Norfolk and Norwich University Hospitals NHS
NHS Foundation Trust

Effect of Diabetes Care on Surgical Outcomes

or Peri-operative Glucose Control - Is it Important?

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Norfolk and Norwich University Hospitals

Data from Public Health England

- People with diabetes are
  - Less likely to be offered day case surgery
  - More likely to have emergency surgery
  - Have a longer LOS following surgery
  - Have higher rates of 28-day readmissions following surgery

Variation in Inpatient Activity: Diabetes. http://www.yhpho.org.uk/resource/view.aspx?RID=105866

Last accessed 20th Sept 2015

Do Peri-Operative High Glucose Levels Cause Harm?

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

Walid MS et al J Hosp Med 2010;5:E10-E14
O'Sullivan CJ et al Europ 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
Chaung 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; DOI: 10.1177/1938640015593077

Excess Mean Length of Stay in Diabetes Inpatients Aged 18 – 60 Years

269,265 Diabetes Discharges and 4,411,593 Matched Controls

	Mean LOS (days)			Excess LOS (days)		n		
	E10	E11	C	E10	E11	E10	E11	C
Surg.	5.4 (0.1)	5.1 (0.1)	4.2 (0.2)	1.2	0.9	18,032	32,135	1,501,453
T &O	4.8 (0.1)	5.3 (0.2)	4.6 (0.1)	0.2	0.7	8,178	12,203	885,606
GM	4.8 (0.2)	5.4 (0.2)	4.4 (0.1)	0.4	1.0	70,988	82,446	1,709,553
Card.	4.2 (0.1)	4.2 (0.1)	3.8 (0.1)	0.4	0.4	5,307	15,009	229,784
MFE	4.8 (0.2)	5.6 (0.2)	4.7 (0.1)	0.1	0.1	2,444	4,549	85,197

E10 = Type 1 diabetes E11 = Type 2 diabetes c = controls

English Hospitals, 4 consecutive years of discharges 2000-2004

Sampson MJ et al Diabetes Research & Clinical Practice 2007;77(1):92-98

Norfolk and Norwich University Hospitals NHS
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All Surgical Admissions to NNUH January 2015 – November 2015

All Surgical admissions to NNUH excluding private patients											
Month of Discharge	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15
Total Number of Spells	4541	4492	4923	4574	4657	4999	5129	4725	4827	5130	4302
Total Length of Stay (Days)	7116	7583	8439	7483	7204	8379	8178	7618	7600	7887	7405
Average Length of Stay (Days)	1.6	1.7	1.7	1.6	1.5	1.7	1.6	1.6	1.6	1.5	1.7
Excluding 0 LOS											
Month of Discharge	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15
Total Number of Spells	1412	1518	1574	1526	1679	1721	1792	1746	1664	1804	1640
Total Length of Stay (Days)	7116	7583	8439	7483	7204	8379	8178	7618	7600	7887	7405
Average Length of Stay (Days)	5.0	5.0	5.4	4.9	4.3	4.9	4.6	4.4	4.6	4.4	4.5

All Surgical admissions to NNUH excluding private patients for diabetes patients											
Month of Discharge	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15
Total Number of Spells	528	513	570	475	486	548	549	506	561	476	394
Total Length of Stay (Days)	904	1270	1608	1086	1291	1356	1336	1246	1422	1094	1161
Average Length of Stay (Days)	1.7	2.5	2.8	2.3	2.7	2.5	2.4	2.5	2.5	2.3	2.9
Excluding 0 LOS											
Month of Discharge	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15
Total Number of Spells	144	175	194	154	179	183	180	177	182	152	171
Total Length of Stay (Days)	904	1270	1608	1086	1291	1356	1336	1246	1422	1094	1161
Average Length of Stay (Days)	6.3	7.3	8.3	7.1	7.2	7.4	7.4	7.0	7.8	7.2	6.8

It's worse than 15 years ago

*Diagnosis codes E10-E14 have been used to determine all types of diabetes

0.1	0.8	1.1	0.7	1.1	0.8	0.8	0.9	1.0	0.8	1.2	0.8
1.2	2.3	2.9	2.1	2.9	2.5	2.9	2.7	3.2	2.8	2.3	2.5

Day Case Avoidance

	Admissions for males with diabetes	Admissions per 1000 males with diabetes	Admissions per 1000 males without diabetes	Diabetes admissions/non-diabetes admissions	Excess admissions in diabetes
0-15	956	99	50	1.99	475
16-24	1,633	51	43	1.20	274
25-34	3,289	70	57	1.24	627
35-44	10,014	93	79	1.18	1,511
45-54	27,487	122	118	1.04	994
55-64	60,788	210	203	1.04	2,148
65-74	87,207	241	355	0.68	-41,187
75+	77,832	328	413	0.79	-20,344
All male	269,206	205	123	0.82 (age adjusted)	-55,501

	Admissions for females with diabetes	Admissions per 1000 females with diabetes	Admissions per 1000 females without diabetes	Diabetes admissions/non-diabetes admissions	Excess admissions in diabetes
0-15	975	106	40	2.63	604
16-24	1,986	58	62	0.94	-136
25-34	3,708	79	91	0.87	-567
35-44	10,390	190	118	1.61	3,942
45-54	23,708	172	160	1.08	1,736
55-64	42,589	202	207	0.97	-1,184
65-74	61,743	233	288	0.81	-14,657
75+	62,924	213	279	0.76	-19,748
All female	208,023	197	137	0.87 (age adjusted)	-30,011
Total (male and female)	477,229	202	130	0.85 (age-adjusted)	-85,512

Men

In 2009-10, 85,512 people with diabetes were denied day case surgery. If 1 bed day costs £300, then this equates to £25.6m

Women

Kerr M, *'Inpatient Care for People with Diabetes: the Economic Case for Change'*. NHS Diabetes 2012

Day Case Surgery at NNUH

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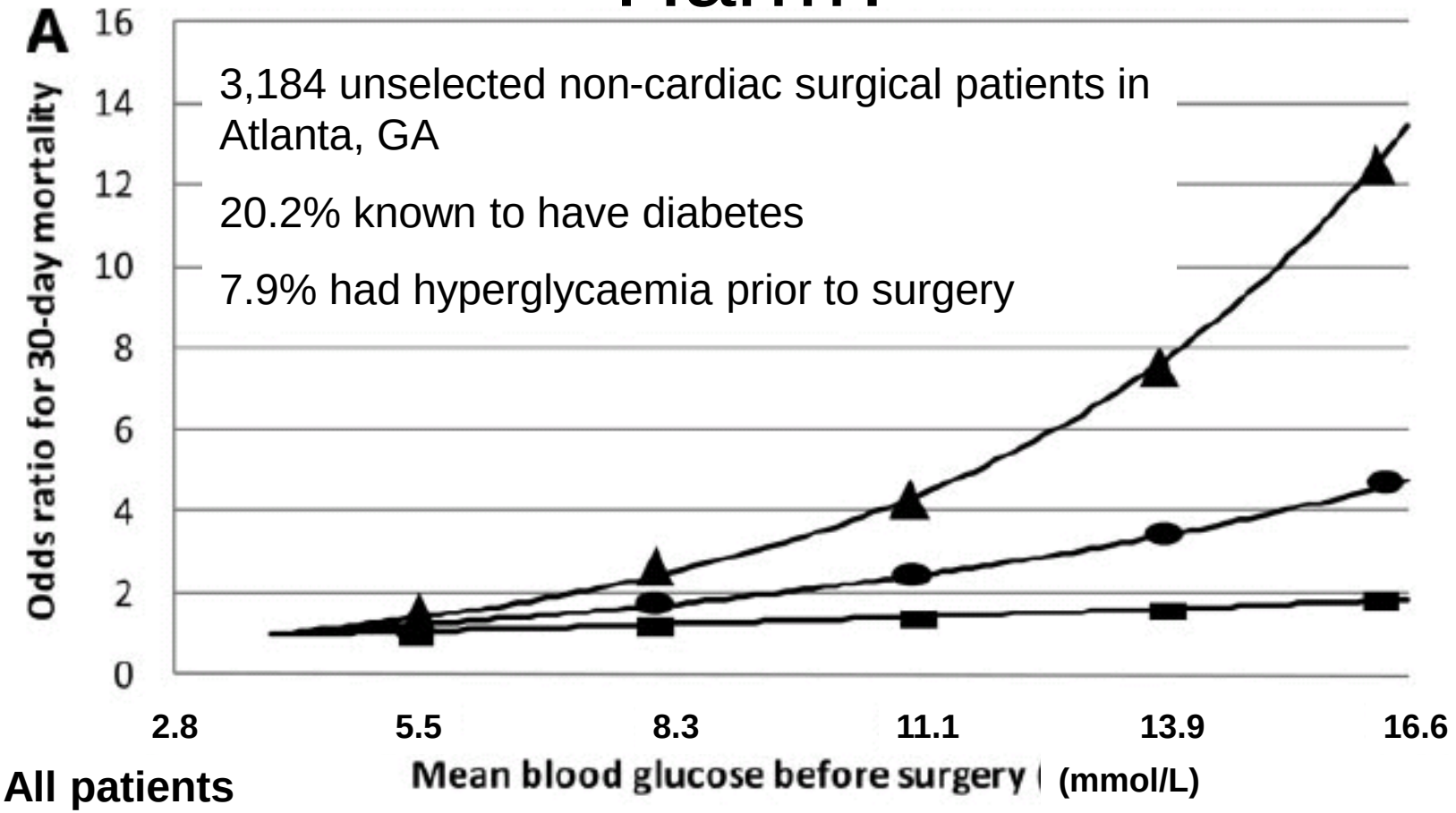
In 2015 61.6% of people without diabetes had day case surgery. This was 40.6% for people with diabetes

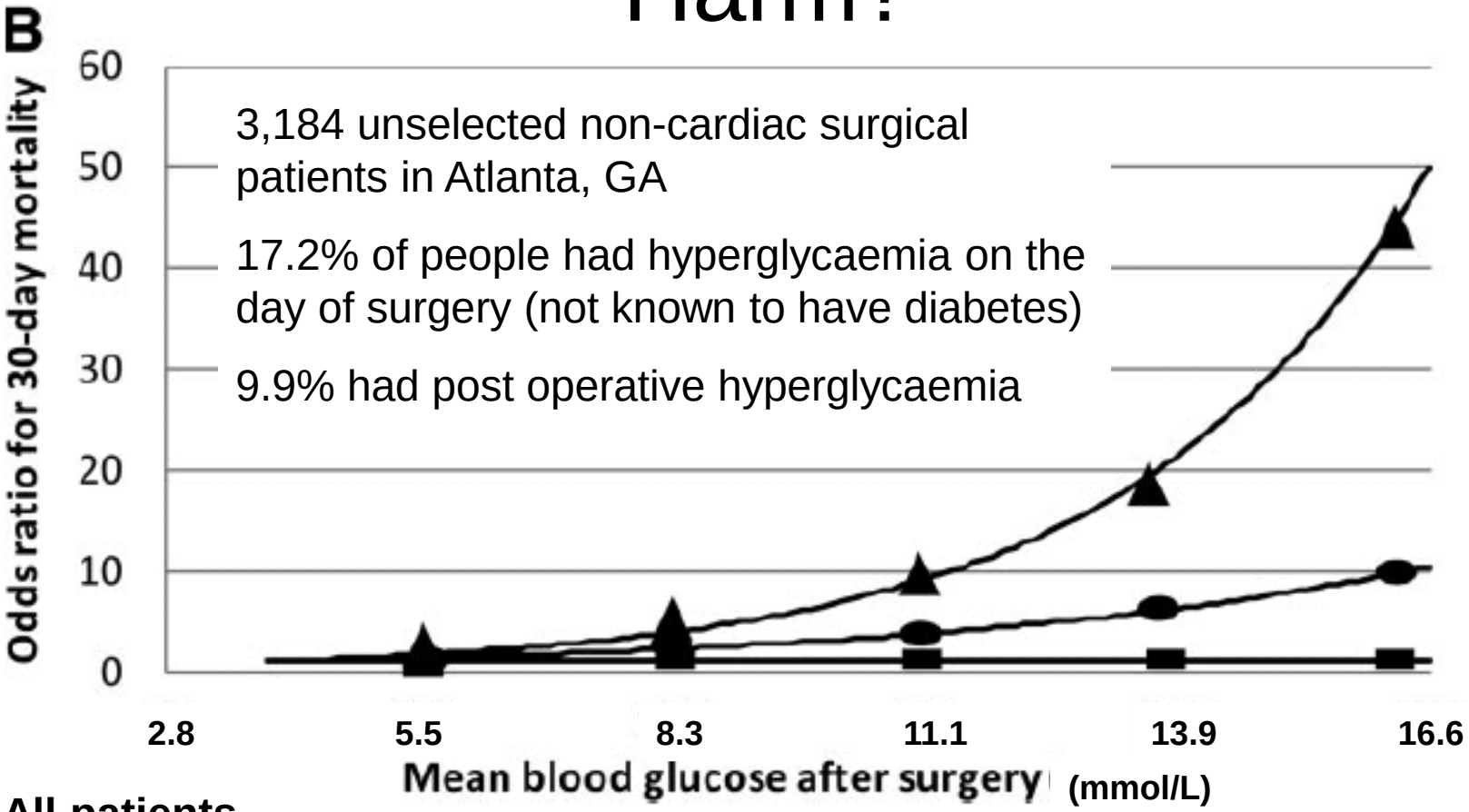
Do High Glucose Levels Cause Harm?



- All patients
- Patients with diabetes
- Patients without diabetes

Frisch A et al Diabetes Care 2010;33(8):1783-1788

Do High Glucose Levels Cause Harm?



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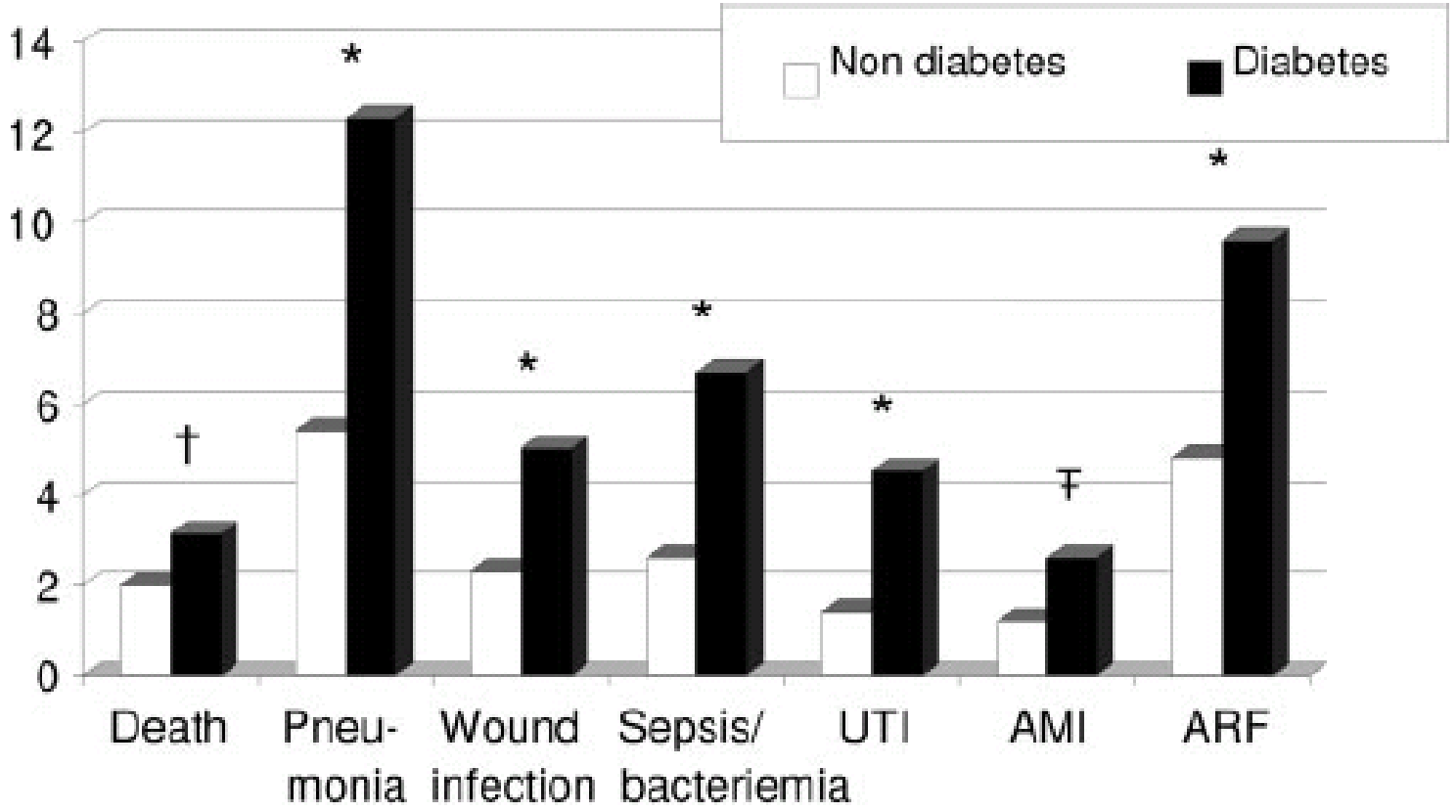
Do High Glucose Levels Cause Harm?



Frisch A et al Diabetes Care 2010;33(8):1783-1788

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)
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)

High glucose levels were associated with poor outcomes

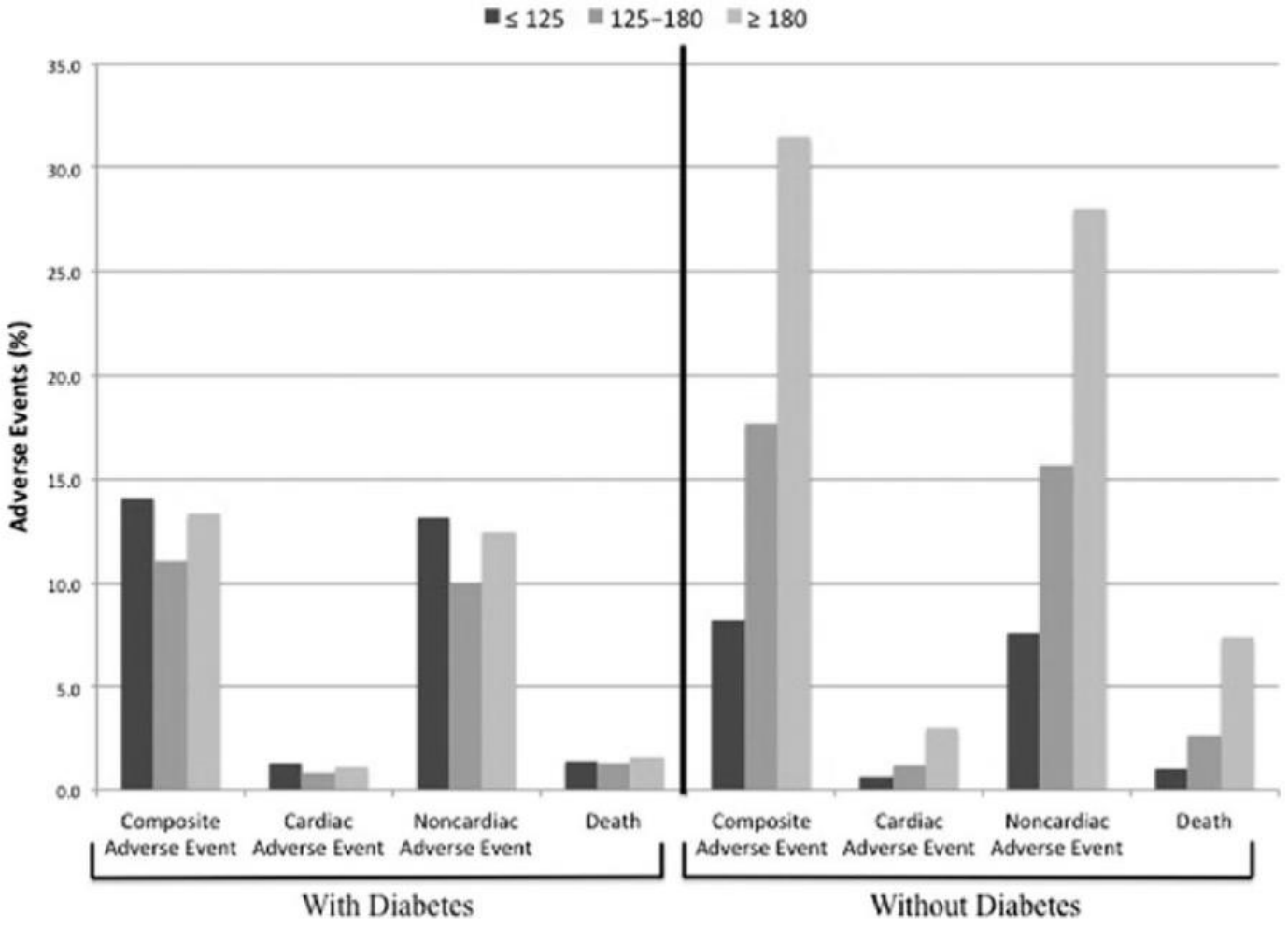
But – having diabetes was protective (?increased vigilance)

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

There is a Trend Emerging

- Data from the 2010-2012 Surgical Care and Outcomes Assessment Programme across 55 hospitals in the US
- 40,836 patients, of whom 19% had DM, and of whom 47% had a peri-operative BG test
- Those who were not known to have diabetes but developed post-operative hyperglycaemia had the worst outcomes

Hyperglycaemia in Previously Normoglycaemia People is Bad



Composite endpoint = readmission; ITU; falls; any infection; debridement; AKI; re-operation

Kotagal M et al Annals of Surgery 2015;261(1):97-103

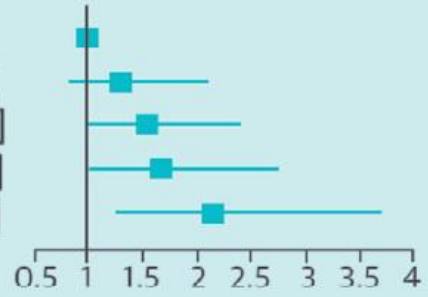
Cardiac Surgery?

- 352 patients (150 without diabetes)
- Randomised to 5.6-7.8 vs 7.9-10 mmol/l post CABG
- 90 day outcomes (death, infections, etc)
- Most benefit achieved in those without diabetes on the intensive treatment arm (p=0.008)

Umpierrez G et al Diabetes Care 2015;38(9):1665-1672

HbA1c and Outcome Post CABG

Death + MACE			
≤7.0 (Ref)	29/358	81 [56 - 116]	1.00
7.1 - 8.0	76/993	76 [61 - 96]	1.34 [0.82 - 2.21]
8.1 - 9.0	122/1,588	77 [64 - 92]	1.59 [1.00 - 2.54]
9.1 - 10.0	64/796	80 [63 - 103]	1.73 [1.03 - 2.90]
>10.0	43/355	121 [90 - 163]	2.25 [1.29 - 3.94]

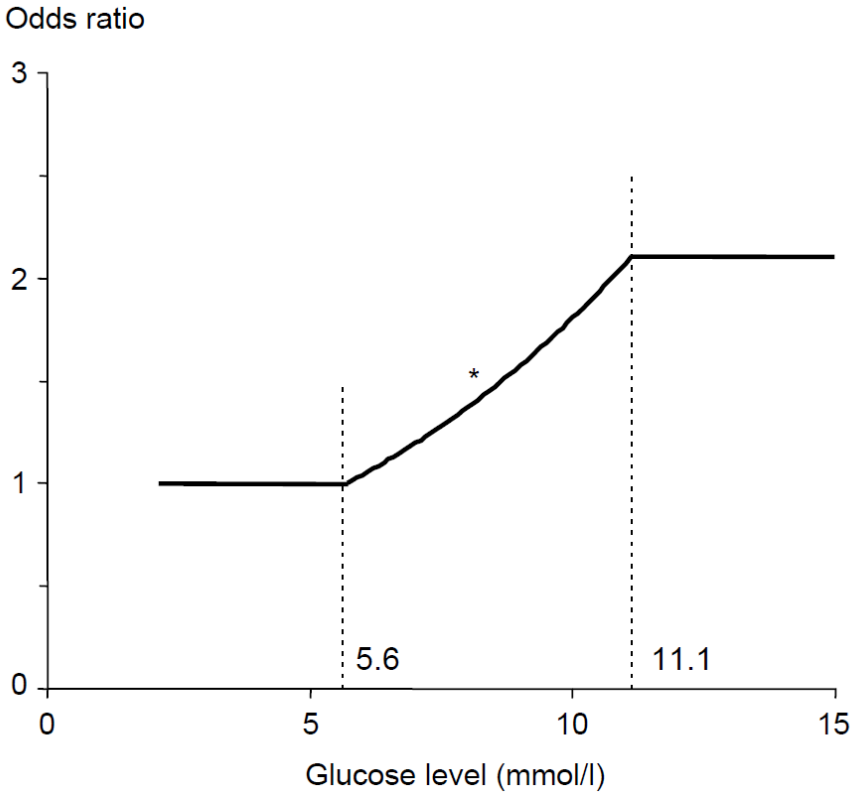


- 764 patients with T1DM undergoing CABG between 1997-2012 in Sweden
- For every 1% (9mmol/mol) rise in pre-operative HbA1c above 7% (53mmol/mol), there was an 18% increase in mortality or MACE

Nyström T et al. JACC 2015;66(5):535-543

In Addition…..

- Other data has confirmed the harm of high pre-operative glucose levels in non-cardiac, non vascular surgery



30 day mortality rates for 989 patients with diabetes – for each mmol/L increase in blood glucose, OR for mortality rose by 1.19 (CI 1.1 - 1.3)

Noordzij PG et al EJE 2007;156(1):137-142

Benefits of Glucose Control Extend to Those Without Diabetes

- 2383 people undergoing cardiac surgery randomised to tight peri- or post-operative glycaemic control (4.4-6.1 mmol/l)
- Those without diabetes had the greatest benefit in reductions complications
  - CV
  - Pulmonary
  - Neurological
  - GI
  - Renal

Blaha J et al J Clin Endo Metabol 2015;100(8):3081-3089

Thus….

- Whilst there is data to show that poor glycaemic control is associated with poor outcomes
- There is no consistent data to show that improving control also improves outcomes

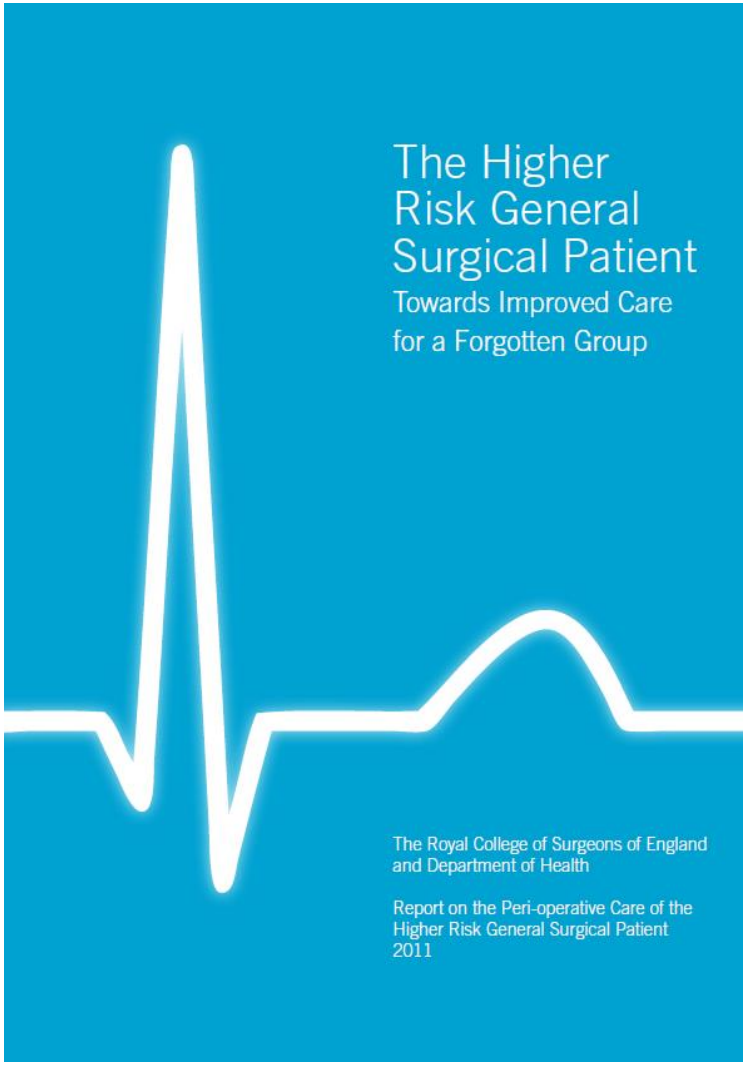
(A bit like diabetes care in general until the mid 1990's)

What About ITU??

Author	Year	Patients	No. pts	% Diabetes	Target blood IGC mg/dl	Glucose CGC mg/dl	Benefit	Outcome
Adults								
Leuven I	2001	Surgical[a]	1548	13	80–110	180–200	Yes	Reduced mortality, AKI, infections, LOS, increased hypoglycemia
Leuven II	2006	MICU	1200	17	80–110	180–200	?	NOB, reduced AKI, LOS, increased hypoglycemia
GLUCONTROL	2007	Mixed	1078	18	80–110	140–180	No	NOB, increased hypoglycemia
VISEP	2008	Mixed[c]	537	30	80–110	180–200	No	NOB, increased hypoglycemia
de la Rosa	2008	Mixed	504	12	80–110	180–200	No	NOB, increased hypoglycemia
Arabi	2008	Mixed	240	40	80–110	180–200	No	NOB, increased hypoglycemia
Bilotta	2008	TBI	97	–	80–120	<220	No	NOB, reduced LOS, increased hypoglycemia
Bilotta	2009	N/surgery	483	10	80–110	<215	No	NOB, reduced LOS, reduced UTI, increased hypoglycemia
NICE-SUGAR	2009	Mixed	6022	20	80–110	<180	No	HARM, increased mortality, increased hypoglycemia
COIITSS	2010	Mixed	509	–	80–110	180–200	No	NOB, increased hypoglycemia
Coester	2010	TBI	88	–	80–110	<220	No	NOB, increased hypoglycemia
INSULINFARCT	2012	Stroke	180	–	IIT	SIT	No	HARM, larger infarct growth
BIOMArCS-2	2013	ACS	280	10	85–110	<288	No	HARM, composite of death and second AMI
CGAO-REA	2014	Mixed	2684	23	80–110	<180	No	NOB, increased hypoglycemia
Children								
Vlasselaers	2009	Mixed	700[b]	3	Infants (50–80) Children (70–100)	214 214	Yes	Reduced LOS, infections, mortality, increased hypoglycemia
SPECS	2012	C/surgery	980	–	80–110	No target	No	NOB
CHiP	2014	Mixed	1369	–	72–126	<216	No	NOB, increased hypoglycemia

Marik PE Intensive Care Medicine 2016;42(9):1475-1477

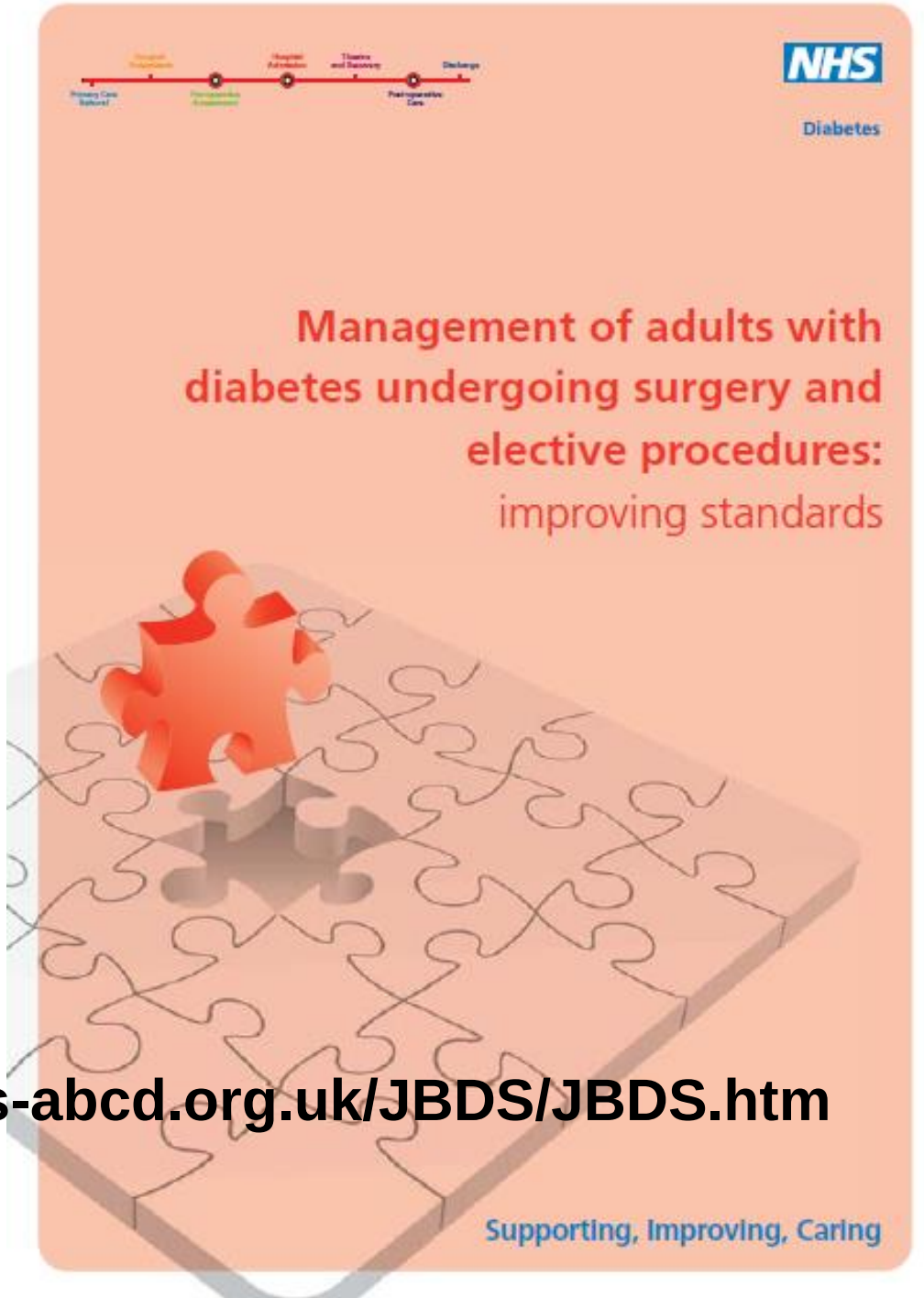
Something Some of You May Have Seen



- Disappointingly, the word ‘diabetes’ appears only once, ‘hyperglycaemia’ and ‘glucose’ do not appear at all in this document

http://www.rcseng.ac.uk/publications/docs/higher-risk-surgical-patient/

In 2011 Along Came This…..



http://www.diabetologists-abcd.org.uk/JBDS/JBDS.htm

How to Access This

- Open your search engine of choice
- Type in ‘ABCD’ and ‘JBDS’
- Click on the first link

Association of British Clinical Diabetologists

JBDS-IP Joint British Diabetes Societies for Inpatient care

Search Documents
Go

Joint British Diabetes Societies (JBDS) for Inpatient Care Group

The Joint British Diabetes Societies (JBDS) for Inpatient Care group was created in 2008 to '*deliver a set of diabetes inpatient guidelines and proposed standards of care within secondary care organisations*', with the overall aim of improving inpatient diabetes care through the development and use of high quality evidence based guidelines, and through better inpatient care pathways. The JBDS – IP group was created and supported by Diabetes UK, ABCD and the Diabetes Inpatient Specialist Nurse (DISN) UK group, and works with NHS England, TREND-UK and with other professional organisations.

Guidelines

The guidelines produced by the JBDS – IP group (including those planned for the future) are listed below and for those already published ***click the live link on the date to view***:

No.	Guideline	Date
1	Hospital management of hypoglycaemia in adults with diabetes	March 2010
1a	Hospital management of hypoglycaemia in adults with diabetes - **revised - second edition 2013**	Sept. 2013
2	The management of diabetic ketoacidosis (DKA) in adults	March 2010
2a	The management of diabetic ketoacidosis (DKA) in adults - **revised - second edition 2013**	Sept. 2013
2b	Adult diabetic ketoacidosis emergency care pathway to use in the case notes - **accompanies the DKA revised guideline 2013**	Sept. 2013
3	Management of adults with diabetes undergoing surgery	March 2011a March 2011b
3a	Management of adults with diabetes undergoing surgery – full document	Sept. 2015
3b	Management of adults with diabetes undergoing surgery - summary	Sept. 2015
3c	Management of adults with diabetes undergoing surgery – changes to 2011 guideline	Sept. 2015
4	Self management of diabetes in hospital	March 2012
5	Glycaemic management during enteral feeding in stroke	June 2012
6	Management of Hyperosmolar Hyperglycaemic State (HHS)	August 2012
7	Admissions avoidance in diabetes	Nov. 2013
8	Steroid use for inpatients with diabetes	Oct. 2014
9	Variable rate insulin infusion (VRII) for medical inpatients with diabetes	Oct. 2014
10	Discharge planning for people with diabetes	Oct. 2015
11	Management of adults with diabetes on the haemodialysis unit	April 2016a April 2016b
12	Managing diabetes during and after delivery	In progress
13	Diabetes in inpatients with mental health issues	In progress
14	New diagnosis of diabetes in inpatients	In progress

A SurveyMonkey of JBDS-IP guidelines undertaken at the end of 2012 revealed:

• Guidelines have been actively distributed (>21,000 copies, excluding downloads)

Links Add new link
British Journal of Diabetes (ABCD journal)
Young Diabetologists & Endocrinologists
Diabetes UK (DUK)
Society for Endocrinology
European Association for the Study of Diabetes (EASD)
American Diabetes Association (ADA)
International Diabetes Federation (IDF)
National Institute for Health and Clinical Excellence (NICE)
National Service Framework (NSF) for Diabetes
NHS Diabetes
National Screening Committee (NSC) - Diabetic Retinopathy
Doctors.net.uk
Other

And This…..

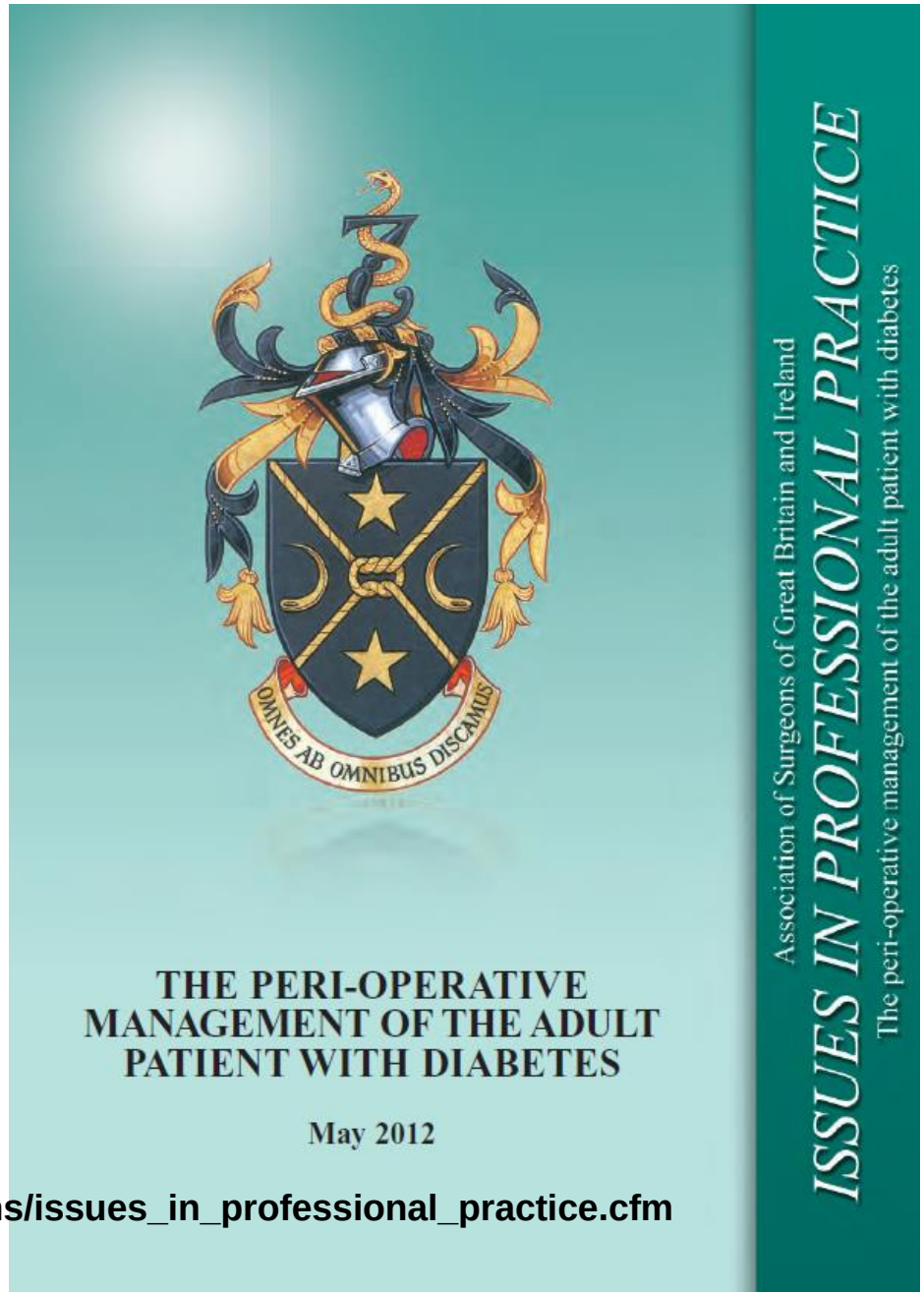
Diabetes UK Position Statements and Care Recommendations

NHS Diabetes guideline for the perioperative management of the adult patient with diabetes*

K. Dhatariya[1], N. Levy[2], A. Kilvert[3], B. Watson[4], D. Cousins[5], D. Flanagan[6], L. Hilton[7], C. Jairam[8], K. Leyden[3], A. Lipp[1], D. Lobo[9], M. Sinclair-Hammersley[10] and G. Rayman[11] for the Joint British Diabetes Societies

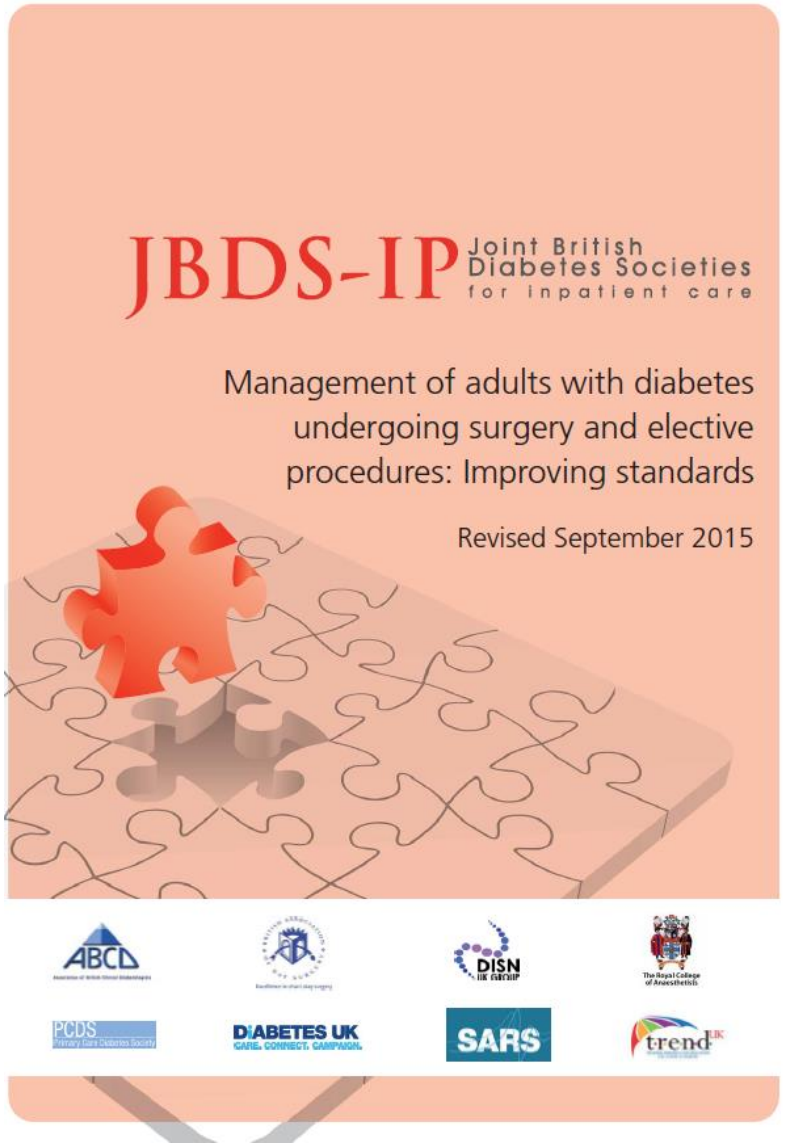
Diabetic Medicine 2012;29(4):420-433

And This…..



http://www.asgbi.org.uk/en/publications/issues_in_professional_practice.cfm

It Has Now Been Updated



It's Part of the Anaesthetists Bible - GPAS

Anaesthesia 2015, 70, 1427–1440 doi:10.1111/anae.13233

Guidelines

Peri-operative management of the surgical patient with diabetes 2015

Association of Anaesthetists of Great Britain and Ireland

Membership of the Working Party: P. Barker, P. E. Creasey, K. Dhatariya,[1] N. Levy, A. Lipp,[2] M. H. Nathanson (Chair), N. Penfold,[3] B. Watson and T. Woodcock

1 Joint British Diabetes Societies Inpatient Care Group
2 British Association of Day Surgery
3 Royal College of Anaesthetists

National Guidelines

- Document divided into sections:
  - Primary care
  - Surgical outpatients
  - Pre-operative assessment clinic
  - Hospital admission
  - Theatre and recovery
  - Post-operative care
  - Discharge

The Peri-Operative Management of Diabetes Drugs

Hypoglycaemic Agents

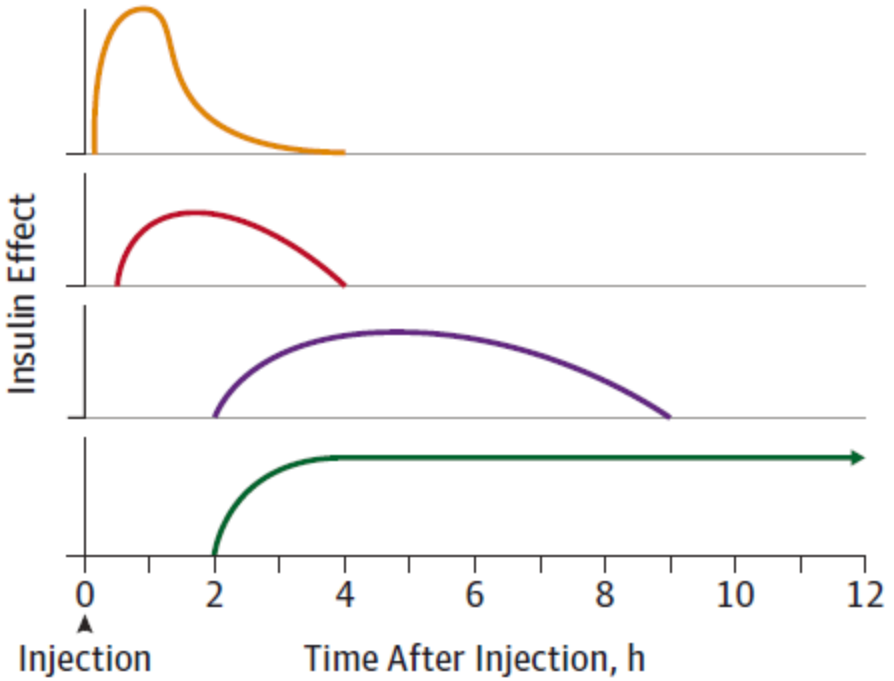
- α glucosidase inhibitors
- Metaglinides
- Metformin
- Sulphonylureas
- Thiazolidindiones
- GLP – 1 analogues
- DPP IV inhibitors
- SGLT2 inhibitors

Tablets	Day prior to admission	Day of Surgery / whilst on a VRIII		
		Patient for AM surgery	Patient for PM surgery	If a VRIII is being used*
Acarbose	Take as normal	Omit morning dose if NBM	Give morning dose if eating	Stop once VRIII commenced, do not recommence until eating and drinking normally
Meglitinide (e.g repaglinide or nateglinide)	Take as normal	Omit morning dose if NBM	Give morning dose if eating	Stop once VRIII commenced, do not recommence until eating and drinking normally
Metformin (eGFR is greater than 60ml/min/1.73m^2 and 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, omit lunchtime dose	Stop once VRIII commenced, do not recommence until eating and drinking normally
Sulphonylurea (e.g glibenclamide, gliclazide, glipizide, etc.)	Take as normal	Once daily am omit Twice daily omit am	Once daily am omit Twice daily omit am and pm	Stop once VRIII commenced, do not recommence until eating and drinking normally
Pioglitazone	Take as normal	Take as normal	Take as normal	Stop once VRIII commenced, do not recommence until eating and drinking normally
DPP IV inhibitor (e.g. sitagliptin, vildagliptin, saxagliptin, alogliptin, linagliptin)	Take as normal	Take as normal	Take as normal	Stop once VRIII commenced, do not recommence until eating and drinking normally
GLP-1 analogue (e.g. exenatide, liraglutide, lixisenatide, dulaglutide)	Take as normal	Take as normal	Take as normal	Take as normal
SGLT-2 inhibitors (e.g. dapagliflozin, canagliflozin)	Take as normal	Omit on day of surgery	Omit on day of surgery	Omit until eating and drinking normally

Insulin Durations

Figure 1. Insulin Activity Profiles

Insulin	Onset, min	Duration, h
Very rapid Lispro, aspart, glulisine	10	4
Rapid (regular) CZI	30	4-8
Intermediate NPH	120	8-10
Long acting Glargine, levemir	120	12-24



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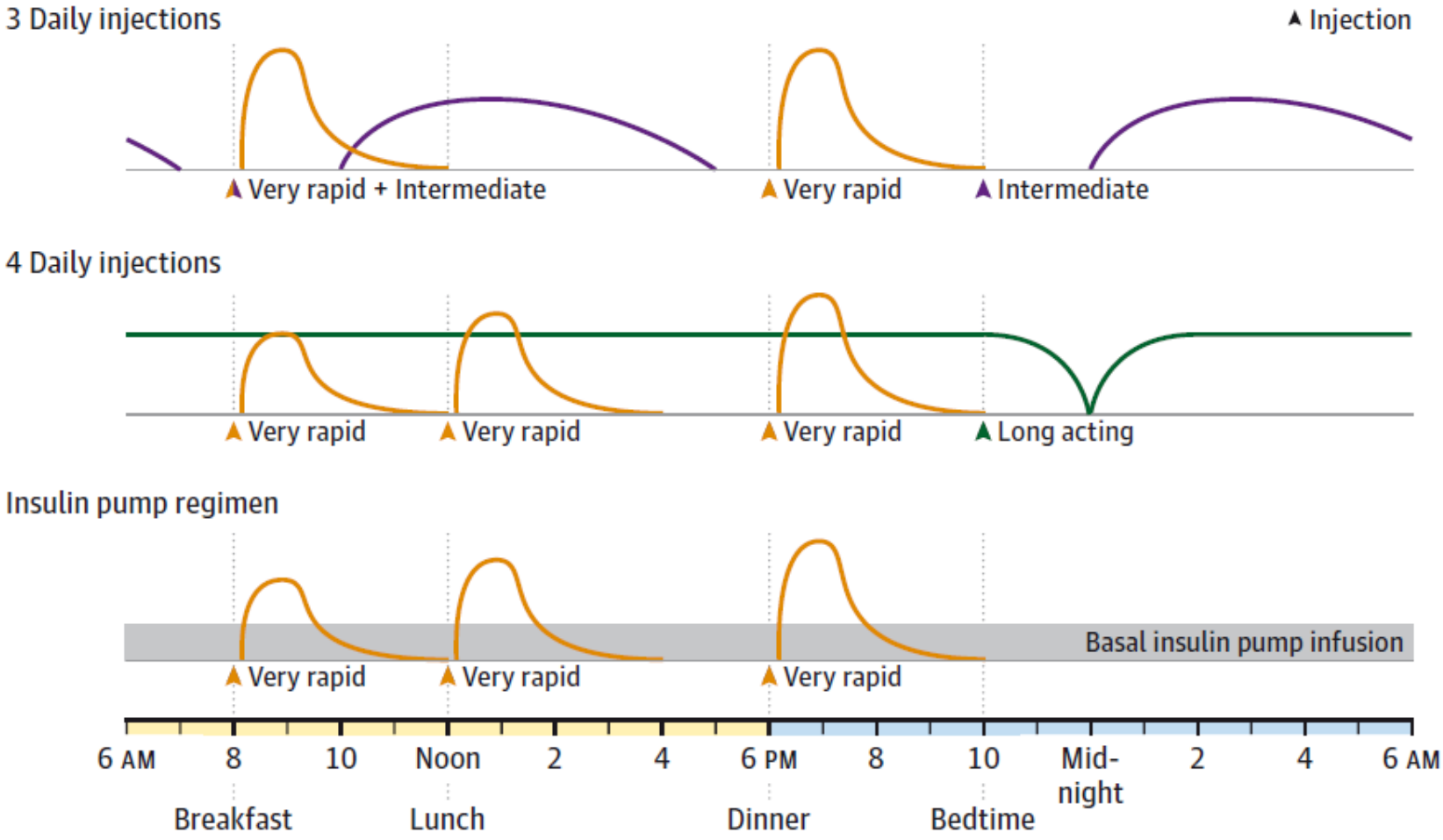
Insulin Regimens

Figure 2. Three Examples of Insulin Regimens for Type 1 Diabetes



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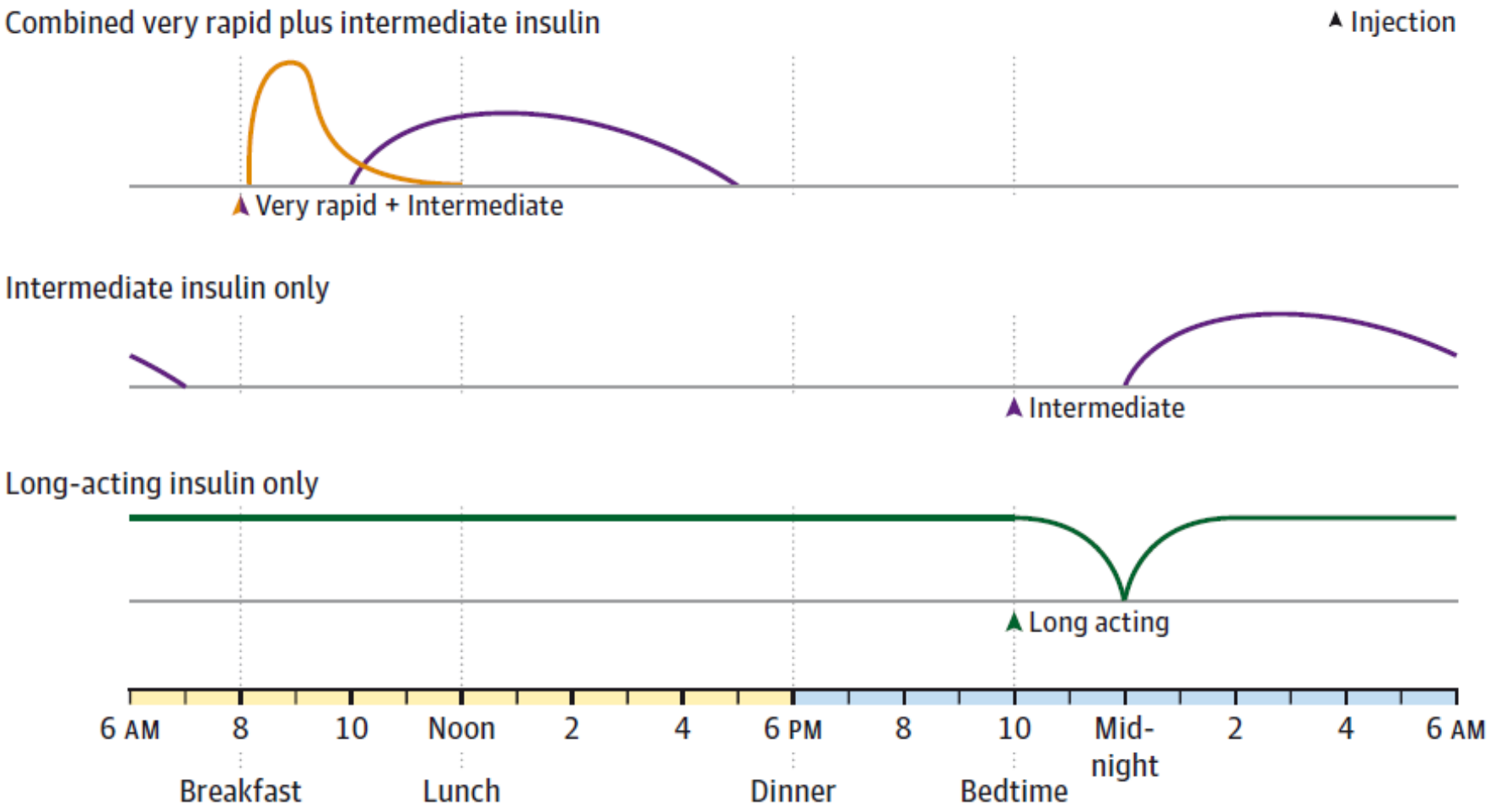
Insulin Regimens

Figure 3. Three Examples of Single Injection Regimens for Type 2 Diabetes



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Insulins	Day prior to admission	Day of Surgery / whilst on a VRIII		
		Patient for AM surgery	Patient for PM surgery	If a VRIII is being used*
Once daily (evening) (e.g. Lantus® or Levemir® Tresiba® Insulatard® Humulin I®) Insuman®)	Reduce dose by 20%	Check blood glucose on admission	Check blood glucose on admission	Continue at 80% of the usual dose
Once daily (morning) (Lantus® or Levemir® Tresiba® Insulatard® Humulin I®) Insuman®)	Reduce dose by 20%	Reduce dose by 20% Check blood glucose on admission	Reduce dose by 20% Check blood glucose on admission	Continue at 80% of the usual dose
Twice daily (e.g. Novomix 30®, Humulin M3® Humalog Mix 25®, Humalog Mix 50®, Insuman® Comb 25, Insuman® Comb 50 twice daily Levemir® or Lantus®)	No dose change	Halve the usual morning dose. Check blood glucose on admission Leave the evening meal dose unchanged	Halve the usual morning dose. Check blood glucose on admission Leave the evening meal dose unchanged	Stop until eating and drinking normally
Twice daily - separate injections of short acting (e.g. animal neutral, Novorapid® Humulin S®) Apidra® **and intermediate acting** (e.g. animal isophane Insulatard® Humulin I® Insuman®)	No dose change	Calculate the total dose of both morning insulins and give half as intermediate acting only in the morning. Check blood glucose on admission Leave the evening meal dose unchanged	Calculate the total dose of both morning insulins and give half as intermediate acting only in the morning. Check blood glucose on admission Leave the evening meal dose unchanged	Stop until eating and drinking normally
3, 4 or 5 injections Daily (e.g. an injection of mixed insulin 3 times a day or 3 meal time injections of short acting insulin and once or twice daily background)	No dose change	**Basal bolus regimens:** omit the morning and lunchtime short acting insulins. Keep the basal unchanged.* **Premixed a.m. insulin:** halve the morning dose and omit lunchtime dose Check blood glucose on admission	Take usual morning insulin dose(s). Omit lunchtime dose. Check blood glucose on admission	Stop until eating and drinking normally

The Future?

Health Technology Assessment Programme

National Institute for Health Research

HTA no 16/25

Poorly controlled diabetes and outcomes of elective surgery

Norfolk and Norwich University Hospitals NHS
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Effect of Diabetes Care on Surgical Outcomes

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