ABCD Pilot Audit of Hyperglycaemia Management in ACS

East & North Herts  Peter Winocour, Debbie Stannistreet, Kylie Murray, Ann Ainsworth
Norwich  Ketan Dhatariya
Oxford  Maggie Hammersley
Portsmouth  Ken Shaw, Marc Atkin

28th November 2008
DM and ACS

• Observational relationship between hyperglycaemia and CVD
• DM without established CVD – at least 3-fold RR of CVD mortality of non-DM
• ? Similar risk to non-DM with prior AMI
• 2-fold greater mortality following AMI with DM than non-DM
• Uncertainty regarding benefit of intensive glycaemic control during ACS
• Intensive longer term glycaemic control (HbA1c target < 6%) in older Type 2 DM led to 1.22 RR of death (ACCORD)
## Background – Digami 1

### Glucose control at admission

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control group n=314</th>
<th>Infusion group n=306</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c 0 hours (%)</td>
<td>8.0±2.0</td>
<td>8.2±1.9</td>
<td>NS</td>
</tr>
<tr>
<td>Blood glucose 0</td>
<td>15.7±4.2</td>
<td>15.4±4.1</td>
<td>NS</td>
</tr>
<tr>
<td>Blood glucose 24</td>
<td>11.7±4.1</td>
<td>9.6±3.3</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

1999

Clinical Audit Team
Background – Digami 1

Long-term mortality
All patients

Stratum 1


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Study objectives

To conduct an international multicenter trial, the basic structure of which is similar to DIGAMI 1. The study population, based on results from DIGAMI 1, will be larger, in the magnitude of 3,000 subjects.
The patients will be randomly allocated to one of three treatment strategies.

**Group 1**  
acute administration of insulin-glucose followed by subcutaneous insulin;

**Group 2**  
acute administration of insulin-glucose followed by conventional treatment;

**Group 3**  
conventional treatment only.

The average time of follow up should be 2 years.
Blood glucose levels by visit and treatment group

mmol/L

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>24 h</th>
<th>3</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>469</td>
<td>454</td>
<td>329</td>
<td>313</td>
<td>295</td>
<td>228</td>
<td>197</td>
<td>144</td>
<td>114</td>
</tr>
<tr>
<td>Group 2</td>
<td>469</td>
<td>452</td>
<td>331</td>
<td>320</td>
<td>304</td>
<td>219</td>
<td>195</td>
<td>151</td>
<td>108</td>
</tr>
<tr>
<td>Group 3</td>
<td>304</td>
<td>282</td>
<td>214</td>
<td>199</td>
<td>184</td>
<td>154</td>
<td>125</td>
<td>98</td>
<td>77</td>
</tr>
</tbody>
</table>

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Primary and secondary endpoints ITT
Group 1 vs Group 2, ITT, unadjusted

<table>
<thead>
<tr>
<th>Event</th>
<th>HR (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1.03 (0.79-1.34)</td>
<td>0.832</td>
</tr>
<tr>
<td>Death/reinfarction/stroke</td>
<td>1.16 (0.94-1.44)</td>
<td>0.173</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.42 (0.76-2.64)</td>
<td>0.268</td>
</tr>
<tr>
<td>Reinfarction</td>
<td>1.38 (0.97-1.96)</td>
<td>0.074</td>
</tr>
</tbody>
</table>
MINAP- 90 day mortality for all patients in database

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MINAP - 90 day mortality without previously recognised diabetes; all ACS

Glucose quartile

- < 5.9
- 5.9 - 7.3
- 7.3 - 9.8
- > 9.8

> 11.0 = 22.5%
MINAP - 90 day mortality ‘non diabetics’ glucose > 11.0 mmol/l

- Any diabetic treatment
- No treatment

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MINAP - Other findings in DM

- DM – Impt dtmnt of pre-hospital delay in door-needle time
- Asian men and women with DM and ACS more often on insulin and oral therapy than Caucasian men and women
- Adjusted 1-year mortality no different between Asian and Caucasian men and women with DM

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MINAP – insulin treatment for hyperglycaemia in ACS

- 10% of MINAP troponin +ve ACS database (3.8K) without known DM had admission glucose >= 11 mmol/l
- 36% received ‘some form of DM Rx’ – insulin in majority (P)I-G > insulin infusion
- 30-day mortality with v without insulin 16% v 22%
- Adjusted RR CVD mortality if not on insulin 1.51

(Weston et al. Heart :2007)
Other recent observations – hyperglycaemia and ACS

• Admission hyperglycaemia in non-DM unreliable in diagnosis of DM*

• Fasting glucose less reliable than 2hr OGTT in diagnosis of DM post-ACS (26% missed diagnoses)+

• Poor prognosis (2-yr survival) in Trop-ve ‘ACS’ in DM (91.1%), comparable to non-DM ACS Trop +ve (90.7%)^  

*Ishihara - Eur Heart J 2006  
+Bartnik - Heart 2007  
^Marso - Diabetes Care 2006
National ABCD audit on in-patient diabetes services – MI care

- Use of insulin after MI in ‘DM patients’
- Use of ‘DIGAMI protocol’ in 177 (79%) /223 responding centres – not in 21%
- 39% of centres stated that ‘negative results’ of DIGAMI 2 had altered practice
- ?? Interpreted as 60% had never used DIGAMI (?) = insulin) or altered practice after DIGAMI 2

Sampson et al, Diabetic Med, 2007
ABCD pilot audit of hyperglycaemia in ACS

- The ‘MINAP black box’ - What happens after hyperglycaemia in ACS detected?
- Who, where, how is glycaemic care provided in different centres?
- Adherence to local/pragmatic standards
- Prospective audit – 50 hyperglycaemic ACS cases expected over 6 months
- 6 centres in bid (Glasgow and Northampton unable to participate)
ABCD ACS Audit - Centre assessment

• Initial management of ACS
• ACS hyperglycaemia protocol
• Glycaemic thresholds for insulin and targets for attainment
• Utilisation of nurse led protocol for glycaemic control
• Policy for insulin continuation post – ACS
• Policy for post-ACS OGTT
• Lab and meter glucose on admission in all cases
• Insulin therapy if admission glucose >= 11 mmol/l
• Target glycaemic average 5-8 mmol/l
• Avoidance of hypoglycaemia
• HbA1c measured during admission
ABCD ACS Audit – ‘Standards’ - 2

- Fasting glucose recorded after ACS if not known DM
- OGTT arranged after ACS if not known DM
- Retinopathy status documented in insulin treated cases
- Assessment by member of DM team during IP stay
- New Insulin therapy at discharge ? 50%
- Assessment for continuation of insulin 90 days post-ACS
ABCD ACS Audit – Centre Protocols

All different!

- **Norwich** - threshold FPG > 7 RBG > 11, No target
  - Rx Insulin infusion / GIK

- **Oxford** - threshold RBG > 8, target 4-8
  - Rx Insulin infusion +/-dextrose -potassium

- **Portsmouth** - threshold RBG >10, target 4-10
  - Rx insulin infusion – varies with DM status

- **E & North Herts** - threshold RBG >= 11, target 5-8
  - Rx insulin infusion +/- dextrose-potassium–varies with prior insulin dose-obesity
MANAGEMENT OF HYPERGLYCAEMIA IN ACUTE CORONARY SYNDROME

PROVEN OR SUSPECTED M.I.

Urgent lab glucose/electrolytes & simultaneous bedside glucose meter measurement.

Bedside glucose with lab confirmation = 11 mmol/L - whether known DM or not: Commence IV insulin infusion schedule. •
Doctor prescribes. Usual infusion rate 1 or 2 units/hr. Target bedside glucose 5-8 mmol/L.

Hourly bedside glucose.

Blood sent for HbA1c.

Nurse-led protocol.

GLUCOSE 5-8 mmol/L after 4 hrs - continue.

GLUCOSE > 8 mmol/L after 4 hrs = doctor to modify schedule i.e. ↑ rate by 1 or 2 units/hr.

When on insulin:

FLUID SCHEDULE

When glucose 8-9 mmol/L - commence 0.5 L 10% dextrose with 20 mmol/L KCl infusion 8-12 hourly †
Doctor prescribed, on fluid chart.

Repeat electrolyte estimated after 6 hrs. Modify potassium content if levels are = 3.5 mmol/L.

After 24-48 hrs - or when CVP stable - doctor to convert to S/C insulin - B.D. or Q.D.S. - contact diabetes team for advice.

• IMPORTANT EXCEPTIONS:
  1. Obesity or known DM on > 60 units/day - start at 3-4 units/hr.
  2. If also in DKA - follow DKA protocol.
  † Start potassium/dextrose earlier if hypokalaemic (< 3.5 mmol/L) on admission.
  Where overt CCF/fluid overload concern - 0.5 l over 12-24 hrs - consider 20% dextrose with 40-60 mmol/L KCl through central line.
ABCD ACS Audit

• Audit sample - 50 consecutive cases with BG \(\geq 11\) mmol/l on admission and/or known diabetes

• Data collection started June 2007

• Analysis October 2008

• Cases analysed:
  - East & North Herts 67 (66 pts)
  - Norwich 59 (55 pts)
  - Oxford 49
  - Portsmouth 28 (27 pts)
  - TOTAL 203 (197 pts)
## Demographics

### Gender

<table>
<thead>
<tr>
<th>Region</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E&amp;N Herts</td>
<td>69%</td>
<td>31%</td>
</tr>
<tr>
<td>Oxford</td>
<td>67%</td>
<td>33%</td>
</tr>
<tr>
<td>Norwich</td>
<td>69%</td>
<td>31%</td>
</tr>
<tr>
<td>Portsmouth</td>
<td>64%</td>
<td>36%</td>
</tr>
<tr>
<td>Total</td>
<td>64%</td>
<td>36%</td>
</tr>
</tbody>
</table>

### Age at presentation

- **Median (Range)**
  - E&N Herts: 72 (40 – 94)
  - Oxford: 74 (40 – 93)
  - Norwich: 74 (51 – 91)
  - Portsmouth: 77 (44 – 93)
  - Total: 74 (40 – 94)

### Ethnicity

- **White**
  - E&N Herts: 90%
  - Oxford: 88%
  - Norwich: 100%
  - Portsmouth: 100%
  - Total: 93%

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*Clinical Audit Team*
ACS, Diabetes and site of care

**Diabetes**

- Undiagnosed/not known diabetes: 83 (41%)
- Known diabetes: 120 (59%)
  - Type 1: 12% (12/100, 78/615)
  - Type 2: 88% (88/100, 39/45)

**ACS**

- E&N Herts: 78% Non STMI, 22% STMI
- Oxford: 59% Non STMI, 41% STMI
- Norwich: 61% Non STMI, 39% STMI
- Portsmouth: 71% Non STMI, 29% STMI
- Total: 67% Non STMI, 33% STMI

**Main site of care**

<table>
<thead>
<tr>
<th>Site of care</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac ward/CCU/ITU</td>
<td>72%</td>
<td>86%</td>
<td>100%</td>
<td>79%</td>
<td>84%</td>
</tr>
<tr>
<td>General wards</td>
<td>13%</td>
<td>8%</td>
<td></td>
<td>18%</td>
<td>9%</td>
</tr>
<tr>
<td>MAU</td>
<td>15%</td>
<td>6%</td>
<td></td>
<td>3%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Clinical Audit Team
# Glucose control – by site

**Standard:** Lab and meter glucose on admission in all cases

<table>
<thead>
<tr>
<th>Method</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab &amp; meter</td>
<td>75%</td>
<td>45%</td>
<td>48%</td>
<td>89%</td>
</tr>
<tr>
<td>Lab or meter</td>
<td>25%</td>
<td>47%</td>
<td>49%</td>
<td>11%</td>
</tr>
<tr>
<td>Neither</td>
<td>8%</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method</th>
<th>Median (Range)</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Lab</td>
<td>12.2 (3.4 – 29.4)</td>
<td>10.5 (6.3 – 20.0)</td>
<td>10.6 (7.1 – 22.9)</td>
<td>13.9 (9.0 – 33.4)</td>
<td></td>
</tr>
<tr>
<td>Initial Meter</td>
<td>10.6 (5.1 – 24.3)</td>
<td>10.4 (7.5 – 26.8)</td>
<td>10.0 (5.8 – 23.4)</td>
<td>12.9 (4 – 26.9)</td>
<td></td>
</tr>
</tbody>
</table>

**Clinical Audit Team**
**Initial bedside meter glucose**

**n = 182**

All patients: Median 10.6 (4 – 26.9)

<table>
<thead>
<tr>
<th>Non known/undiagnosed diabetes</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NDM</strong></td>
<td><strong>DM</strong></td>
</tr>
<tr>
<td><strong>Median (Range)</strong></td>
<td>10.1 (5.8 – 24.3)</td>
</tr>
</tbody>
</table>

Clinical Audit Team
# Immediate Management Plan

**n = 203**

<table>
<thead>
<tr>
<th>Management Plan</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV insulin/sliding scale</td>
<td>63%</td>
<td>96%</td>
<td>27%</td>
<td>43%</td>
</tr>
<tr>
<td>Subcut insulin</td>
<td>7%</td>
<td>2%</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>Diet only/glucose monitoring</td>
<td>9%</td>
<td>4%</td>
<td>3%</td>
<td>11%</td>
</tr>
<tr>
<td>Oral hypoglycaemic therapy</td>
<td>9%</td>
<td></td>
<td></td>
<td>11%</td>
</tr>
<tr>
<td>No treatment</td>
<td></td>
<td>2%</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Nil recorded</td>
<td>12%</td>
<td>66%</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>

Clinical Audit Team
Glucose control – Site targets

Level of control:
(Mean bedside meter glucose over 1st 24 hrs - % of available data)

<table>
<thead>
<tr>
<th>Site</th>
<th>Target:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>E &amp; N Herts</td>
<td>5 – 8</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>Oxford</td>
<td>4 – 8</td>
<td>79%</td>
<td></td>
</tr>
<tr>
<td>Norwich</td>
<td>??</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portsmouth</td>
<td>4 – 10</td>
<td>35%</td>
<td></td>
</tr>
</tbody>
</table>
Treatment 1

Standard: Insulin therapy if admission lab and/or meter glucose > 11 mmol/l

Compliance: Variable between sites
Variable use between IV and subcut insulin
Lack of information

<table>
<thead>
<tr>
<th>Treatment</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Insulin infusion</td>
<td>72%</td>
<td>96%</td>
<td>38%</td>
<td>50%</td>
</tr>
<tr>
<td>Subcut insulin</td>
<td>8%</td>
<td></td>
<td>4%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Oral therapy</td>
<td>5%</td>
<td></td>
<td></td>
<td>12.5%</td>
</tr>
<tr>
<td>Diet only</td>
<td>5%</td>
<td>4%</td>
<td>12%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Not recorded</td>
<td>10%</td>
<td></td>
<td>46%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>
Treatment 2

n = 83

Standard: Fasting glucose recorded after ACS if NOT known DM

Compliance: Very variable between sites

E&N Herts: 50%
Oxford: 81%
Norwich: 12%
Portsmouth: 18%
## HbA1c

**Standard:** HbA1c measured through admission

**Compliance:** Very variable between sites

<table>
<thead>
<tr>
<th></th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c measured</td>
<td>31%</td>
<td>92%</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>&lt;7.5 %</td>
<td>8</td>
<td>36</td>
<td>0%</td>
<td>1</td>
</tr>
<tr>
<td>&gt;7.5%</td>
<td>13</td>
<td>9</td>
<td>0%</td>
<td>2</td>
</tr>
<tr>
<td>Range (%)</td>
<td>5 – 12.5</td>
<td>4.8 – 16.5</td>
<td>7.1 – 13.5</td>
<td></td>
</tr>
</tbody>
</table>
Centre-reported Hypoglycaemia
(<4 mmol/l in 1st 24 hrs)

Standard: Avoidance of hypoglycaemia
Compliance: Centre-reported on at least 1 occasion
Reported quite commonly in 2 centres

Pts with Hypoglycaemia incident reported
OGTT

Standard: OGTT arranged after ACS if NOT known DM

Result: Very poor uptake of ‘standard’

Undiagnosed/not known diabetes 2 (2%)

1 in Norwich
1 in East & North Herts

n = 83

Clinical Audit Team
Retinopathy

Standard: Retinopathy status documented in insulin treated cases
Compliance: Poor compliance with standards

Immediate Management Plan – Insulin = 126

Retinopathy status documented:

- E&N Herts: 17%
- Oxford: 11%
- Norwich: 6%
- Portsmouth: 20%

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Assessment by Diabetic Team

Standards: Assessment by member of DM team during IP stay

Compliance: Wide range from 19% - 100%

n = 105

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Discharge Therapy for undiagnosed – not-known diabetes pts

- Wide variation in discharge therapy between sites
- Information not recorded in 4-21%

<table>
<thead>
<tr>
<th>Therapy Type</th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet only/no therapy</td>
<td>43%</td>
<td>78%</td>
<td>85%</td>
<td>82%</td>
</tr>
<tr>
<td>Oral therapy</td>
<td>21%</td>
<td>9.5%</td>
<td>4%</td>
<td>18%</td>
</tr>
<tr>
<td>Insulin therapy</td>
<td>14%</td>
<td>3%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Not recorded</td>
<td>21%</td>
<td>9.5%</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>

n = 83

Clinical Audit Team
Diabetes Therapy – Admission/Discharge for prior known Diabetes pts

- 13% overall increase in insulin therapy
- 30% increase East & North Herts
- 14% increase Portsmouth
- No increase in Oxford
- Decrease at Norwich

Clinical Audit Team
# In Hospital Mortality

## By Site*

<table>
<thead>
<tr>
<th></th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>9%</td>
<td>19%</td>
<td>7%</td>
<td>11%</td>
</tr>
</tbody>
</table>

*Complete dataset for Norwich and Portsmouth only

## By Diabetes

<table>
<thead>
<tr>
<th></th>
<th>Not known-Undiagnosed diabetes</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>10%</td>
<td>9%</td>
</tr>
</tbody>
</table>

## By Type of ACS

<table>
<thead>
<tr>
<th></th>
<th>Non STMI</th>
<th>STMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>11%</td>
<td>7%</td>
</tr>
</tbody>
</table>

n = 166

Clinical Audit Team
Sub cut insulin newly commenced continued at 3 mths

**n = 66**

### By Site

<table>
<thead>
<tr>
<th></th>
<th>E&amp;N Herts</th>
<th>Oxford</th>
<th>Norwich</th>
<th>Portsmouth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>46%</td>
<td>8%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### By Diabetes

<table>
<thead>
<tr>
<th></th>
<th>Non diabetes</th>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12%</td>
<td>41%</td>
</tr>
</tbody>
</table>

### By Type of ACS

<table>
<thead>
<tr>
<th></th>
<th>Non STMI</th>
<th>STMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>26%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Clinical Audit Team
Main Findings and Discussion - 1

- The 4 centres have subtly different protocols for insulin initiation and glycaemic targets
- Males:Females 2:1 except Portsmouth!
- Effectively an all white study
- 1/6 cared for out of ‘intensive setting’
- 2:1 Non STMI:STMI - as expected
- 60% known DM – of these 1/10 Type 1
- Variable centre adherence to standard re lab and meter glucose on admission

Clinical Audit Team
Main Findings and Discussion - 2

- Apparent good matching of admission lab vs admission meter glucose
- Variable use of insulin by centre for 110 with admission glucose $\geq 11$ mmol/l
- Patchy measurement of fasting glucose if not known to have DM
- Variable adherence to process measures by site
- Very variable HbA1c measurement
Main Findings and Discussion - 3

• Hypos happen!! ++ apart from Portsmouth?- Case for basal-bolus rather than IV infusion of insulin if eating
• OGTT - a rare event
• Retinopathy documentation infrequent - ? important – for insulin initiation and thrombolysis
• DM team review – a process best in Oxford – a case for IP DM medical team
• Insulin Rx post MI increase in established DM – modest increase at discharge
• Insulin continuation at 3 months – ? less frequent reflecting DIGAMI 2
Conclusions

• ACS glycaemic care within and between centres remains variable
• DIGAMI2 may have adversely affected approach to care although more recent MINAP data highlights importance of good glycaemic control
• Process of care ? requires proactive IP DM specialist medical and nursing team
• Need for detailed national review and standards for ACS glycaemic care