

Bariatric surgery in the treatment of diabetes

Corinne Owers, Roger Ackroyd

Diabetes (the coexistence of type 2 diabetes and obesity) is rapidly becoming a global “epidemic”. Worldwide, estimates suggest that approximately 44% of the diabetes burden is attributable to obesity and being overweight (World Health Organization, 2012). To tackle the problem of diabetes, lifestyles must be modified and weight loss programmes given priority. Weight loss with conservative measures is usually relatively modest, and although any amount of weight loss can significantly improve glycaemic control, it is rarely substantial enough to result in complete remission of type 2 diabetes. Bariatric surgery therefore can be considered as a worthwhile and cost-effective intervention. Weight loss of this magnitude has been shown to cause remission of type 2 diabetes in up to 90% of people. Therefore, primary and secondary care practitioners should be aware of the impact that bariatric surgery can have on this condition, and consider surgical intervention for people in whom lifestyle modification has not affected their weight, or their diabetes. This article reviews various bariatric surgeries and the impact of each procedure on weight and diabetes.

Obesity is fast becoming one of the largest drains on NHS resources. In February 2011, a report issued by the NHS Information Centre (2011a) suggested that the number of obesity-related hospital admissions rose by 30% in 2010. The majority of these hospital admissions are secondary to conditions such as hypertension and diabetes. According to NICE, the annual cost to the NHS of obesity and related illness is £4.3 billion (Office of Health Economics, 2010), and leading UK surgeons believe that following NICE guidance on selecting individuals for bariatric surgery could save the NHS up to £56 million per annum (Office of Health Economics, 2010).

NICE (2006) guidance recommends bariatric surgery as a treatment option for people with obesity if all of the following criteria are fulfilled:

- They are ≥ 18 years of age.
- They have a BMI of 40 kg/m^2 or more, or between 35 kg/m^2 and 40 kg/m^2 and other significant

conditions (for example, type 2 diabetes or high blood pressure) that could be improved if they lost weight.

- They are or will be receiving intensive management in a specialist obesity clinic at a hospital.
- They have tried all other appropriate non-surgical treatments to lose weight but have not been able to maintain weight loss.
- They have no other specific medical or psychological reasons why they should not have this type of surgery.
- They are generally fit enough to have an anaesthetic and surgery.
- They understand that they will need long-term follow-up by a doctor and other healthcare professionals such as dietitians or psychologists.

Operative interventions

The antidiabetes effects of bariatric operations are due to decreasing insulin resistance and increasing the efficiency of the pancreatic secretion of insulin

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Article points

1. The antidiabetes effects of bariatric operations are due to decreasing insulin resistance and increasing the efficiency of the pancreatic secretion of insulin and the decrease of tissue inflammation.
2. Bariatric surgery has become increasingly advanced over the past few decades, especially since the introduction of laparoscopic surgery. Safety and efficacy has improved dramatically and it is becoming a much more reliable alternative for those with obesity.
3. In obese individuals in whom medical management of their diabetes is unsuccessful in controlling their hyperglycaemia, or in the morbidly obese (BMI $>35 \text{ kg/m}^2$), bariatric surgery may be a viable and effective treatment and both primary and secondary care practitioners should be aware of its success in treating diabetes.

Key words

- Biliopancreatic diversion
- Gastric band
- Gastrointestinal liner
- Intra-gastric balloon
- Roux-en-Y gastric bypass
- Sleeve gastrectomy

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Page points

1. Although strictly not a bariatric surgical operation (as it can be performed by any qualified endoscopist), the simplest form of bariatric intervention is the insertion of an intra-gastric balloon.
2. The laparoscopic adjustable gastric band (LAGB) involves placing an adjustable band around the proximal end of the stomach, creating a small pouch above it. As food is swallowed, the pouch fills, causing early satiety.
3. Unlike the gastric band, sleeve gastrectomy is irreversible as it involves stapling off and removing the greater part of the stomach, leaving a thin cuff of lesser curve.

and the decrease of tissue inflammation (Cummings et al, 2004).

Operations can be divided into restrictive and malabsorptive categories. The gastric band is a purely restrictive operation, but most others have an element of both. The gastric sleeve is mainly restrictive as it removes a significant part of the stomach, but restricts gastric absorption of lipid-soluble substances such as alcohol, aspirin and non-steroidal anti-inflammatories. The gastric bypass and biliopancreatic diversion fit into both categories as they involve a gastric restrictive component, and a significant bypass of small bowel, which is the primary site of nutrient absorption. Estimates suggest that normoglycaemia is achieved in 48–72% of people after a restrictive operation (James et al, 2001) and over 80% of people after malabsorptive surgery (Dixon et al, 2005).

Intra-gastric balloon

Although strictly not a bariatric surgical operation (as it can be performed by any qualified endoscopist), the simplest form of bariatric intervention is the insertion of an intra-gastric balloon. A saline-filled balloon is placed endoscopically into the stomach, where it stays for 6 months before removal. This works simply by reducing the overall capacity of the stomach, but is the least effective of all procedures, with an average excess weight loss of 15–20% (Pinkney and Kerrigan, 2004). Although the amount of weight lost is often modest in comparison with the other commonly used bariatric procedures, any amount of weight loss is beneficial and contributes significantly to achieving good glycaemic control in obese people with diabetes.

Gastric band

The gastric band is one of the most commonly performed bariatric procedures. Its precursor, the vertical banded gastroplasty (VBG), is not adjustable, and is no longer routinely performed in the UK. People with VBG are often converted to a laparoscopic adjustable gastric band (LAGB) or bypass. The LAGB (*Figure 1*) involves placing an adjustable band around the proximal end of the stomach, creating a small pouch above it. As food is swallowed, the pouch fills, causing early satiety. Many studies report differing amounts of weight loss achieved; a review of the available meta-analyses focusing on gastric banding demonstrated an average



Figure 1. An adjustable gastric band in position. The port is placed in the subcutaneous tissues, allowing for saline fills.

excess body weight loss of 50–56% (Cunneen, 2008). Although gastric banding has a mortality approaching 0% and few immediate complications, long-term complications are more significant. The most common complication is band slippage – this is where the band slips down on the stomach, creating a much bigger pouch than originally intended, and causes vomiting and dysphagia. This occurs in 2–14% of cases (Chevallier et al, 2004). Erosion is another very significant complication, occurring 1–3% of the time (Suter et al, 2006). Up to 15% of people experience problems with their port or the port tubing (Abu-Abeid et al, 2003; Chevallier et al, 2004; Lattuada et al, 2007; Dixon et al, 2012) – for example, port rotation making access difficult, port infection or leaking tubing – although not all people with port problems require further surgery. Although weight loss can be significant, it requires a high level of patient adherence to be successful.

Sleeve gastrectomy

Unlike the gastric band, sleeve gastrectomy is irreversible as it involves stapling off and removing the greater part of the stomach, leaving a thin cuff of lesser curve (*Figure 2*). This works by restricting the capacity of the stomach, resulting in early satiety, but still allowing secretion of intrinsic factor and digestive enzymes. The malabsorptive effects are reduced although some surgeons still recommend long-term treatment with vitamins and B12 injections following this type of surgery. Traditionally, sleeve gastrectomy has been performed as a first operation



Figure 2. Sleeve gastrectomy. The greater part of the stomach is removed, leaving a thin tube of lesser curve behind.



Figure 3. A Roux-en-Y gastric bypass. A pouch of stomach is created and a small bowel loop brought up to create an anastomosis. The stomach and duodenum are re-anastomosed further down the small bowel, allowing for normal enzyme secretion.

to lose weight before converting to a gastric bypass or duodenal switch, although it is becoming more common as a stand-alone procedure. One systematic review demonstrated excess body weight loss ranging from 33–90% maintained for up to 3 years (Shi et al, 2010); another showed a mean of 47.3% at 13 months (Gill et al, 2010). Resolution of type 2 diabetes has been shown to range from 50% to 90% up to 3 years after the operation (Gill et al, 2010; Nosso et al, 2011), suggesting that this is an effective treatment for diabetes. Complications of sleeve gastrectomy

include mortality and staple-line leak rates of between 1 and 3% (Vetter et al, 2009; Higa et al, 2011; Valezi et al, 2011). Some centres offer the sleeve gastrectomy as a first-line treatment for the morbidly obese individual, although this is often based on the surgeon's preference and no general consensus exists as to which operation is "best".

Biliopancreatic diversion with duodenal switch

Traditionally the biliopancreatic diversion with or without the duodenal switch was a commonly performed operation, but has lost much of its popularity in recent years. This is mainly due to the complication rates (Smith et al, 1996; Schauer et al, 2003; Sugerman et al, 2003; Wickremesekera et al, 2005; Farag and Gaballa, 2011) or consequential nutritional problems such as hypoproteinaemia, malabsorption and malnutrition (Evans and Scott, 2001). Hepatic impairment after these operations is also a well-documented consequence (Pories, 1992) that does not seem to occur in the gastric bypass, sleeve or band.

A mark is made on a segment of ileum approximately 60 cm from the ileocaecal valve, and the jejunum approximately 230–260 cm from the ileocaecal valve is transected. The proximal end is then anastomosed to the 60 cm mark. Performing a partial gastrectomy creates a small pouch of stomach and this is then anastomosed on to the free distal end of the transected jejunum. Although weight loss is significant, which makes the operation an attractive option for people with type 2 diabetes, complications can lead to other long-term problems that may in themselves contribute to hospital admissions and morbidity. Although no systematic reviews specifically detail biliopancreatic diversion or duodenal switch in terms of diabetes resolution, studies have shown an improvement in glycaemic control in close to 100% of individuals (Lifante and Inabnet, 2008; Mingrone and Castagneto, 2009).

Laparoscopic Roux-en-Y gastric bypass

The laparoscopic Roux-en-Y gastric bypass (Figure 3) is a highly successful operation in terms of diabetes treatment. The stomach is divided to create a small pouch and a further division is made approximately a metre along the small bowel (although length is variable according to the surgeon's practice). The distal end of the small bowel is then anastomosed

Page points

1. Traditionally the biliopancreatic diversion with or without the duodenal switch was a commonly performed operation, but has lost much of its popularity in recent years. This is mainly due to the complication rates.
2. Although no systematic reviews specifically detail biliopancreatic diversion or duodenal switch in terms of diabetes resolution, studies have shown a 98–100% improvement in glycaemic control.
3. The laparoscopic Roux-en-Y gastric bypass is a highly successful operation in terms of diabetes treatment.

Page points

1. One meta-analysis has shown a trend towards an increase in excess weight loss with a longer Roux-en-Y limb that suggests a benefit in super-obese people. Early remission of diabetes following gastric bypass has been shown to be as high as 83%.
2. A gastrointestinal liner is an endoscopically placed implant that has the effect of mimicking an intestinal bypass.
3. Projections from the World Health Organization estimate that by 2030, approximately 366 million people worldwide will have diabetes and Diabetes UK statistics estimate that this number will include more than 4 million of the UK's population.

onto the remaining pouch of stomach. After measuring a further metre down the small bowel (again this length varies), the remaining cut end of the small bowel (which receives the stomach and duodenal contents including bile and pancreatic juices) is re-anastomosed at this point. Food content passes through the small pouch and then joins with digestive enzymes at the distal anastomosis. This has both a restrictive and malabsorptive component, unlike the sleeve or the band.

The physiological effects of the Roux-en-Y bypass can be summarised by the acronym BRAVE (Kresser, 2010):

- Bile flow alteration.
- Reduction of gastric size.
- Anatomical gut rearrangement and altered flow of nutrients.
- Vagal manipulation.
- Enteric gut hormone modulation.

Excess body weight loss after gastric bypass has been shown in systematic reviews to be 68–76% (Tice et al, 2008). One meta-analysis has shown a trend towards an increase in excess weight loss with a longer Roux-en-Y limb that suggests a benefit in super-obese people (Orci et al, 2011). Early remission of diabetes following gastric bypass has been shown to be as high as 83% (Cossu et al, 2004). By altering the physiological function of the foregut in this manner, the action of insulin is improved and glucose metabolism altered (Michielson et al, 1996). In many cases, the authors' unit's practice is to stop insulin in post-bypass patients immediately after surgery because of the success of this procedure in helping to control diabetes. Most people continue their metformin, although they must be monitored closely post-operatively in order to see a change in blood glucose.

Gastrointestinal liners

A gastrointestinal liner (such as the EndoBarrier™ [GI Dynamics Inc, Lexington, MA, USA]) is an endoscopically placed implant that has the effect of mimicking an intestinal bypass (*Figure 4*). A sleeve is deployed that sits in the first 60 cm of jejunum secured in place with a metal anchor, blocking absorption of food. Cheaper than the gastric bypass, it also has the advantage of being reversible. As of 2010, a UK trial was recruiting people for the EndoBarrier technology, to confirm its efficacy in



Figure 4. Endoscopic insertion of a gastrointestinal liner. This is a temporary adjunct to weight loss.

the general UK population. Although the results of this trial have not yet been made available, another prospective non-randomised study demonstrated a mean weight loss of 20.4 kg at 1 year and a decrease in HbA_{1c} from 73 to 46 mmol/mol (8.8 to 6.4%). All diabetes medications with the exception of metformin were reduced, and in two people these were stopped altogether (De Moura et al, 2011). Although these results seem promising, only 22 people were recruited and nine people had early removal of the EndoBarrier due to device migration or other complications. The results of the larger UK study involving 60 people will provide further data.

Discussion

A report estimated that £9 billion, or 10% of the total NHS budget (Hex et al, 2012), is spent on treating diabetes and its complications, and that 4.3% of the UK's population in 2009/10 had diabetes (NHS Information Centre, 2011b). This number is thought to be increasing rapidly and, as a result, the number of hospital-related diabetes admissions are rising. Projections from the World Health Organization (WHO) estimate that by 2030, approximately 366 million people worldwide will have diabetes (Wild et al, 2004) and Diabetes UK (2010) statistics estimate that this number will include more than 4 million of the UK's population. Not all cases of diabetes are related to obesity, but an increased BMI

is a well-known precursor of the condition. In fact, many of the glucose and insulin abnormalities that are found in diabetes are also found in obese people without diabetes (Scopinaro et al, 1998).

Therefore, diabetes is a topic that has recently been the subject of much discussion by the WHO (2012) and the International Diabetes Federation (IDF; 2012). People with diabetes often have a number of issues including abdominal obesity, hypertension, dyslipidaemia (low high-density lipoprotein cholesterol levels, high low-density lipoprotein cholesterol levels and high triglyceride levels), and high blood glucose level (HbA_{1c} <37 mmol/mol [$<5.5\%$]). There is also a tendency to form thrombus, and a generalised systemic inflammation. This inflammation is significant in that it can be a precursor to weight gain. Infusion of inflammatory cytokines into normal healthy rats causes insulin resistance (Yu et al, 2002), and therefore perhaps by measuring these levels of cytokines, future weight gain in humans could be predicted. Inflammation begins in the fat cells – as these cells undergo hypertrophy, they become more inflamed and more resistant to insulin.

Estimates suggest that in 2011, nearly a quarter of the UK's population (22% of men and 24% of women [IDF, 2012]), had reached a BMI of >30 kg/m², which is the clinical definition of obesity. NICE guidance suggests that people with a BMI of >40 kg/m², or 35–40 kg/m² with a significant obesity-related comorbidity (including diabetes or hypertension), are eligible for surgical treatment on the NHS. Worldwide, estimates suggest that 44% of the diabetes burden is attributable to obesity and being overweight (WHO, 2012).

As with any new diagnosis of type 2 diabetes, initial management should be lifestyle modification and weight loss. In some circumstances, weight loss can completely reverse insulin resistance. Some authorities believe that for the severely obese person, especially with concurrent diabetes, bariatric surgery should be offered almost as an initial treatment (Van Nieuwenhove et al, 2011), as dietary weight loss is often not as quick, nor as effective and recurrence of weight gain is more common. Bariatric surgery “enforces” weight loss whereas simple modification of lifestyle relies on the individual adhering to their weight-loss regimen (James et al, 2001). Other studies suggest that

there is a relationship between the length of time a person is obese, and their likelihood of developing hypertension or diabetes; therefore the sooner someone is offered bariatric surgery, the more beneficial it will be to their health (Abu Abeid et al, 2003). A study by Sjöström et al (2012) showed that, when compared with a cohort of obese people not undergoing surgery, mortality was decreased in those who had undergone surgery, primarily because of reduced cardiovascular deaths.

Bariatric surgery has become increasingly advanced over the past few decades, especially since the introduction of laparoscopic surgery. Safety and efficacy has improved dramatically and it is becoming a much more reliable alternative for those with obesity. Those with diabetes may reap the most benefit; long-term studies have shown a significant benefit in reduction of diabetes (James et al, 2001; Suter et al, 2006; Mittermair et al, 2009; Van Nieuwenhove et al, 2011). One study showed that, in fact, out of 165 patients, 82.9% remained in remission from their diabetes after a mean follow-up of 14 years (Pinkney and Kerrigan, 2004). The

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2. As with any new diagnosis of type 2 diabetes, initial management should be lifestyle modification and weight loss. In some circumstances, weight loss can completely reverse insulin resistance.
3. Bariatric surgery has become increasingly advanced over the past few decades, especially since the introduction of laparoscopic surgery.

Box 1. Case study.

Mr X is a 47-year-old non-smoker with a weight of 141 kg and a BMI of 44 kg/m². He had been obese since the age of 22 and was diagnosed with type 2 diabetes at the age of 35 years. He also took anti-hypertensive medications and regular analgesics for osteoarthritis.

Although his diabetes was originally controlled with metformin 1 g twice daily, his glycaemic control had become more difficult with his HbA_{1c} ranging from 97 to 108 mmol/mol (11 to 13%). He was therefore commenced on insulin with an initial regimen of 20 units in the morning and at lunchtime and 18 units at night. He was advised by his GP to lose weight and referred to the practice weight loss programme.

After an initial loss of 15 kg following a low-calorie diet and use of medications including sibutramine and orlistat, he regained all of his weight after a hospital admission for pneumonia. His weight was now 148 kg with a BMI of 46.1 kg/m²; therefore he was referred to the local bariatric service.

A laparoscopic Roux-en-Y gastric bypass was performed. He was discharged home on the third post-operative day after being seen by the dietitian and having stopped his insulin. He was advised to regularly self-monitor his blood glucose and within 4 days of the operation, his blood glucose level was well controlled with readings between 5 and 7 mmol/L.

Following his surgery, Mr X had a 6-week review with the dietitian and the surgeon, both of whom were happy with his progress. The dietitian made regular appointments to see him over the next year, offering advice on low-calorie or sugar alternative foods. His diabetes was regularly monitored at his GP practice. By his 1-year follow-up appointment, Mr X had succeeded in losing 49 kg. As well as no longer requiring his insulin, his metformin requirement had decreased to 500 mg twice daily. His latest HbA_{1c} was measured at 50 mmol/mol (6.7%). He was advised to continue with his new healthy lifestyle, and discharged from the bariatric services back to the care of his GP at 2 years. He still attends his local bariatric support group and helps to offer support and advice to other people considering bariatric surgery.

Page points

1. The follow-up of individuals after bariatric surgery varies between hospitals and is often up to the individual unit.
2. Specialist dietitians are often part of the bariatric unit and they have expertise in monitoring the nutritional and diabetes aspect of bariatrics.
3. In obese individuals in whom medical management of their diabetes is unsuccessful in controlling their hyperglycaemia, or in the morbidly obese (BMI >35 kg/m²), bariatric surgery may be a viable and effective treatment and both primary and secondary care practitioners should be aware of its success in treating diabetes.

benefits of improved glycaemic control can be seen fewer than 6 days after surgery (Suter et al, 2006), and to a lesser extent, there is an improvement in beta-cell function (James et al, 2001).

The follow-up of individuals after bariatric surgery varies between hospitals and is often up to the individual unit. Initial follow-up usually occurs approximately 4–6 weeks post-surgery and then at regular intervals. At present in Sheffield, patients are followed up in hospital for 2 years and then discharged to primary care where possible. More frequent follow-up may be required in some people, especially those with gastric bands. Follow-up in this initial period is important to monitor weight loss, nutritional status, and glycaemic control.

Specialist dietitians are often part of the bariatric unit and they have expertise in monitoring the nutritional and diabetes aspects of bariatrics. Individuals are advised to return to the diabetes clinic either at the hospital or at their GP practice, and to contact their diabetes specialist nurse on discharge from hospital. Individuals that have been treated with insulin for their type 2 diabetes for more than 5 years before surgery are often given metformin and low-dose insulin until they have lost a significant amount of weight and their glycaemic control returns to normal.

Conclusion

In obese individuals in whom medical management of their diabetes is unsuccessful in controlling their hyperglycaemia, or in the morbidly obese (BMI >35 kg/m²), bariatric surgery may be a viable and effective treatment and both primary and secondary care practitioners should be aware of its success in treating diabetes. Early referral to a bariatric clinic would allow the individual access to weight-loss seminars, dietitians, psychologists (who have an active role in the management of obesity, particularly for individuals who binge eat), diabetologists and surgeons. The earlier a person with diabetes loses weight, either by medical or by surgical means, the less time there is for them to develop the complications of type 2 diabetes such as retinopathy, nephropathy and neuropathy, and hypertension, atherosclerosis and peripheral vascular disease (Mittermair et al, 2008). This, ultimately, will be beneficial not only to the individual in terms of morbidity and life expectancy, but also, significantly, to the health services throughout the UK. ■

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Online CPD activity

Visit www.diabetesonthenet.com/cpd to record your answers and gain a certificate of participation

Participants should read the preceding article before answering the multiple choice questions below. There is ONE correct answer to each question. After submitting your answers online, you will be immediately notified of your score. A pass mark of 70% is required to obtain a certificate of successful participation; however, it is possible to take the test a maximum of three times. A short explanation of the correct answer is provided. Before accessing your certificate, you will be given the opportunity to evaluate the activity and reflect on the module, stating how you will use what you have learnt in practice. The CPD centre keeps a record of your CPD activities and provides the option to add items to an action plan, which will help you to collate evidence for your annual appraisal.

1. According to 2011 estimates, which is the single most appropriate estimate of the proportion of the UK population who have a BMI of 30 kg/m² or more? Select ONE option only.

- A. <1%
- B. 2–5%
- C. 10%
- D. 25%
- E. 50%

2. What is the single most appropriate estimation of the proportion of the NHS budget of £90 billion that is spent on diabetes and its complications? Select ONE option only.

- A. <1%
- B. 2–5%
- C. 7.5%
- D. 10%
- E. 15%

3. A 54-year-old man is obese and has poorly controlled type 2 diabetes. Despite trying appropriate non-surgical treatments to lose weight he has been unable to maintain weight loss. There are no reasons why surgery would be contraindicated. According to NICE guidance, what is the threshold BMI at which bariatric surgery should be recommended to him?

- A. 25 kg/m²
- B. 30 kg/m²
- C. 35 kg/m²
- D. 40 kg/m²
- E. 50 kg/m²

4. Which one of the following is NOT thought to significantly contribute to the antidiabetes effects of bariatric surgery? Select ONE option only.

- A. Decreased insulin resistance.
- B. Decreased tissue inflammation.
- C. Increased incretin secretion.
- D. Increased insulin secretion.

5. Which one of the following operations would be most likely to have a restrictive rather than a malabsorptive mechanism of action? Select ONE option only.

- A. Biliopancreatic diversion with duodenal switch
- B. Gastric band
- C. Gastrointestinal liner
- D. Laparoscopic Roux-en-Y gastric bypass
- E. Sleeve gastrectomy

6. Which one of the following interventions would be expected to result in the LEAST amount of weight loss? Select ONE option only.

- A. Biliopancreatic diversion with duodenal switch
- B. Gastric band
- C. Intra-gastric balloon
- D. Sleeve gastrectomy
- E. Vertical banded gastroplasty

7. A 46-year-old man has a BMI of 50 kg/m² and has been assessed as suitable for bariatric surgery by a secondary care specialist obesity clinic. Which is the single most appropriate procedure to offer him? Select ONE option only.

- A. Biliopancreatic diversion with duodenal switch
- B. Gastric band
- C. Gastrointestinal liner
- D. Intra-gastric balloon
- E. Laparoscopic Roux-en-Y gastric bypass
- F. Sleeve gastrectomy
- G. Vertical banded gastroplasty
- H. None of the above

8. Which of the following is the most common expected long-term complication of gastric banding? Select ONE option only.

- A. Biliary colic
- B. Diarrhoea
- C. Dyspepsia
- D. Gastro-oesophageal reflux
- E. Vomiting and dysphagia

9. Which is the single most appropriate statement regarding people with diabetes post-bariatric surgery? Select ONE option only.

- A. Insulin doses should be tapered off gradually starting 6 weeks following bariatric surgery.
- B. Metformin is contraindicated post-bariatric surgery.
- C. Normoglycaemia is achieved long-term in the majority of people.
- D. Resolution of type 2 diabetes occurs in 90% of people 3 years post-bariatric surgery.
- E. Sulphonylureas are the most appropriate antidiabetes drugs post-bariatric surgery.

10. According to recent evidence, obese people undergoing bariatric surgery have reduced premature mortality rates compared with obese people not undergoing surgery. A reduction in which one of the following causes of mortality is the most appropriate explanation of this finding? Select ONE option only.

- A. Alzheimer's disease
- B. Cancer rates
- C. Cardiovascular disease
- D. Infectious disease
- E. Suicide