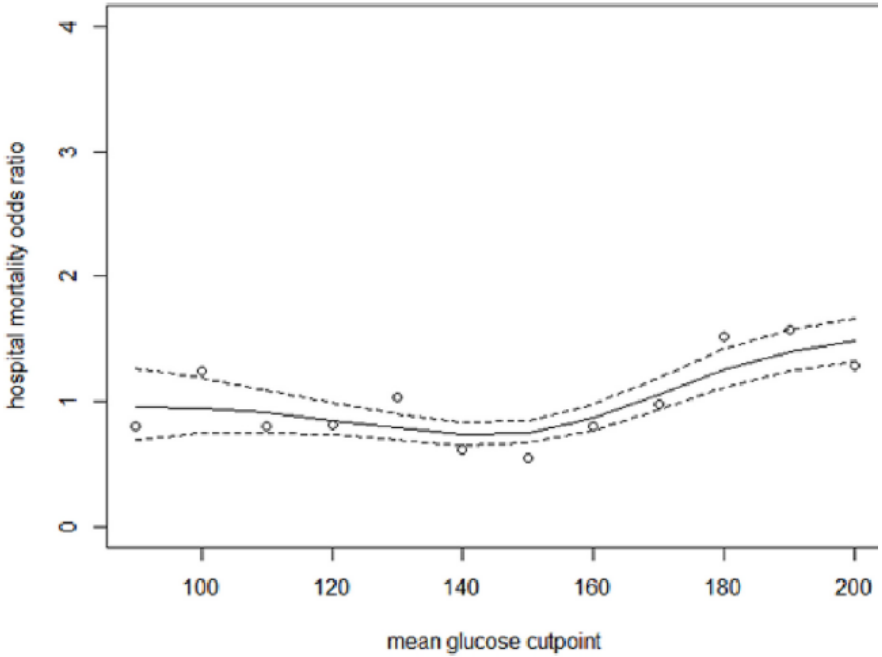
	Q1 (BG 52–129) (n = 352)	Q2 (BG 129.1–159.8) (n = 351)	Q3 (BG 159.9–197.6) (n = 352)	Q4 (BG 197.7–969) (n = 351)	P-value
Average BG checks/day, median (IQR)	6.0 (3.6, 11.3)	7.0 (4.7, 16.9)	9.2 (6.0, 22.3)	8.6 (6.2, 13.9)	<0.01

Baseline demographics for average blood glucose quartiles patients without diabetes.

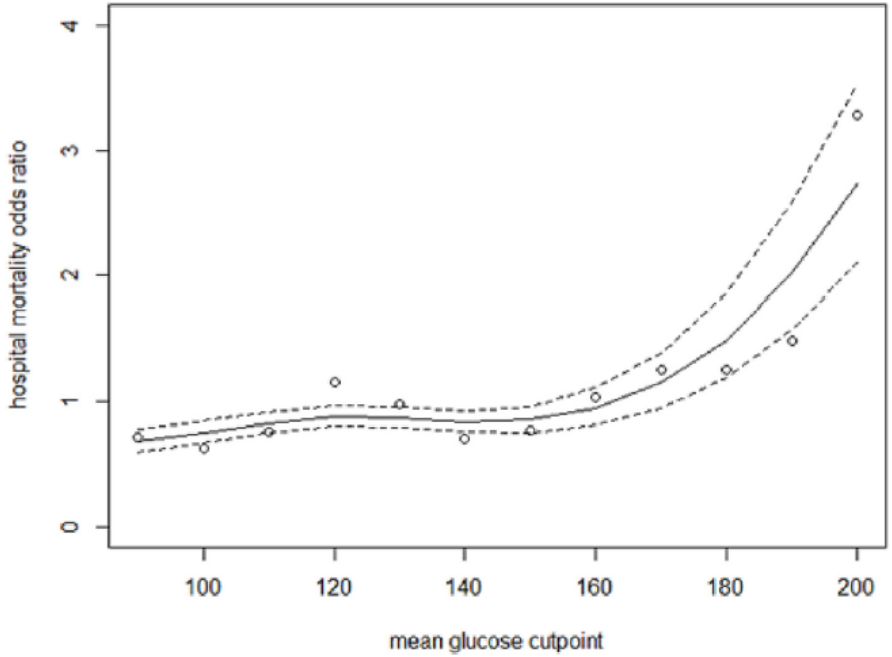
	Q1 (BG 67.5–104.6) (n = 453)	Q2 (BG 104.7–116.2) (n = 453)	Q3 (BG 116.3–132.4) (n = 452)	Q4 (BG 132.5–415.5) (n = 453)	P-value
Average BG checks/day, median (IQR)	3.1 (2.0, 6.3)	4.2 (2.7, 8.3)	5.1 (3.0, 11.9)	6.9 (3.9, 16.0)	<0.01

Adie SK et al J Diab Complications 2023;37(4):108453

Mortality



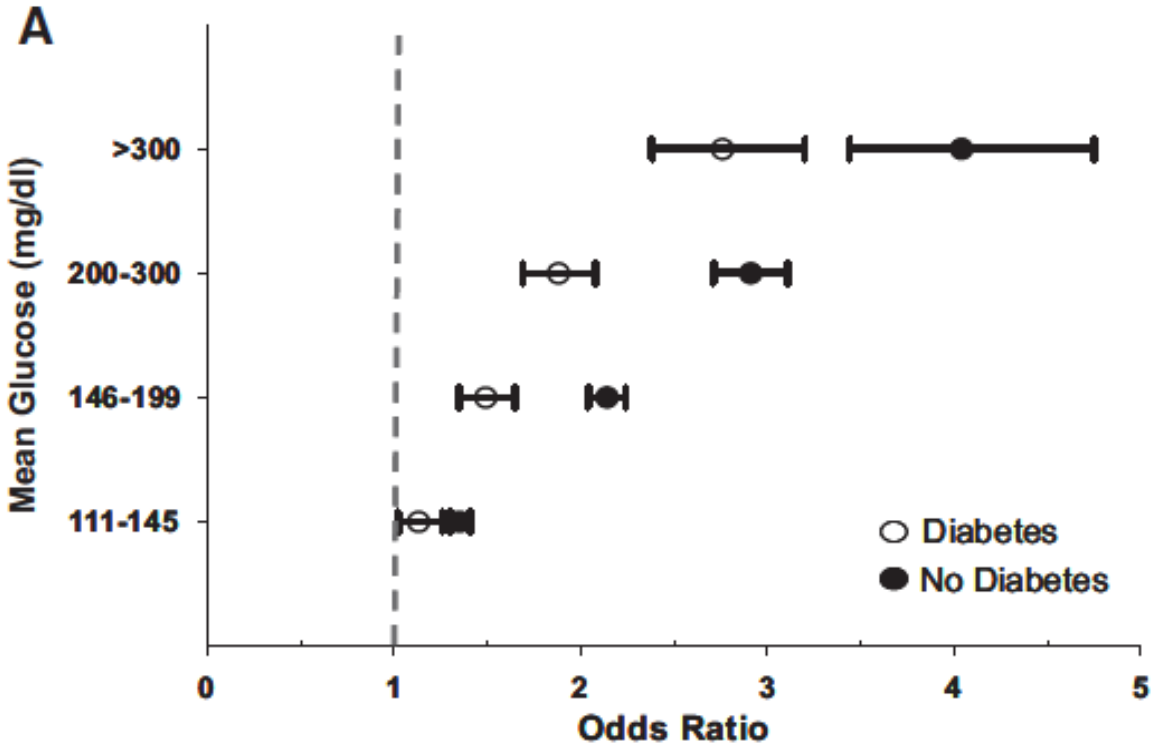
With diabetes



Without diabetes

Adie SK et al J Diab Complications 2023;37(4):108453

ITU



Falciglia M et al Crit Care Med 2009;37(12):3001-3009

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

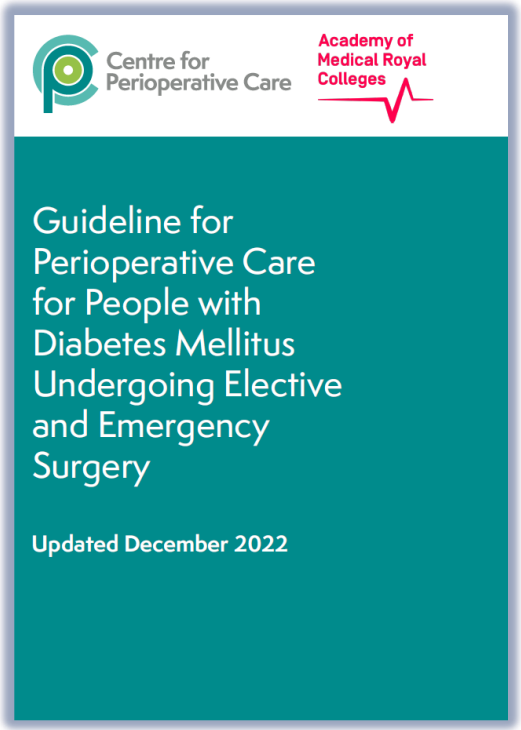
- Knowledge of glycaemic targets
- Belief about consequences of hyper / hypoglycaemia
- Available resources
- Adaptability of insulin regimens
- Skills to initiate insulin

Flemons K et al Can J Diab 2023;47(7):560-565

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?



https://cpoc.org.uk/sites/cpoc/files/documents/2022-12/CPOC-Diabetes-Guideline-Updated2022.pdf

Non-Insulin Agents

Diabetes medication	Day prior to admission	Timing of surgery	
		Patient for am surgery	Patient for pm surgery
Acarbose	Take as normal	Omit morning dose if not eating	Give morning dose if eating
Meglitinide (repaglinide or nateglinide)	Take as normal	Omit morning dose if not eating	Give morning dose if eating
Metformin (AND eGFR >60 ml/min/1.73m² OR procedure not requiring use of contrast media**)	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
Sulphonylurea (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
Pioglitazone	Take as normal	Take as normal	Take as normal
DPP4 inhibitor (eg sitagliptin, vildagliptin, saxagliptin, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal
GLP-1 Receptor Agonist (eg exenatide, liraglutide, lixisenatide, dulaglutide, semaglutide) Daily/Weekly administration	Take as normal	Take as normal	Take as normal
SGLT-2 inhibitors (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® Humalog Mix 25® Humalog Mix 50® Hypurin Porcine 30/70 Mix®) Insuman Comb 15® Insuman Comb 25® Insuman Comb 50® Novomix 30®	No dose adjustment necessary	Halve usual morning dose. Blood glucose to be checked on admission Resume usual l 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

https://cpoc.org.uk/sites/cpoc/files/documents/2022-12/CPOC-Diabetes-Guideline-Updated2022.pdf

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				

https://cpoc.org.uk/sites/cpoc/files/documents/2022-12/CPOC-Diabetes-Guideline-Updated2022.pdf

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

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