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9 – Diabetes care

Diabetes is a major risk factor for the development of peripheral vascular disease and 349/628 (55.6%) of the patients in this study had diabetes.

Hospital inpatients with diabetes are on average older, sicker and have a longer length of stay than the general population. Around 15% of hospital beds are occupied by people with diabetes.[22] High quality diabetes care has the potential to improve outcomes and shorten length of stay. It is important not only in this patient group but in all hospital patients. This section will explore the process and quality of care as well as outcomes in patients with diabetes.

In the general population, approximately 10% of people with diabetes are affected by type 1 diabetes.[6] In this study, 21.5% (75/349) of patients with diabetes had type 1 diabetes. The higher incidence of type 1 diabetes illustrates its importance as a risk factor for the development of vascular disease. In addition to type 1 diabetes, treatment with insulin also identifies a group of patients with a higher risk of complications.[19]

In the overall population of inpatients with diabetes, 40% are on treatment with insulin. In the patients included in this study, 183/313 patients (58.5%) were receiving insulin therapy. This is therefore a patient group with more complex diabetes than the general population and therefore a high risk of complications. Table 9.1 summarises the treatment regimens for people with diabetes in this study.

Table 9.1 Diabetes treatment on admission *(Clinical questionnaire data)*

	n	%
Insulin	183	58.5
Sulphonylureas	64	20.4
Metformin	133	42.5
Thiazolidinediones	8	2.6
Dipeptidylpeptidase-4 inhibitors	12	3.8
GLP-1 agonists	2	0.6
Other	21	6.7
Subtotal	**313**	
Not answered	36	
Total	**349**	

**Answers may be multiple*

Referral to the specialist diabetes team has the potential to optimise diabetes control and to improve management of co-morbidities. Early referral to the specialist diabetes team is recommended in higher risk patients and patients undergoing emergency surgery.[19] In the National Diabetes Inpatient Audit just over half of the general inpatients with diabetes were reviewed by a diabetes specialist.[22]

In this study, 58.4% (160/274 where the answer was known) of patients were reviewed by a diabetes nurse specialist during the pre-operative period. In cases assessed by the Advisors, 123/217 (56.7%) had received advice from the diabetes team about pre-operative diabetes control (data not shown). As already noted in chapter 2 (Organisation of care), routine review by a diabetes nurse specialist only occurred in 73/132 (55.3%) hospitals performing amputations.

Table 9.2 Patients with diabetes reviewed by DNS and insulin treatment *(Clinical questionnaire data)*

Pre-operative review by DNS	Insulin		No insulin		**Subtotal**	Not answered	**Total**
	n	**%**	**n**	**%**	**n**	**n**	**n**
Yes	102	55.7	51	39.2	**153**	10	**163**
No	81	44.3	79	60.8	**160**	26	**186**
Total	**183**		**130**		**313**	**36**	**349**

It is worth noting that a similar percentage of patients were on insulin treatment as were seen by the diabetes nurse specialist (DNS). This might be taken to imply that patients on insulin were seen by a DNS. Table 9.2 shows that although a greater proportion of patients on insulin were seen by a DNS (55.7% vs. 39.2%), there were 81 patients (44.3%) on insulin who were not seen.

In the Advisors' view all patients with diabetes should have been reviewed pre-operatively by a diabetes nurse specialist. They also considered that there was the potential to improve care if patients were reviewed by a consultant diabetologist to advise on optimal management of co-morbidities and complications of diabetes.

It has been noted earlier that only 27 patients required immediate surgery. In the patients with diabetes, there were 31 cases (9%) in whom surgery occurred on the day of admission and 105 (30.6%) who had surgery within 48 hours of admission. This suggests that in the majority of cases it should be possible to make arrangements for a review of diabetes care prior to the operation.

Case study 8

An elderly patient with diabetes was admitted under the general surgical team with cellulitis and an ischaemic toe. The patient was dehydrated with an acute kidney injury and high blood sugar. A below-knee amputation was undertaken 48 hours after admission. The post operative course was complicated by stump breakdown but the patient improved slowly and was discharged.

The Advisors felt that management by a diabetes specialist had the potential to improve pre and peri-operative glycaemic control as well as optimise the management of the acute kidney injury.

The majority (62.2%; 173/278) of patients with diabetes received intravenous insulin during their admission.

In this group, the incidence of hypoglycaemia reported by the clinician who had responsibility for the patient was 10% (Table 9.3).

Table 9.3 Hypoglycaemia (glucose <4mmol/l) occurred while on the insulin infusion *(Clinical questionnaire data)*

	n	%
Yes	15	10.0
No	135	90.0
Subtotal	**150**	
Unknown	21	
Not answered	2	
Total	**173**	

While this appears at the lower end of the reported 10-20% incidence of hypoglycaemia,[22] in cases assessed by the Advisors, hypoglycaemia occurred in 22/97 (22.7%) cases where they were able to comment (Table 9.4). It is worth noting that the number of cases where the Advisors were able to identify hypoglycaemia was greater than the number identified by the clinicians.

Table 9.4 Hypoglycaemia occurred whilst on the insulin infusion (glucose <4mmol/l) *(Advisors' opinion)*

	n
Yes	22
No	75
Subtotal	**97**
Unable to answer	22
Not answered	11
Total	**130**

In cases reviewed by the Advisors, 130/255 (51%) patients received an intravenous insulin infusion. This continued for one or two days in 70/102 patients. Blood sugar monitoring is recommended at least hourly during surgery and in the immediate post operative period.[19] In 14/112 cases, blood sugar measurements were made less frequently than two hourly while patients were receiving intravenous insulin (Table 9.5).

Table 9.5 Glucose measurements were taken at least two hourly while on the infusion *(Advisors' opinion)*

	n	%
Yes	98	87.5
No	14	12.5
Subtotal	**112**	
Not applicable	6	
Not answered	12	
Total	**130**	

In order to maintain glycaemic control, usual diabetes treatment should be re-started before stopping an insulin infusion. When the insulin infusion was stopped, there were 12/64 cases where the usual diabetes treatment was not re-started before stopping this (Table 9.6).

Table 9.6 The usual diabetes treatment was re-started before the intravenous infusion was stopped *(Advisors' opinion)*

	n
Yes	52
No	12
Subtotal	**64**
Unable to answer	58
Not answered	8
Total	**130**

There were also 13/95 cases where Advisors thought that hyperglycaemia was not adequately managed or avoided during intravenous insulin treatment (Table 9.7).

Table 9.7 Hyperglycaemia was adequately managed/ avoided during the insulin infusion *(Advisors' opinion)*

	n
Yes	82
No	13
Subtotal	**95**
Unable to answer	24
Not answered	11
Total	**130**

In the majority of cases, the clinician responsible for the patient thought that peri-operative control of diabetes was satisfactory (Table 9.8). In contrast, the Advisors considered that it was either poor or unacceptable in 40/230 (17.4%) of cases (Figure 9.1).

Table 9.8 Was there satisfactory diabetes control in peri-operative period *(Clinical questionnaire data)*

	n	%
Yes	246	94.3
No	15	5.7
Subtotal	**261**	
Unknown	24	
Not answered	64	
Total	**349**	

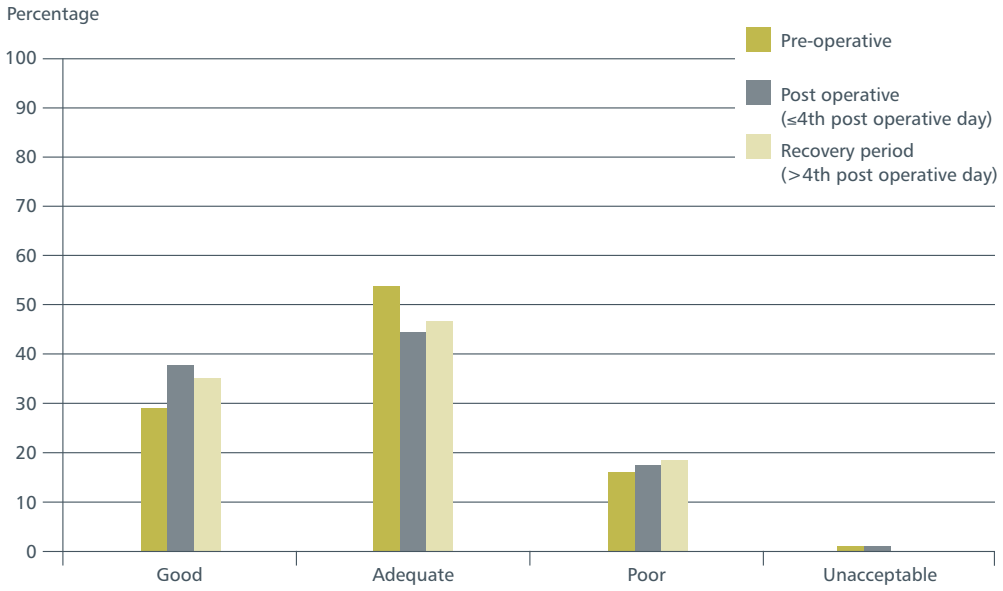

Figure 9.1 Overall rating of glycaemic control *(Advisors' opinion)*

Of 40 cases where glycaemic control was assessed as poor or unacceptable, in 9 cases, there was no clear effort made to address this prior to surgery (Table 9.9).

Table 9.9 Evidence that an effort was made to address pre-operative diabetes control prior to surgery *(Advisors' opinion)*

	n
Yes	24
No	9
Subtotal	**33**
Unable to answer	4
Not answered	3
Grand Total	**40**

Of the 24 patients with a corresponding clinical questionnaire, Advisors were able to identify review by a DNS in 9/19 cases where they were able to comment. In the 54 cases where adequate attempts were made to control blood sugar and Advisors were able to comment, 40 patients had been seen by a DNS. Review by a DNS was therefore more likely to be associated with better control of diabetes.

Good diabetes control, defined as no more than one reading of >11 mmol/l and none <4 mmol/l in a 24 hour period was achieved in 74/197 cases (37.6%) in the immediate post operative period. Glycaemic control in this period was poor or unacceptable in 36/197 (18.3%) of cases (Figure 9.1).

In the recovery period beyond the fourth post operative day, good control was achieved in a similar percentage of patients (63/181; 34.8%) (Figure 9.1). There is therefore potential to improve blood sugar control of amputation patients with diabetes at all stages of the surgical pathway.

Diabetes prescribing

Where drug charts were available for review in patients with diabetes, information on prescribing was recorded. The results of this assessment are presented in the two tables (Table 9.10 and Table 9.11).

Table 9.10 Oral Hypoglycaemic Agent (OHA) prescribing *(Advisors' opinion)*

	Did occur	Did not occur	Unable to answer	Not answered
OHA was written up	79	9	48	40
Prescription was signed by prescriber	85	8	35	47
OHA was signed as given	78	6	40	51
Dose was reduced following hypoglycaemia	17	16	93	49
Dose was changed when persistent BG>11mmol/l	20	22	83	50
Inappropriate omission of dose after hypoglycaemia	2	38	82	53

Table 9.11 Insulin prescribing *(Advisors' opinion)*

	Did occur	Did not occur	Unable to answer	Not answered
Insulin was written up	112	11	23	29
Name of insulin correct	111	8	21	35
Number (dose) clear	110	11	19	35
Unit abbreviated to 'u' or written unclearly	45	76	18	36
Insulin prescription was signed by prescriber	113	8	18	36
Insulin was signed as given	106	12	20	37
Insulin was increased when persistent BG>11 mmol/L	49	25	57	44
Insulin was reduced if unexplained BG <4mmol/L	47	12	72	44
Inappropriate omission of insulin after episode of hypoglycaemia	7	56	64	48

Basic prescribing errors were common including failure to sign prescriptions or lack of clarity of the dose required. Of the 175 cases where drug charts were available for review, 85 (48.6%) had at least one prescribing error. For insulin prescribing, this lack of clarity and specifically the abbreviation of units to the letter "u" was identified as a safety issue by the National Patient Safety Agency in 2010[52] as it has the potential to result in a ten-fold overdose risk if not written clearly (u interpreted as 0). The National Inpatient Diabetes Audit[22] has shown a progressive improvement in this safety issue from 6.3% in 2010 to 1.9% in 2013. In this study, this failure to prescribe the insulin dose was the most frequent error occurring in 45/279 (16.1%) of all patients with diabetes. The frequency with which this issue was found in patients undergoing amputation is worrying and suggests that this group of patients is more at risk from the consequences of this type of prescribing error than the general inpatient population with diabetes.

The response to both hypoglycaemia and hyperglycaemia was also examined. There was an inconsistent response in terms of prescribing both for insulin and for oral hypoglycaemic agents with no clear or logical prescription changes in response to abnormal glucose levels. This suggests that either local guidance is required to ensure an appropriate response to poor blood sugar control or the specialist diabetes team needs to be more involved in the management of these patients. Both the use of guidelines and involvement of the specialist diabetes team have been recommended in previous guidance.[19] In addition, implementation of electronic prescribing systems has the potential to reduce or eliminate the prescribing errors identified.

Complications in patients with diabetes

Patients with diabetes have a higher incidence of complications than those without diabetes.[19] This might be expected for infections, cardiovascular complications and development of renal failure, as diabetes is a risk factor for all of these in the general population.

Table 9.12 Complications in diabetes vs. no diabetes *(Clinical questionnaire data)*

	Diabetes		No diabetes		Total
	n	%	n	%	
Complication	160	45.8	130	46.6	**290**
No complication	189	54.2	149	53.4	**338**
Total	**349**		**279**		

In this study, the overall rate of complications was similar for patients with and without diabetes (Table 9.12). At least one complication occurred in 45.8% of the patients with diabetes and 46.6% of patients without diabetes.

When individual complications (listed in Table 9.13) were examined, there was no clear difference between the groups. Similarly, when they were grouped into infections or cardiovascular complications there was no clear difference. It is important to note this as it may reflect the severity of the co-morbidities other than diabetes that lead to vascular disease and the need for amputation. As discussed in the section on pre-operative co-morbidities, this would support the concept that all patients undergoing amputation, not just those with diabetes, require a service organised to deliver optimal care of their non-surgical problems.

Table 9.13 The presence of complication by diabetes *(Clinical questionnaire data)*

	Diabetes		No diabetes	
	n	%	n	%
Post operative bleeding	0	0	4	1.4
Wound infection	41	11.5	37	13.2
Chest infection	57	15.9	45	16.0
Retention of urine	10	2.8	6	2.1
Urinary tract infection	20	5.6	14	5.0
Respiratory failure	25	7.0	16	5.7
Cardiac failure	16	4.5	15	5.3
Cardiac arrhythmia	3	<1	4	1.4
Myocardial infarction	13	3.6	5	1.8
Stroke	6	1.7	5	1.8
Post operative delirium	21	5.9	14	5.0
Bloodstream infection	14	3.9	4	1.4
Clostridium difficile infection	5	1.4	5	1.8
Significant deterioration in renal function	23	6.4	10	3.6
Deep vein thrombosis	0	0	1	<1
Acute renal failure requiring RRT	5	1.4	5	1.8
Pulmonary embolus	1	<1	2	<1
Pressure sores - contralateral limb	4	1.1	10	3.6
Subtotal	**160**		**130**	
None	189		149	
Total	**349**		**279**	

Case study 9

A young patient with type 1 diabetes and peripheral neuropathy was admitted with an infected foot and poor glycaemic control. Below-knee amputation was delayed for five days while attempting to improve blood sugar. Peri- and post operative glycaemic control remained poor. The diabetes specialist team were not involved until the fifth post operative day.

Advisors thought that the specialist diabetes team should have been involved immediately on admission and that this would have provided better co-ordination of medical care and a more logical approach to blood sugar management.

Length of stay

Previous studies have shown that patients with diabetes have an increased length of stay compared with the general population of hospital inpatients.[22] In this study, there was no difference in length of stay between the patients with diabetes and without diabetes (Figure 9.2). This was not due to early mortality in patients with diabetes as there was no increase in 30 day mortality either. Again this might suggest that the complexity and co-morbidities of the cohort of patients without diabetes undergoing amputation has a similar effect to diabetes on outcomes.

It has been suggested that patients with diabetes may have a shorter length of stay if managed by the diabetes specialist team.[22] As already noted, there was considerable room for improvement in the diabetes care received. There did not however appear to be a

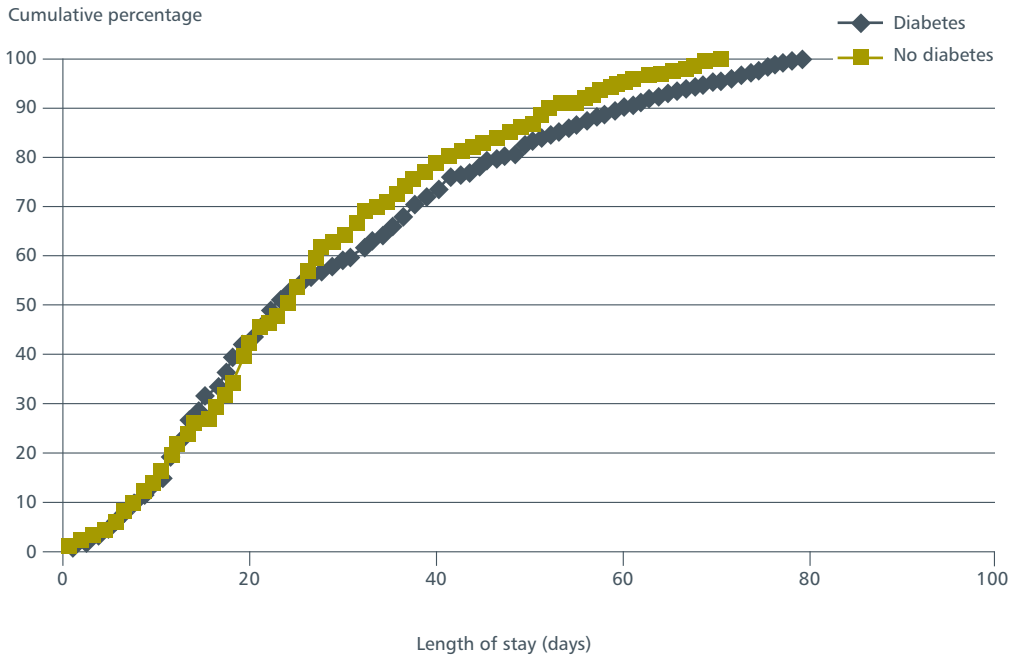

Figure 9.2 Length of stay (in patients discharged alive) by the presence of diabetes
(Clinical questionnaire data)

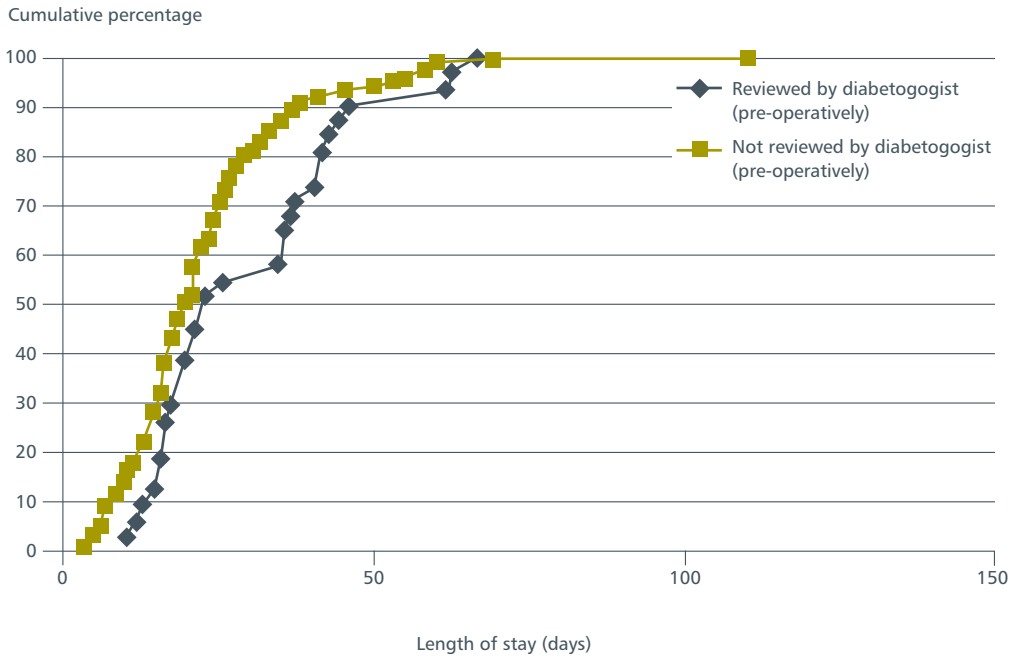

Figure 9.3 Length of stay (in patients discharged alive) by pre-operative diabetes review if not admitted under the diabetes team. *(Clinical questionnaire data)*

difference in length of stay when patients with diabetes were reviewed by the diabetes service pre-operatively (Figure 9.3). This may be because patients who were referred had worse diabetes control or more complex medical problems. Length of stay will be influenced by complication rates as well as the need for rehabilitation and complex discharge planning.

Mortality

Peri-operative mortality rates have been quoted in many studies, and as being up to 50% higher in patients with diabetes than in the non-diabetic population.[53] In the present study, the 30 day mortality was 11.6% in patients with diabetes and 13.3% in patients without diabetes.

Patients in this study with diabetes were younger (average 68 years) than those without diabetes (average 71 years). This is unlikely to explain the difference between the data on mortality presented here and in previously published work. The different rates of co-morbidities present in patients with diabetes and those without diabetes have also been discussed in chapter 3.

Overall the Advisors rated the care of diabetes as good in just under a third of patients (84/269; 31.2%) and poor or unacceptable in 28/269 (10.4%) (Figure 9.4)

It is clear from the data presented in this chapter that there is room for improvement in the care of patients with diabetes who undergo lower limb amputation. Organisation of services to provide specialist diabetes team input for this group of patients has the potential to improve diabetes control, reduce prescribing errors and deliver improved quality of care.

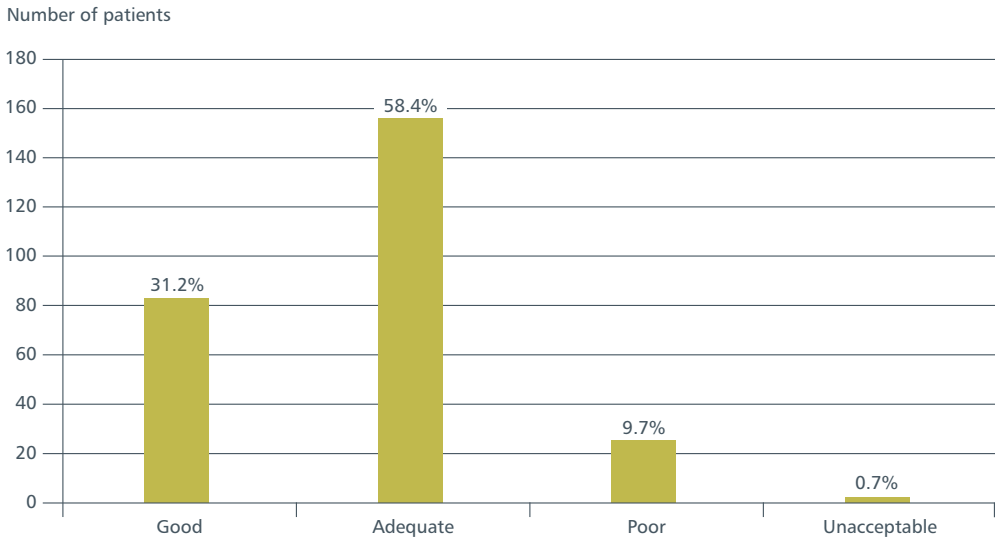

Figure 9.4 Rating of overall diabetes care *(Advisors' opinion)*

Key findings

1. 349/628 (55.6%) patients included in the study had diabetes. Patients with diabetes had a higher than average incidence of both type 1 diabetes and insulin use compared to the general population.

2. Only 41/310 (12.8%) patients with diabetes were admitted under the care of the diabetes service.

3. 160/274 (58.4%) patients with diabetes were reviewed pre-operatively by a diabetes nurse specialist.

4. The Advisors considered that glycaemic control was poor or unacceptable in 43/161 (26.7%) patients at some point within the surgical pathway.

5. Prescribing errors for both insulin and oral hypoglycaemic agents occurred commonly. The failure to prescribe insulin dose (unit abbreviated to 'U' or written unclearly) was the most frequent error occurring in 45/279 (16.1%) patients.

Organisational data

7. 140/143 (97.9%) hospitals had clinical/diabetes nurse specialists, however, where present they routinely reviewed patients under the care of the vascular unit in only 73/132 (55.3%) hospitals.

8. Diabetic foot clinics were present in 130/143 (90.9%) of hospitals.

9. Although diabetes specialists are the main specialty involved in the staffing of diabetes foot clinics (always present in 106/125 hospitals), diabetology input was less frequent at the point of MDT discussion (51/107 hospitals) and there was no presence at morbidity and mortality meetings.