Glucose management team significantly improves glycaemic care and commitment to in-hospital guidelines within arthroplastic patients

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Short title: Dedicated team improves glycaemic care

Keywords: diabetes; glucose management team; glycaemic care; hyperglycaemia; implementation of guidelines; perioperative

Trial registration number: Clinical Trials.gov (NCT03306810).

Statements to comply with ethical requirements: The study protocol was approved by the Ethics Committee of the Tampere University Hospital

Declaration of interest: The authors declare that they have no conflict of interest.

Statement of informed consent: Informed consent was obtained from all individual participants in the study

Abbreviations: AGS = Acute Glucose Service, a glucose management team **AGS1**= AGS intervention group 1, **AGS2 =** AGS intervention group 2, **CPG** = capillary plasma glucose, **GMT** = glucose management team, **HbA1c =** glycated haemoglobin A1c

Word count:

Abstract:246

Main body of the text: 2904

Figures:5

Tables:2

Supplementary material: 3

Abstract

Background: Perioperative dysglycaemias are a risk for harm but guidelines to improve glucose management are poorly adhered to.

Aim: To determine whether a specialized team and diabetes education improves implementation of guidelines and glucose values.

Methods: We conducted a prospective study of 611 nonselected, consecutive patients attending for elective hip or knee arthroplasty. The first 209 patients received conventional care and the following 402 patients received intervention (Acute Glucose Service, AGS) in two chronological groups; either perioperatively (AGS1) or also preoperatively (AGS2). The AGS -team provided diabetes education, identified the patients with diabetes risk and adjusted the medication when needed. Capillary plasma glucose (CPG) was repeatedly measured and glycated haemoglobin (HbA1c) obtained before and after the surgery. The study objectives were to evaluate the staff actions when hyperglycaemia was severe (CPG >10 mmol/l), and to assess improvement of the glycaemic values and the complication rate within 3 months.

Results: None of the severely hyperglycaemic events in the reference group were treated according to guidelines. In the AGS 1 group, 50 % and in the AGS2 group, 53% were appropriately managed ($p < 0.001$). The events of hyperglycaemia (CPG >7.8 mmol/l at least twice) and of severe hyperglycaemia (CPG >10 mmol/l) decreased in all patient groups. The medians of the highest, mean and variability of CPG values improved. The mean HbA1c improved significantly within AGS 2. There was no association between improved glycaemic care and early complications.

Conclusions: AGS intervention significantly improves adherence to guidelines and glucose values.

Introduction

Perioperative dysglycaemias, regardless of previous diagnosis of diabetes, are associated with complications (including infections, vascular and embolic events), hospitalisation and increased mortality [1-4]. Perioperative patients with undiagnosed diabetes have a three-fold increase in 1-year mortality compared to diabetic patients [5]. Treatment of hospital hyperglycaemia with insulin improves outcomes, if hypoglycaemia is avoided [2].

Despite of the several controversial issues on the means, safety and outcomes, most guidelines agree with a perioperative glycaemic target between 6 and10 mmol/l [108-180 mg/dL] [6-8] but are poorly adhered to [9], usually attributed to the concern for hypoglycaemia and insufficient support [10]. In our recent study on nonselected 209 elective arthroplastic patients, more than 80% presented perioperative hyperglycaemia (>7.8 mmol/l at least twice) and 40.2% had severe hyperglycaemia (>10 mmol/l). None of these events was treated according to guidelines. Hyperglycaemia was frequent among patients with no diabetes but with a suggested diabetes risk. Additionally, most of the patients with diabetes would have benefited from an intervention but no action was taken [11].

Dedicated teams have previously shown to stabilize glycaemic care and to decrease complication rates [12-15]. This study was to determine whether a specialized team improves actions taken in case of severe hyperglycaemia, glucose values and rate of complications within 3 months of surgery.

Methods

Study design, setting and participants: This is a prospective cohort study of 611 consecutive patients attending for arthroplasty at the Päijät-Häme Central Hospital, Finland, between October 2017 and May 2019. The eligibility criteria were elective primary hip or knee arthroplasty and age over 18 years. Exclusion criteria were residence outside the catchment area, inability to give informed consent or fill the research questionnaire. The study protocol "Recognition and treatment of dysglycaemias. AGS - Acute Glucose Service" was approved by the Ethics Committee of the Tampere University Hospital and registered with the Clinical Trials.gov. (NCT03306810). Informed consent was obtained from all individual participants in the study.

Patient enrollment: Of the 1084 patients presenting for primary elective arthroplasty, 611 (56.4%) were enrolled (Figure 1). The first 209 patients received usual care and constituted a reference group [11]. To improve screening and treating of dysglycaemias, continuous education and co-operation between healthcare professionals, in May 2018 we established a glucose management team (Acute Glucose Service, AGS). The team consisted of a nurse specialist and a consulting diabetologist. AGS nurse visited the ward daily from Monday to Friday and diabetologist when needed. A rolling programme of short diabetes education sessions at weekly meeting for the whole staff was established (Figure 2). The consecutive 200 patients formulated AGS 1 group and 202 patients AGS 2 group based on the date of the operation. The details of the patient selection, flow chart of the study and AGS team interventions are presented in Figures 1 and 2.

The primary outcome was improvement in adherence to guidelines (actions taken in case of severe hyperglycaemia) and in events of hyperglycaemia. The secondary outcome was complication rate within 3 months. The exposure variables were: no AGS, AGS1 and AGS2.

Data sources: All patients were assessed one week before surgery. Routine laboratory tests, including glycated haemoglobin (HbA1c) and random plasma glucose measurements were taken.

The patients completed a FINDRISC questionnaire (Suppl. A) [16], an 8-item risk score targeting theestimated diabetes risk within the next 10 years (FINDRISC score < 7 low, 7-11 slightly elevated, 12-14 moderate, 15-20 high and >20 a very high risk).

Capillary plasma glucose (CPG) values were measured from admission until hospital discharge at least four times daily (in the morning, before lunch, in the afternoon and in the evening). Hyperglycaemia was defined as CPG >7.8 mmol/l [140 mg/dL] ≥2 times and severe hyperglycaemia as CPG >10 mmol/l [180 mg/dL]. These cut-off points were based on the definitions of hyperglycaemia and severe hyperglycaemia by the American Diabetes Association [6]. All measurements were performed by nursing teams using the Contour XT meters (Bayer Ag, Basel, Switzerland). All laboratory analyses were performed by Clinical Laboratory at the Päijät-Häme Central Hospital. The volume of perioperative bleeding, the number of units of red blood cells administered, the number of days at the intensive care unit, of total hospital days, of other complications and of readmissions within 3 months were evaluated among the study groups. All patients attended a clinical control 3 months after the operation.

The AGS -team adjusted the perioperative diabetes medication and basal insulin of the diabetic patients: in AGS 1 during hospitalization and in AGS 2 also preoperatively. Otherwise, dysglycaemias were managed according to the institutional guidelines (Suppl. B).

All patients in AGS 1 and AGS2 received a personal feedback form (Suppl. C) including the CPG values, the preoperative HbA1c, the random plasma glucose and the FINDRISC score. The exercise and nutrition routines of the patients were discussed, and written recommendations were provided. The patients without diabetes who had a FINDRISC score ≥12 were identified and informed. In AGS 2, patients with no diabetes but with a FINDRISC score ≥12 were also advised to enrol in free, pre-emptive lifestyle guidance of the primary health care services.

The actions of the staff to glucose values were analysed retrospectively. A plasma glucose of >10 mmol/l triggered action. Action was classified as positive if either insulin was admistered or the CPG value was remeasured within 1 hour and found <10 mmol/l. If glucose was neither treated with insulin nor remeasured, action was classified as negative.

Study size: Due to the descriptive nature of the first period of the study a formal sample size calculation was not conducted. The size of the two intervention groups was based on the size of the reference group (n=209).

Quantitative variables and statistical methods: All statistical analyses were performed using the IBM SPSS Statistics for Windows, version 27 (IBM Corp, Armonk, NY, USA). Quantitative data were expressed as means, standard deviations (SD) or medians and quartiles (Q1-Q3), while categorical data were expressed as numbers (percentages). The means of continuous variables were compared with independent samples t-test. The χ^2-test was used to compare categorical variables. To compare the medians of the 3 groups, the Kruskal-Wallis test was used with Bonferroni´s correction for multiple comparisons. Wilcoxon´s signed rank test was used to compare related samples. The difference was calculated between HbA1c at 3 months minus preoperative HbA1c as point estimate with 95% confidence interval. A p-value less than 0.05 was considered significant.

Results

Of the 611 participants, 112 (18.3%) had a previous diagnosis of diabetes and 35 (5.7%) were on insulin. Detailed patient characteristics and the preoperative glycaemic variables are presented in Table 1. The distribution of patients into the 3 groups is shown in Figure 1.

Perioperative period.

Figure 3B shows the improvement in staff actions in 3 study groups for the participants who had CPG >10 mmol/l. Whereas none of the patients in the reference group was treated according to guidelines, 41/82 patients (50.0%) in the AGS1 and 35/66 (53.0%) in the AGS2 were appropriately managed. The corresponding figures for the patients with diabetes were 0%, 71.4% and 72.7% and for the patients with no diabetes 0%, 38.9% and 33.3%. The number of CPG measurements other than those required by the study protocol. The number of CPG measurements other than those required by the study protocol increased up to 50% (from 42 in the reference group to 81 in AGS1 and to 77 in AGS2).

During perioperative period, 480 (78.6%) patients had hyperglycaemia (CPG >7.8 mmol/l) and 223 (36.5%) had severe hyperglycaemia (CPG >10 mmol/l). The events of severe hyperglycaemia are illustrated in Figure 3A. In the incidence of hyperglycaemia, among the patients with no diabetes there was a significant decrease between the reference group and AGS2 ($p=0.004$) and between AGS1 and AGS2 ($p<0.001$). In the patients with diabetes, the difference was not significant.

The mean, highest and variability medians of CPG values in the 3 study groups are illustrated in Figure 4. Among the patients with diabetes, there was a trend of decreasing values in all variables between the 3 study groups, but the improvement was not statistically significant. Among the patients with no diabetes, the difference was significant in all variables.

There were 3 events of hypoglycaemia (<4 mmol/l, [72 mg/dL]), in insulin-treated patients after a self-managed insulin bolus injection to correct for high glucose values. The lowest measured value was 3.1 mmol/l [55.8 mg/dL].

Postoperative period

The mean differences in the HbA1c between before and 3 months after the operation are displayed in Figure 5. The volume of perioperative bleeding, the number of units of red blood cells administered and the use of corticosteroids were evaluated. There were no statistically significant differences in these respects between the 3 study groups.

Table 2 reports the serious complications (death, deep infection, other serious infection, vascular event, embolic event or other) and all reported infections. The number of days at the intensive care unit, of total hospital days, of other complications and of readmissions within 3 months were evaluated among the study groups. There was no difference in any of these categories in any of these comparisons.

Of the 176 patients with no diabetes in the reference group, 92 (52.3%) were with FINDRISC ≥12. Of these patients, 77 (83.7%) had hyperglycaemia and 38 (41.3%) had severe hyperglycaemia which went unnoticed. In AGS1, 89/95 (93.7%) patients with no diabetes but with FINDRISC ≥12 had hyperglycaemia and 18/95 (19.0%) had severe hyperglycaemia. The corresponding figures in AGS2 were 93/104 (97.9%) and 22/104 (21.2%). In AGS1, 92.0% and in AGS2, 84.4% of these patients had written documentation in the patient chart and a message to primary care. An oral glucose tolerance test (OGTT) was recommended for 45.4% of patients with no diabetes in the AGS1 and for 41.3% patients in AGS2.

In the reference group, 6.1% patients with diabetes in need of intervention were referred to their primary care provider. One patient who had undiagnosed diabetes and 21 (63.6%) in need of intervention went unnoticed. In the AGS1, 75.7% and in the AGS 2, 81.0% of the patients with

diabetes needed intervention. One patient (2.7%) in the AGS1 and one patient (2.4%) in the AGS2 were diagnosed diabetes during perioperative period. Oral diabetes medication was initiated or adjusted in 24 % of patients both in the AGS1 and AGS2. The corresponding percentages for insulin were 18.9% and 13.0%. Of the patients with insulin in the AGS1, 75.7% were referred to follow-up in the primary care and 40.4% in the AGS2.

Discussion

Our study shows that the educative support of the AGS team has a significant and effect on staff commitment to guidelines and perioperative glycaemic values of the type 2 diabetic and nondiabetic patients: The incidence of hyperglycaemic events as well as medians of the highest, the mean and the variability of CPG values decreased. The number of hypoglycaemic events did not increase.

Potential reasons for these results may be many. First, the more active treatment of hyperglycaemia has probably resulted in lower glucose values. More than 80% of the treated events were outside office hours (without direct support of the AGS team), which may be considered a result of successful staff training. Second, patients were provided education on nutrition and exercise and this may have been of importance, as also suggested by the reduced HbA1c values. Third, proactive patient education and an individualised medication plan in AGS2 when compared to AGS1 group seems to have brought about substantial improvement. There was no additional improvement on staff actions between AGS1 and AGS2. Because of the unavoidable staff turnover during the study period this may, however, also be considered a result of successful training.

Our previous study demonstrated poor adherence to institutional guidelines and non-existent actions in response to hyperglycaemia [11]. It revealed the obvious need of active guidance and unfailing support, since the management of perioperative dysglycaemias proved to be challenging in surgical wards. In addition, it showed that patients at the risk of dysglycaemia or diabetes easily went undetected instead of referral to follow up. The results were disappointing but not surprising or new [9, 17]. As reported by Cook and colleagues, insufficient education, the fear of hypoglycaemia and poor physician support have been the leading causes for overlooking guidelines [10]. While treatment resulting in hypoglycaemia may abolish treatment targets, these findings were corroborated by discussions with the staff.

The period following hip or knee arthroplasty patients does not allow normal physical activity and poses a challenge for metabolic control. Although not statistically significant, the 1.2 mmol/mol improvement of mean difference in HbA1c among insulin-treated patients with diabetes in AGS2 and the 1.0 mmol/mol decrease within patients with no insulin in AGS1 may well be considered clinically important. Among the diabetic patients with no insulin (3.1 mmol/mol) and patients with no diabetes (1 mmol/mol) in AGS 2 the reduction of mean difference in HbA1c was significant.

A plausible mechanism for these convincing post-discharge results is the individualized patient education. Proactive planning, adjustment of diabetes medication and preprogramed follow-up contributed to this effect.

The incidence of serious postoperative complications was low. Hence, it is impossible to evaluate the effect of the AGS intervention on these variables. There were, however, some interesting observations. First, most of the deep infections occurred in the patients without diabetes. Second, all serious complications and 4 of the 5 deep infections occurred among the patients with preoperative HbA1c < 42 mmol/mol and random plasma glucose < 7.8 mmol/l. Thus, most of the complications were observed in patients who had neither diabetes nor prediabetes.

Interestingly, 4 of the 5 deep infections, 8 of the 9 other infections and both embolic events were observed among patients with no diabetes but a FINDRISC score ≥12. These patients also presented severe hyperglycaemia more frequently than patients with a FINDRISC score <12. These results corroborate our previous findings that FINDRISC is a stronger predictor of postoperative hyperglycaemia than preoperative HbA1c or a random plasma glucose [11]. The findings also suggest that FINDRISC may be an inexpensive and easy tool not only for identification of surgical patients with a future risk of diabetes [16] but also for evaluating the surgical outcomes.

The strengths of our study are that it is prospective, the study population is homogenous, HbA1c and random plasma glucose values are available and that the clinical parameters are robust

(FINDRISC score and basic data of all participants). The coverage of daily scheduled CPG measurements was high (82-100%) and their documentation was precise. The education program proceeded in consecutive steps which allowed comparison of the results of the 2 intervention groups feasible.

The study has some limitations. It was designed to evaluate longitudinal changes in the guideline implementation and glycaemic care. Patient enrolment was not randomised with respect to the intervention, but the chosen design was the only possible for examination of the impact of the AGS in the ward. Further, the sample size of patients with diabetes remained small and potential achievements within this patient group did not reach statistical power. It was not possible to determine whether the CPG values (other than on the morning of the operation) were pre-prandial or postprandial. Ideally the measurement of glucose values would have been continuous, but this was precluded because of the costs. Also, the 473 patients who declined to participate or did not meet the eligibility criteria may cause some bias.

Previous studies have shown promising results on in-hospital glucose management teams [13-15, 18-22]: Retrospective analyses suggest that they improve access to care and glycaemic control but reduce readmissions and duration of the inpatient period [13, 15, 18-20] and of costs [21]. Prospective studies are few: Wallaert and co-writers studied 38 surgical patients with vascular disease and showed that the involvement of a glucose management team improves glycaemic care [22]. Gardiner and colleagues proved that GMT reduce blood glucose and HbA1c levels [14]. These studies did not include patients with no diabetes.

Diabetes and abnormal glucose metabolism will affect a growing proportion of surgical patients. Not only patients with diabetes but also those at risk of dysglycaemic events and future diabetes need to be identified and managed without a delay. The results of our study provide evidence that structured and uninterrupted education and co-operation within the healthcare professionals may

improve the outcomes of these patients. As the improvements resulting by initial adherence to guidelines tend to diminish over time [24], we intend to continue the work of the AGS -team.

Conclusions

To improve perioperative glucose management, we established a glucose management team (Acute Glucose Service, AGS) consisting of a nurse and a consulting diabetologist. The AGS intervention included diabetes education which was directed to the nursing staff and the patients and this was accomplished in two consecutive steps (May - December 2018 and December 2018 - May 2019).

AGS intervention was effective and lead to significantly improved adherence to guidelines and perioperative glycaemic care. Postoperative glycaemic values improved significantly among patients with no diabetes, many of whom had a risk of diabetes (FINDRISC score ≥12). Among all patients, the mean postoperative HbA1c values tended to decrease (1 to 3 mmol/mol), significantly among diabetic patients with no insulin and among patients with no diabetes in the second intervention group. There was no association between improved glycaemic values and outcomes during the brief follow-up of 3 months. The success in glycaemic care and identifying the patients in need of further intervention is encouraging and may accomplish the long-term results. The patients of this study will be followed up to 5 years and we intend to report

Acknowledgements

The authors are grateful for the cooperation of colleagues and staff members at Päijät-Häme Central Hospital for CPG measurements and R. Kaikkonen, RN and S. Ranta-aho,RN for recruiting and informing the participants.

Funding: This study was funded by the Competetive Governmental Research Financing of the Expert Responsibility area of Helsinki University, [grant numbers: 2018 200230029, 2019 200230041], from the Olavi Lehtinen fund, Lahti, Finland and from the Tuovinen Foundation, Lahti, Finland.

M.Y. received personal funding from the Päijät-Häme Cultural Foundation, Lahti and from the Finnish Diabetes Association.

The funders had no role in designing and conducting the study, data collection, data analysis, reporting or interpreting of the results.

Conflicts of interest: The authors declare that they have no conflict of interest.

Legends:

Figure 1. Study flow chart

Figure 2. Details of AGS1 and AGS2 interventions

Figure 3. Proportion (as percentages) of severe hyperglycaemia (CPG > 10 mmol/l) (panel A) and proportion (as percentages) of staff actions on severe hyperglycaemia (CPG>10 mmol/l) (panel B). Results are shown in 3 study groups, separately for diabetic and nondiabetic patients. The p-values other than shown not significant.

(Abbreviations: Reference = Conventional treatment [No diabetes n=176, diabetes n=33], AGS1= Intervention group 1[No diabetes n=163, diabetes n=37], AGS2= Intervention group 2 [No diabetes n=160, diabetes n=42], Black column = No diabetes, Grey column = Diabetes

Figure 4. Boxplots of the perioperative (operation day, the1st and the 2nd postoperative days) capillary plasma glucose (CPG) values (mmol/l). A) Mean, B) highest and C) variability (SD) are presented as medians and quartiles within diabetic patients with insulin (DM insulin), diabetic patients with oral medication or GLP-1 (DM no insulin) and patients with no diagnosis of diabetes (no DM) in 3 study groups. P-values other than shown not significant.

Reference group [No diabetes n=176, diabetes n=33],

Intervention group 1 [No diabetes n=163, diabetes n=37]

Intervention group 2 [No diabetes n=160, diabetes n=42],

Figure 5. Mean differences in HbA1c (mmol/mol) between before and 3 months after surgery. Error bars show 95% confidence intervals. The results in the three study groups are shown within diabetic patients with insulin, diabetic patients with no insulin and patients with no diagnosis of diabetes.

(Abbreviations: Reference = conventional treatment group [No diabetes n=176, diabetes n=33], AGS 1= Intervention group 1[No diabetes n=163, diabetes n=37], AGS2= Intervention group 2 [No diabetes n=160, diabetes n=42],)

Supplementary materials:

A. FINDRISC score (diabetes risk questionnaire)
B. Institutional guidelines of Päijät-Häme Central Hospital (version 2017)
C. Patient feedback form

References:

1. Frisch A, Chandra P, Smiley D, et al. Prevalence and clinical outcome of hyperglycemia in the perioperative period in noncardiac surgery. Diabetes Care 2010; 33:1783-8.

2. Garg R, Hurwitz S, Turchin A, Trivedi A. Hypoglycemia, with or without insulin therapy, is associated with increased mortality among hospitalized patients. Diabetes Care 2013; 36:1107-10.

3. Kotagal M, Symons RG, Hirsch IB, et al. SCOAP-CERTAIN Collaborative. Perioperative hyperglycemia and risk of adverse events among patients with and without diabetes. Ann Surg 2015; 261:97-103.

4. Kwon S, Thompson R, Dellinger P, Yanez D, Farrohki E, Flum D. Importance of perioperative glycemic control in general surgery: a report from the Surgical Care and Outcomes Assessment Program. Ann Surg 2013; 257:8-14.

5. Teo WW, Ti LK, Lean LL, et al. The neglected perioperative population of undiagnosed diabetics - a retrospective cohort study. BMC Surg 2020; 20:188-2.

6. American Diabetes Association. 15. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes-2020. Diabetes Care 2020; 43:S193-202.

7. Dhatariya K, Levy N, Kilvert A et al. Joint British Diabetes Societies. NHS Diabetes guideline for the perioperative management of the adult patient with diabetes. Diabet Med 2012; 29:420-33.

8. Joshi GP, Chung F, Vann MA, et al. Society for Ambulatory Anesthesia. Society for Ambulatory Anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. Anesth Analg 2010; 111:1378-87.

9. Jackson MJ, Patvardhan C, Wallace F, et al. NWRAG Peri-Op Diabetes Audit Group. Perioperative management of diabetes in elective patients: a region-wide audit. Br J Anaesth 2016; 116:501-6.

10. Cook CB, Elias B, Kongable GL, Potter DJ, Shepherd KM, McMahon D. Diabetes and hyperglycemia quality improvement efforts in hospitals in the United States: current status, practice variation, and barriers to implementation. Endocr Pract 2010; 16:219-30.

11. Ylikoski M, Jokinen JJ, Lahtela J, Kauppi MJ, Huhtala H, Immonen H, Tiihonen R. Perioperative hyperglycaemia in elective arthroplasties. Should we do better? Acta Anaesthesiol Scand 2020. https://doi.org/10.1111/aas.1366

12. Bansal V, Mottalib A, Pawar TK, et al. Inpatient diabetes management by specialized diabetes team versus primary service team in non-critical care units: impact on 30-day readmission rate and hospital cost. BMJ Open Diabetes Res Care 2018; 6:e000460.

13. Flanagan D, Moore E, Baker S, Wright D, Lynch P. Diabetes care in hospital--the impact of a dedicated inpatient care team. Diabet Med 2008; 25:147-51.

14. Gardiner FW, Nwose EU, Bwititi PT, Crockett J, Wang L. Does a hospital diabetes inpatient service reduce blood glucose and HbA1c levels? A prospective cohort study. Ann Med Surg (Lond) 2017; 26:15-8.

15. Garg R, Schuman B, Bader A, et al. Effect of Preoperative Diabetes Management on Glycemic Control and Clinical Outcomes After Elective Surgery. Ann Surg 2018; 267:858-62.

16. Lindstrom J, Tuomilehto J. The diabetes risk score: a practical tool to predict type 2 diabetes risk. Diabetes Care 2003; 26:725-31.

17. Malcolm JC, Kocourek J, Keely E, et al. Implementation of a screening program to detect previously undiagnosed dysglycemia in hospitalized patients. Can J Diabetes 2014; 38:79-84.

18. Garg R, Metzger C, Rein R, et al. Nurse practitioner-mediated intervention for preoperative control of diabetes in elective surgery patients. J Am Assoc Nurse Pract 2016; 28:528-33.

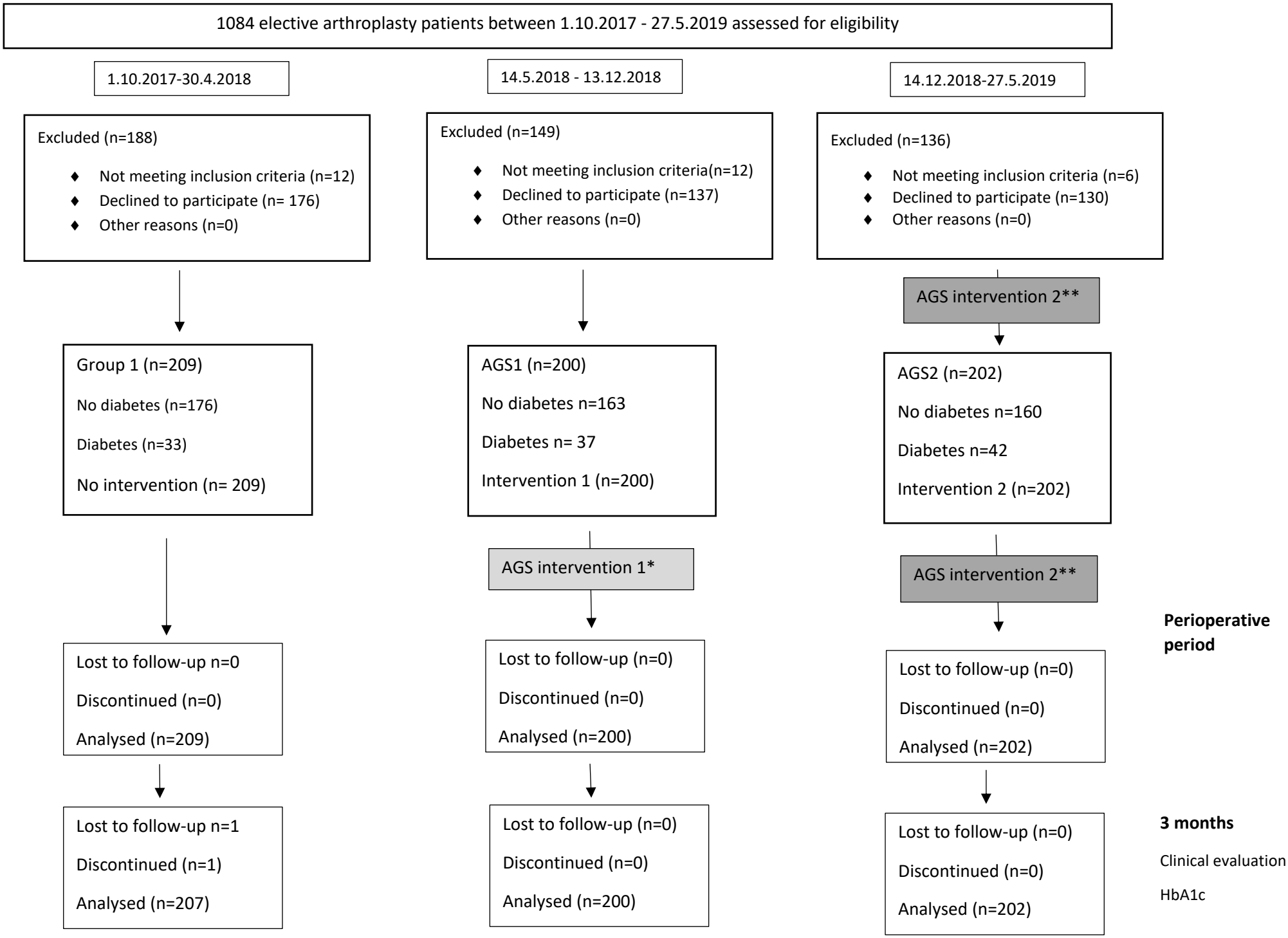
19. Wang YJ, Seggelke S, Hawkins RM, et al. Impact of Glucose Management Team on Outcomes of Hospitalizaron in Patients with Type 2 Diabetes Admitted to the Medical Service. Endocr Pract 2016; 22:1401-5.

20. Momesso DP, Costa Filho RC, Costa JLF, et al. Impact of an inpatient multidisciplinary glucose control management program. Arch Endocrinol Metab 2018; 62:514-22.

21. Newton CA, Young S. Financial implications of glycemic control: results of an inpatient diabetes management program. Endocr Pract 2006; 12 Suppl 3:43-8.

22. Wallaert JB, Chaidarun SS, Basta D, et al. Use of a glucose management service improves glycemic control following vascular surgery: an interrupted time-series study. Jt Comm J Qual Patient Saf 2015; 41:221-7.

23. Udovcic M, Castro JC, Apsey HA, Stearns JD, Schlinkert RT, Cook CB. Guidelines to improve perioperative management of diabetes mellitus: assessment of the impact of change across time. Endocrine Practice 2015; 21:1026-34.


1084 elective arthroplasty patients between 1.10.2017 - 27.5.2019 assessed for eligibility
1.10.2017-30.4.2018
14.5.2018 - 13.12.2018
14.12.2018-27.5.2019
Excluded (n=188)
Not meeting inclusion criteria (n=12)
Declined to participate (n= 176)
Other reasons (n=0)
Excluded (n=149)
Not meeting inclusion criteria(n=12)
Declined to participate (n=137)
Other reasons (n=0)
Excluded (n=136)
Not meeting inclusion criteria (n=6)
Declined to participate (n=130)
Other reasons (n=0)
AGS intervention 2**
Group 1 (n=209)
No diabetes (n=176)
Diabetes (n=33)
No intervention (n= 209)
AGS1 (n=200)
No diabetes n=163
Diabetes n= 37
Intervention 1 (n=200)
AGS2 (n=202)
No diabetes n=160
Diabetes n=42
Intervention 2 (n=202)
AGS intervention 1*
AGS intervention 2**
Perioperative period
Lost to follow-up n=0
Discontinued (n=0)
Analysed (n=209)
Lost to follow-up (n=0)
Discontinued (n=0)
Analysed (n=200)
Lost to follow-up (n=0)
Discontinued (n=0)
Analysed (n=202)
Lost to follow-up n=1
Discontinued (n=1)
Analysed (n=207)
Lost to follow-up (n=0)
Discontinued (n=0)
Analysed (n=200)
Lost to follow-up (n=0)
Discontinued (n=0)
Analysed (n=202)
3 months
Clinical evaluation
HbA1c

***AGS (Acute Glucose Service) intervention 1**

Patient

Preoperative assessment: No intervention

Perioperative period:

- Personal feedback[1] and lifestyle intervention
- Adjustments of diabetic medication, if necessary
- Follow-up care plan (documented on patient chart and primary care informed)

Personnel

- Daily visits without consultation
- Active support and interactive communication
- Weekly interactive lessons (15 min) on the following topics:

Hyperglycaemia (institutional guidelines)

Hypoglycaemia (institutional guidelines)

Difference between insulin-dependent and not insulin-dependent diabetic patients

[1]Presented in supplement

**** AGS (Acute Glucose Service) intervention 2**

Patient

Preoperative assessment:

All patients: Education

Diabetic patients:

- Individual medication plan, adjustments if necessary
- Patients on insulin: written dosage plan until second postoperative day,
- Patients not on insulin: written basal-bolus dosage plan until second postoperative day

Perioperative period:

All patients: Personal feedback[1] and lifestyle intervention

- Follow-up care plan (documented on patient chart and primary care informed)
- Contact to primary care ensured

Diabetic patients:

- Individual medication plan
- Adjustments of medication, if necessary

Non-diabetic risk patients (FINDRISC ≥12) advised to attend preventive groups

Personnel:

- Daily visits without consultation
- Active support and interactive communication
- Weekly interactive lessons (15 min) on the following topics:

Hyperglycaemia (institutional guidelines)

Hypoglycaemia (institutional guidelines)

Special treatment of insulin-dependent (DM1) and not insulin-dependent (DM2) diabetic patients

Diabetes technology (wish from personnel)

Oral diabetic and GLP-1 medications (wish from personnel)

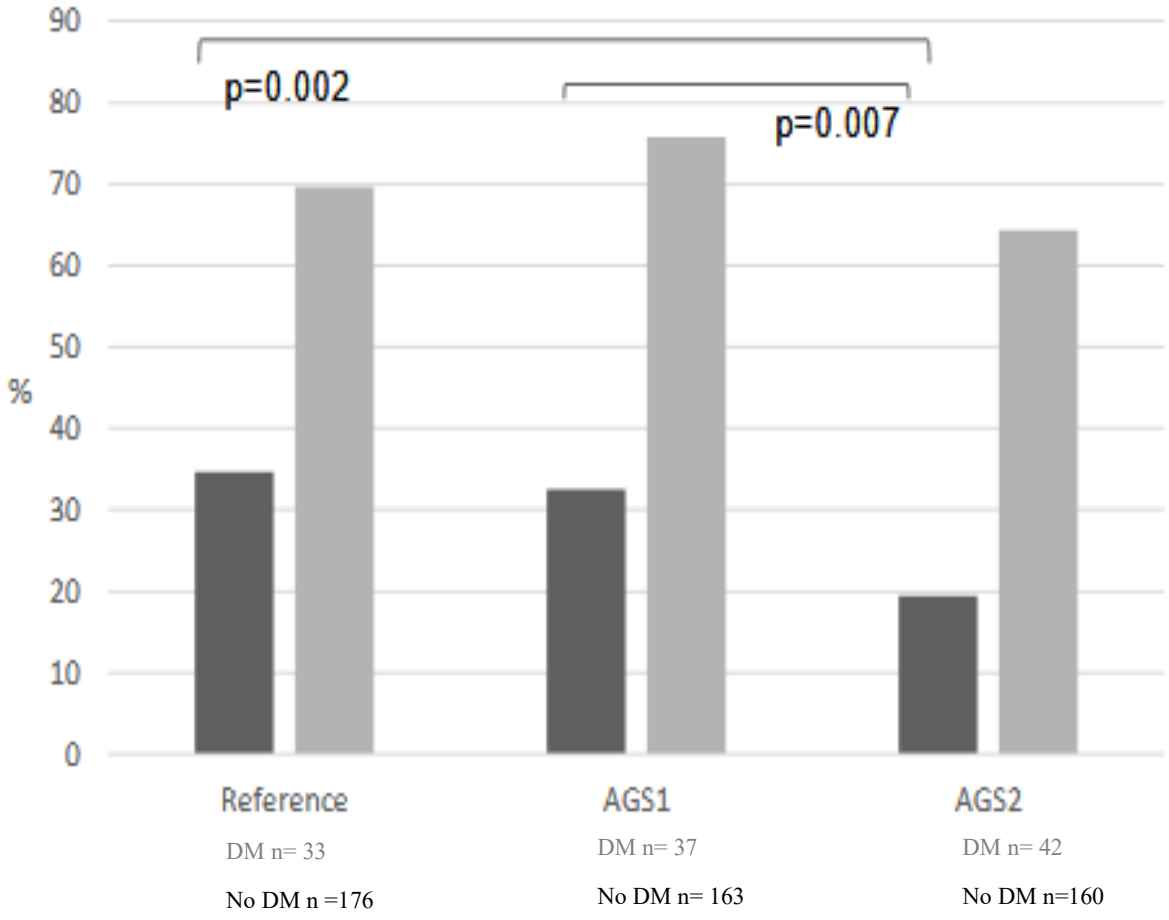
[1] Presented in supplement

Table 1. Basic patient characteristics, preoperative HbA1c, random plasma glucose and FINDRISC score (suppl) among nondiabetic and diabetic patients in 3 study groups

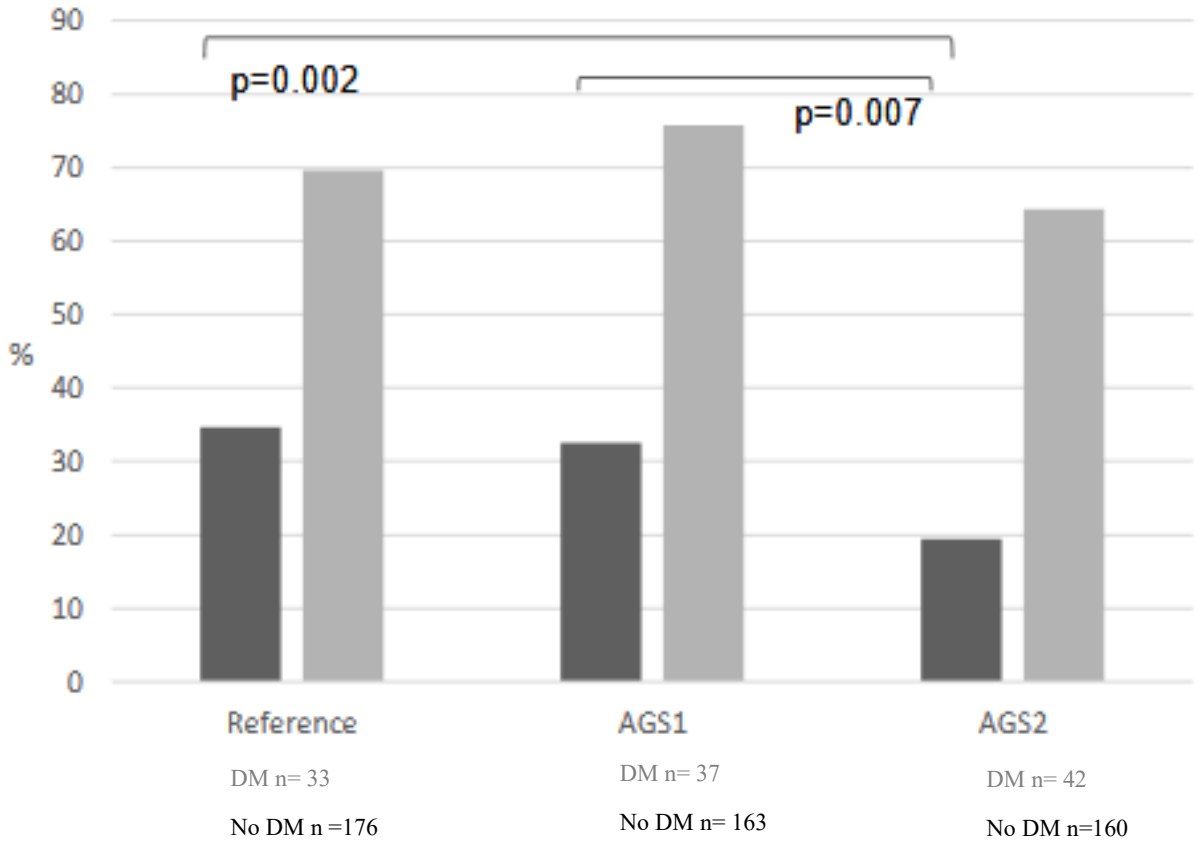
Characteristics	No DM							DM						
	Ref		AGS1		AGS2			Ref		AGS1		AGS2		
	n=176		N=163		N=160			N=33		N=37		N=42		
	n/mean	%/ (SD)	n/mean	%/ (SD)	n/mean	%/(SD)	p-value	n/mean	%/(SD)	n/mean	%/ (SD)	n/mean	%/(SD)	p-value
Age, years	67.5	(9.9)	68.3	(9.5)	66.8	(9.2)	0.33	66.1	(9.7)	67.9	(7.4)	68.3	(7.3)	0.46
Female	117	66.5	98	60.1	83	51.9		13	39.4	20	54.1	21	50.0	0.45
BMI, kg/m^2	28.9	(4.6)	29.2	(4.9)	30.2	(5.0)	0.05	30.7	(4.7)	32.5	(5.7)	32.8	(4.8)	0.22
Waist, cm	99.5	(12.4)	100.5	(13.4)	103.5	(12.1)	0.02	109.3	(12.7)	109.3	(12.6)	110.8	(10.6)	0.82
Comorbidities														
Hypertension	84	47.7	90	55.2	89	55.6	0.26	26	78.8	31	83.8	38	90.5	0.37
Hyperlipidaemia	69	39.2	57	35.0	59	36.9	0.72	24	72,7	14	37.8	25	59.5	0.01
Atherosclerotic disease	20	11.9	24	15.1	25	15.6	0.46	6	18.2	7	18.9	8	19.0	0.10
Chronic kidney disease	8	4.5	7	4.3	13	8.1	0.24	3	9.1	7	18.9	7	16.7	0.49
Sleep apnoea	8	4.5	6	3.7	16	10.1	0.02	7	21.2	10	27.0	5	11.9	0.23
Rheumatoid arthritis	5	2.5	6	3.7	6	3.8	0.88	3	9.1	4	10.8	2	4.8	0.59
HbA1c,mmol/mol	35.3	(3.8)	36.0	(4.2)	36.5	(4.01)	0.02	46.1	(9.8)	47.4	(8.8)	47.1	(7.4)	0.02
Random plasma glucose, mmol/l														
< 7.8	169	96	151	92.6	151	94.4	0.40	22	66.7	22	59.5	26	61.9	0.82
≥ 7.8	7	4.0	12	7.4	9	5.6		11	33.3	15	40.5	16	38.1	
FINDRISC score														
< 12 Little risk	84	47.7	68	41.7	54	33.8	0.03	2	6.1	2	5.4	2	4.8	0.97
≥ 12 Intermediate to high risk	92	52.3	95	58.3	106	66.3		31	93.9	35	94.6	40	95.2	

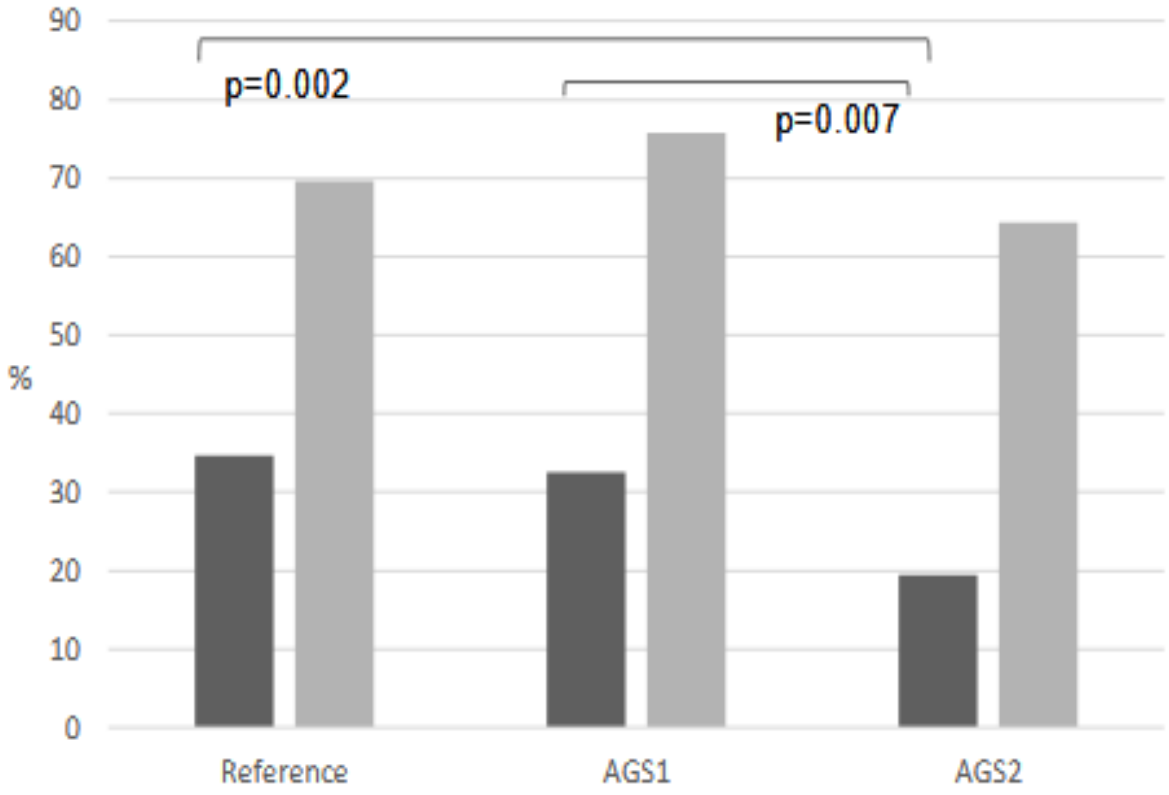
Ref=reference group, AGS1= Intervention group 1, AGS2= Intervention group 2

3A

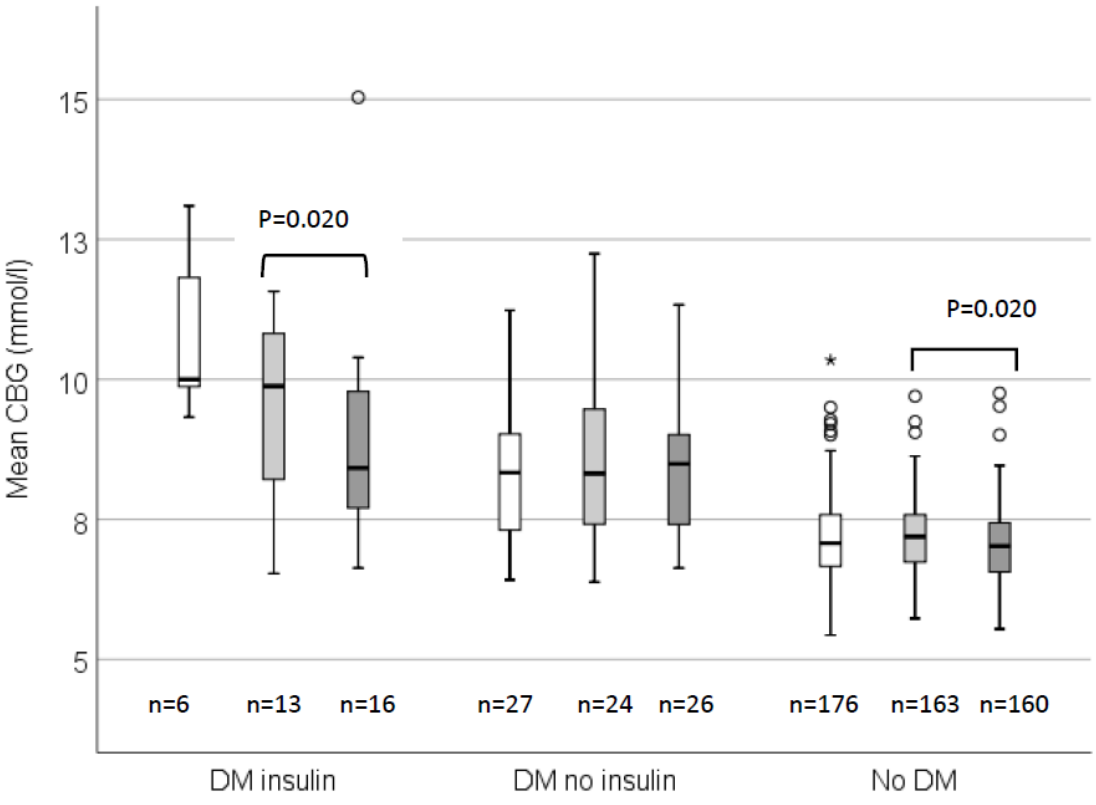

90
80
70
60
50
%
40
30
20
10
0
p=0.002
p=0.007
Reference
AGS1
AGS2
DM n= 33
No DM n =176
DM n= 37
No DM n= 163
DM n= 42
No DM n=160

3B

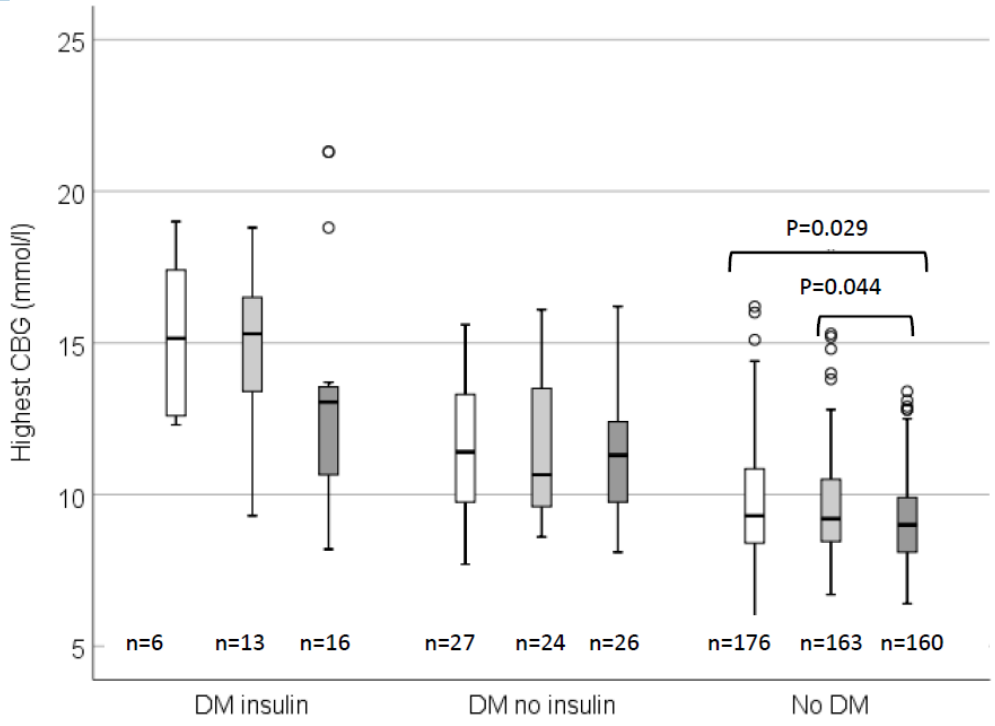

90
80
70
60
50
%
40
30
20
10
0
p=0.002
p=0.007
Reference
AGS1
AGS2
DM n= 33
No DM n =176
DM n= 37
No DM n= 163
DM n= 42
No DM n=160


90
80
70
60
50
40
30
20
10
0
%
p=0.002
p=0.007
Reference
AGS1
AGS2

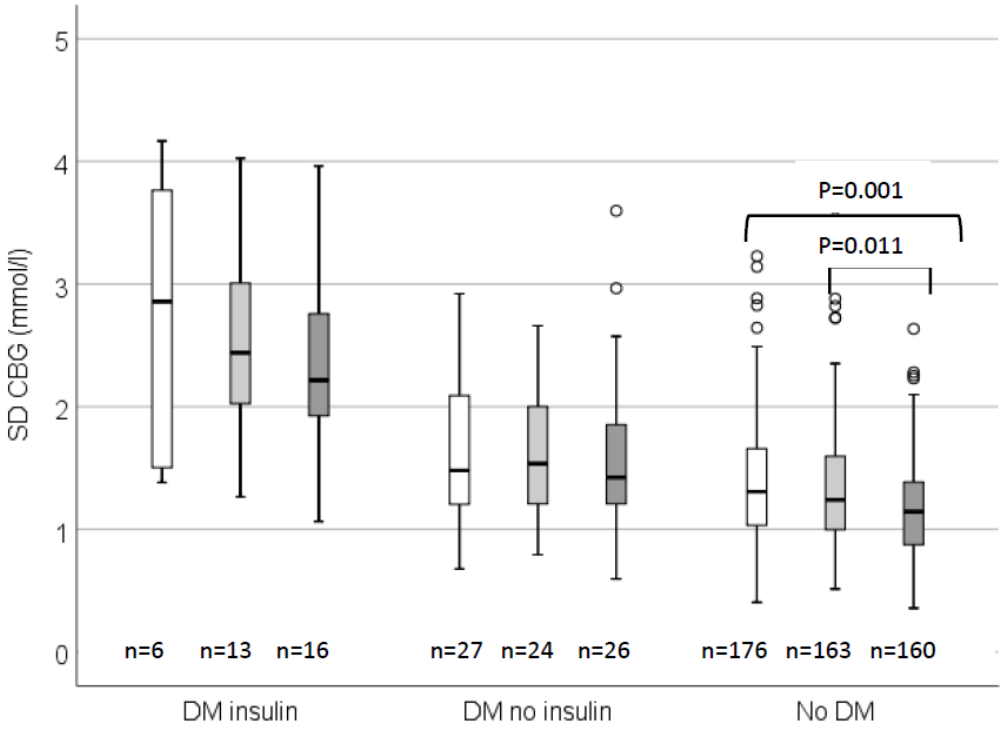
A.


Mean CBG (mmol/l)
15
13
10
8
5
P=0.020
P=0.020
n=6
n=13
n=16
n=27
n=24
n=26
n=176
n=163
n=160
DM insulin
DM no insulin
No DM

B.


Highest CBG (mmol/l)
25
20
15
10
5
P=0.029
P=0.044
n=6
n=13
n=16
n=27
n=24
n=26
n=176
n=163
n=160
DM insulin
DM no insulin
No DM

C.


SD CBG (mmol/l)
5
4
3
2
1
0
P=0.001
P=0.011
n=6
n=13
n=16
n=27
n=24
n=26
n=176
n=163
n=160
DM insulin
DM no insulin
No DM

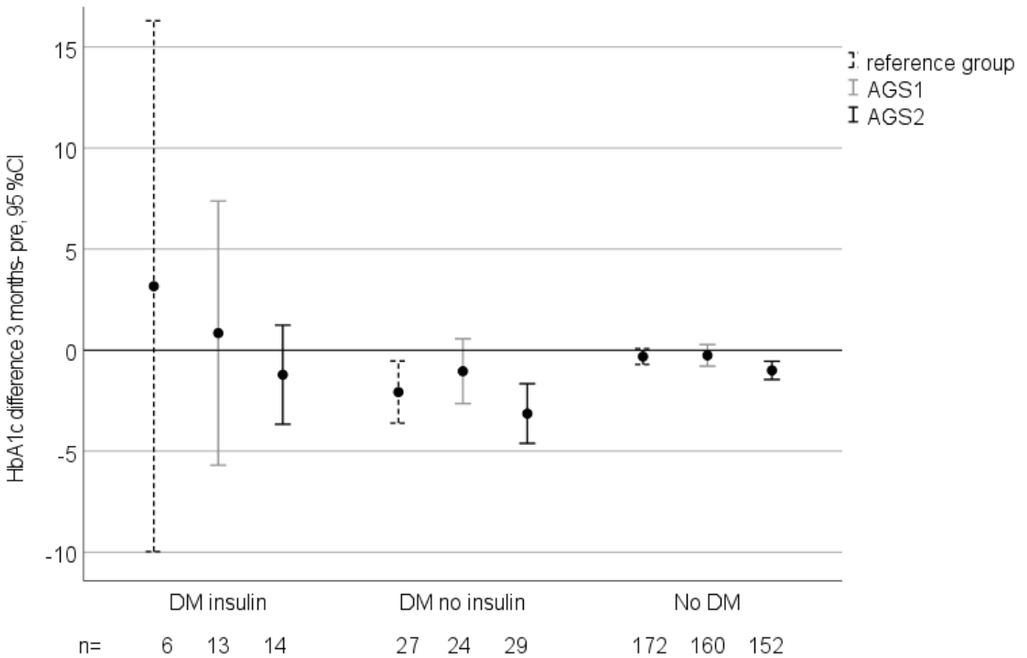

15
10
5
0
-5
-10
HbA1c difference 3 months- pre; 95 %CI
reference group
AGS1
AGS2
DM insulin
DM no insulin
No DM
n=
6
13
14
27
24
29
172
160
152

Table 2. Serious complications and other infections in the 3 study groups.

	No DM						**DM**					
	Ref		AGS1		AGS2		Ref		AGS1		AGS2	
	N= 176	%	N=163	%	N=160	%	N=33	%	N=37	%	N=42	%
Serious complications												
Death	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deep infection	1	0.6	0	0.0	4	2.5	1	3.0	0	0.0	0	0.0
Other serious infection	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Vascular	3	1.7	0	0.0	0	0.0	0	0.0	0	0.0	1	2.4
Embolism	1	0.6	0	0.0	1	0.6	1	3.0	0	0.0	1	2.4
Other	0	0.0	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
Surgical:	5	2.8	2	1.2	2	1.3	0	0.0	2	5.4	2	4.8
Other infections	3	1.7	2	1.2	4	2.5	1	3.0	5	13.5	3	7.1
All complications:	13	7.4	5	3.1	11	6.9	3	9.1	7	18.9	8	21.6

Deep infection: Prosthesis infection, reoperation and/or prolonged antibiotic treatment and/or in-hospital care. Other serious infection: Other infection requiring intravenous antibiotics and/or in-hospital care. Vascular: Acute coronary syndrome, atrial fibrillation or stroke. Embolism: Deep venous or pulmonary embolism. Other: Delirium. Surgical: Luxation, fracture, seroma or nerve injury. Other infection: Infections (urinary, skin or respiratory) not requiring in-hospital care

There were no significant differences with respect to complications between the three groups (separately within nondiabetic and diabetic patients), p-values not shown.

PÄIJÄT-HÄMEEN
hyvinvointikuntayhtymä

TYYPIN 2 DIABETEKSEN RISKIIN VOI ITSE VAIKUTTAA

- tyypin 2 diabetes on aineenvaihdunnan sairaus, joka kehittyy pitkän ajan, usein noin kymmenen vuoden kuluessa
- jokainen voi elintavoillaan vaikuttaa tyypin 2 diabeteksen sairastumisriskiin, vaikka kantaisikin perinnöllistä sairastamisalttiutta
- painonhallinta, säännöllinen liikunta, terveellinen syöminen ja laadukas uni auttavat pienentämään tyypin 2 diabeteksen riskiä

Esidiabetes

On tyypin 2 esivaihe, jolloin verensokeri on hieman koholla

Punasoluihin tarttuva sokeri, **sokerihemoglobiini HbA1c** kuvastaa pitkäaikaista sokeritasapainoa

Veren glukoosi eli sokeri voi kohota kolmesta eri syystä:

- keho ei reagoi insuliiniin kunnolla (=insuliiniresistenssi)
- keho ei tuota riittävästi insuliinia
- molemmat edellä mainitut yhdessä

Oma tilanteeni

HbA1c_____ **Tyypin 2 dm riskipistetestin pisteet**_____

P-gluc_____ **Verensokeriseuranta osastolla**_____

_____

_____

_____

PÄIJÄT-HÄMEEN
hyvinvointikuntayhtymä

TEESIT DIABETESRISKIN NUJERTAMISEEN

Lisää liikettä arkeen!

Terveyden ja hyvinvoinnin kannalta on tärkeintä löytää itselle sopivia liikuntamuotoja, joita jaksaa ja haluaa tehdä säännöllisesti. Tärkeää on aloittaa rauhallisesti ja kuunnella omaa kehoa. Vähitellen aikaa ja rasitustasoa voi lisätä.

Monipuolinen liikunta pienentää monien sairauksien, kuten tyypin 2 diabeteksen ja verisuonisairauksien riskiä. Tärkeintä on liikkua riittävästi ja säännöllisesti.

kestävyysliikunta

Vahvistaa sydämen, keuhkojen ja verisuonien kuntoa ja toimintakykyä (esim.kävely, sauvakävely, hölkkä, juoksu, uinti, pyöräily, rullaluistelu ja hiihto)

lihasvoimaharjoittelu

Vahvistaa lihaksia sekä parantaa voimatasoa ja tasapainoa (esim. kuntosaliharjoittelu, kotijumppa, raskaat puutarha- ja lumityöt, painavien taakkojen kantaminen)

Vältä runsasta yhtäjaksoista istumista, pienikin jalottelu istumisen katkaisemiseksi tekee keholle hyvää.

Onko minulla kestävyys- ja lihaskuntoa kuormittavaa liikuntaa?_____

_____

Hyötyliikunnalla lisäät päivän aktiivisuutta merkittävästi!

Esimerkkejä hyötyliikunnasta:

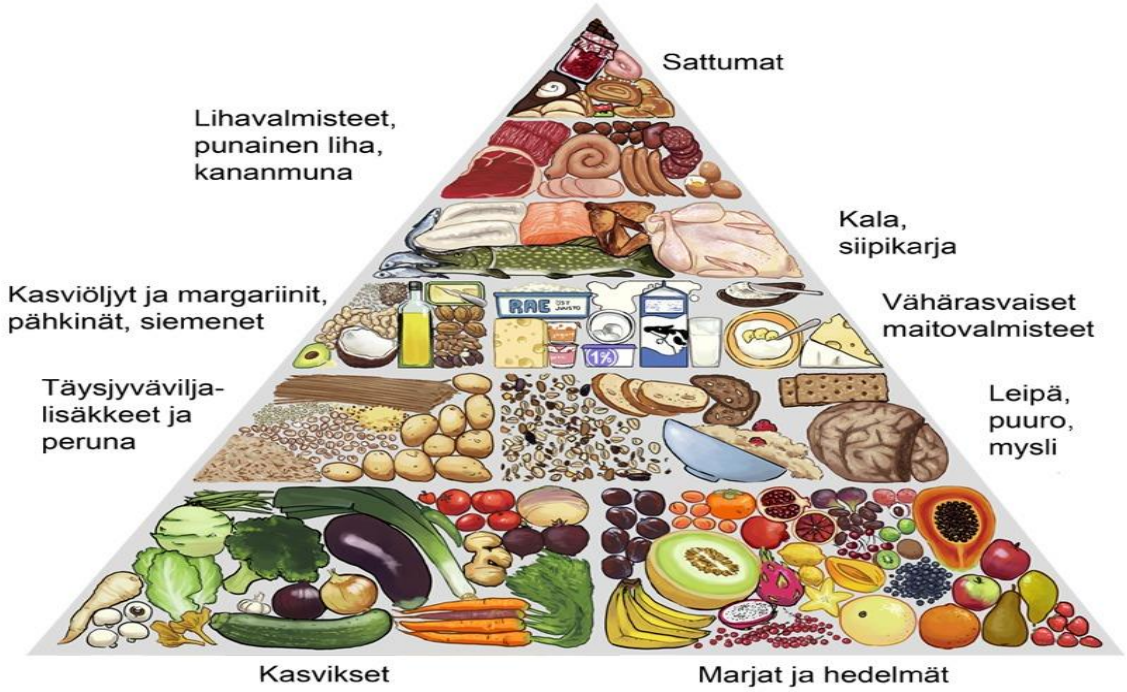
- Parkkeeraa auto 200 m päähän työpaikalle mennessä -> 2 km/viikko
- Hoida kolmena päivänä viikossa kauppareissut (500m) kävellen tai pyörällä -> 3 km /viikko
- Kävele kahtena päivänä viikossa bussin tai auton sijaan 1 km/suunta -> 4 km viikko
- Tee lyhyt iltalenkki kolmena iltana viikossa 1,5 km suunta -> 9 km/viikko

Mitä hyötyliikuntaa voin lisätä omaan arkeeni?_____

_____

Lisää ohjeita liikkumiseen www.ukkinstituutti.fi tai oman kunnan liikuntaneuvojalta.

Ruokakolmio



Rytmiä ruokailuun!

Monipuolinen ruokavalio edistää terveyttä ja hyvinvointia. Syömisessä kannattaa kiinnittää huomiota ruuan määrään ja laatuun sekä ruokarytmiin. Sopiva määrä ruokaa kohtuullisina annoksina aterioilla, auttaa säilyttämään normaalipainon. Toteuta omaan elämääsi soveltuvaa ateriarytmiä, jolloin aterioiden väli ei jää liian pitkäksi ja kohtuusyöminen onnistuu. Terveelliset ruokatottumukset ovat jokaisen ulottuvilla olevaa lääkkeetöntä hoitoa.

Kenties syöt jo paljon hedelmiä, mutta unohtuvatko vihannekset, juurekset tai marjat?

_____

_____

Lisää

Juureksia, vihanneksia, marjoja ja hedelmiä erivärisinä. Syö jokaisella aterialla reilu kourallinen kasviksia, hedelmiä tai marjoja. Näin ruokavalio kevenee ja keho saa tarvitsemiaan vitamiineja, kivennäisaineita ja kuitua. Käytä kasviksia ruoanlaitossa ja syö jälkiruoaksi ja välipalaksi marjoja hedelmiä eri muodoissa. Aloita lisäämällä annos kerrallaan.

Mistä minun on helpointa aloittaa?_____

Syö **kalaa** vähintään kahdesti viikossa kalalajeja vaihdellen. Kalasta saa paljon tyydyttämätöntä pehmeää rasvaa, D-vitamiinia ja proteiinia. Kalan rasva on sydänystävällistä, sillä se sisältää välttämättömiä rasvahappoja.

Vaihda

Vaaleat viljavalmisteet täysjyvävalmisteisiin. Suosi täysjyvää ja valitse ainakin puolet viljatuotteista täysjyväisinä. Täysjyvätuotteet pitävät nälän loitolla, verensokerin tasaisena ja mielen virkeänä. Kuidun saantia voi parantaa suosimalla täysjyväisiä viljatuotteita (esim. ruisleipä, näkkileipä, 100 % kauraleipä, hiutalepuurot, leseet, täysjyväpasta, runsaskuituiset murot ja myslit). Täysjyvätuotteista keho saa runsaasti kuitua, vitamiineja ja kivennäisaineita.

Miten saan lisättyä täysjyvää käytännössä arkeeni?_____

_____

Vaihda voi/voita sisältävät levitteet öljyiksi ja kasvismargariineiksi

Vaihda rasvaiset nestemäiset maitovalmisteet rasvattomiksi tai vähärasvaisiksi (rasvaa 1% tai vähemmän)

Vaihda rasvaiset juustot vähärasvaisiksi (rasvaa 17 % tai vähemmän)

Vaihda punainen liha osittain siipikarjaan. Punaisella lihalla tarkoitetaan naudan-, sian- ja lampaanlihaa. Punaista lihaa ja prosessoituja lihatuotteita suositellaan korkeintaan 500 g viikossa.

Kuinka voit korvata osan jauhelihasta resepteissä?_____

Vaihda eläinproteiini (liha, kala, kananmuna, maitotaloustuotteet) osittain kasvisproteiiniin (palkokasvit, soijatuotteet, pähkinät)

Vaihda runsassuolaiset tuotteet vähemmän suolaa sisältäviin. Suolaa saadaan eniten leivästä, leikkeleistä ja makkaroista. Suolan vähentäminen alentaa verenpainetta ja sydän, verenpaine ja aivot voivat hyvin kun verenpaine laskee.

Kuinka vähennän suolan käyttöä?_____

_____

Vaihda jodioimaton suola jodioituun. Liian vähäinen jodin saanti lisää riskiä sairastua kilpirauhasen vajaatoimintaan ja struumaan. Käytä ruoanlaitossa vähän suolaa, mutta valitse jodioitu vaihtoehto. Erityissuolat ovat harvoin jodioituja. Jodia saa myös maitotuotteista, kalasta ja muista merenelävistä.

Vähennä

Syö **vähemmän** ruokia, jotka sisältävät **eläinrasvaa tai piilorasvaa**. Tyydyttynyttä eli kovaa rasvaa saadaan liha- ja maitotuotteista ja teollisista leivonnaisista, kakuista ja kekseistä. Näkymätön piilorasva on yleensä kovaa rasvaa.

Kuinka vähennän kovaa rasvaa ruokavaliostani?_____

_____

Herkkuja harkiten!

Syö **vähemmän sokeripitoisia ruokia ja juomia**. Puhdas sokeri sisältää paljon energiaa mutta ei lainkaan vitamiineja ja kivennäisaineita. Vähennä lisättyä sokeria sisältäviä juomia ja ruokia (limsa, mehut, energiajuomat, makeiset, suklaa, maustetut jogurtit ja leivonnaiset, jäätelö)

Kuinka vähennän käytännössä sokerin käyttöä?_____

_____

Sokeria suositellaan syötävän korkeintaan 22 sokeripalan verran päivässä!

Herkuissa on eroja:

kakkupala= 5,5 sokeripalaa

0,5 l limsaa= 20 sokeripalaa

karkkipussi = 33 sokeripalaa

maustettu jogurtti (200g) = 7 sokeripalaa

jäätelö 2 palloa = 5,5 sokeripalaa

Lisää kuitua!

Kuidun saantia voi parantaa suosimalla täysjyväisiä viljatuotteita (esim. ruisleipä, näkkileipä, 100 % kauraleipä, hiutalepuurot, leseet, täysjyväpasta, runsaskuituiset murot ja myslit). Täysjyvätuotteista keho saa runsaasti kuitua, vitamiineja ja kivennäisaineita. Kuitupitoisen ruoan syönti on tärkeää myös suoliston terveyden kannalta. Se myös tasaa verensokeritasoa ja madaltaa kolesteroliarvoja.

Saatko riittävästi kuitua?

_____

_____

Lisää pehmeää rasvaa!

Ruoasta saatavan rasvan laatu jaetaan tyydyttyneisiin eli koviin rasvoihin (voi, voita sisältävät levitteet ja punainen liha) ja tyydyttymättömiin eli pehmeisiin rasvoihin (kasviöljyt, öljypohjaiset salaatinkastikkeet, pähkinät siemenet ja mantelit).

Kasviöljyt ja kasvirasvalevitteet, joissa on rasvaa vähintään 60 % ja Sydänmerkki, ovat oiva valinta leivän päälle. Näistä levitteistä keho saa hyviä rasvoja sekä rasvaliukoisia vitamiineja.

Mitä rasvoja käytän ruoanvalmistuksessa ja leivällä?_____

_____

Rasvan laatu testi http://www.sydan.fi/rasvatesti

Tee muutoksia vähän kerrallaan

Isoa ruokaremonttia ei kannata tehdä kerralla, vaan tehdä pieniä valintoja vähän kerrassaan. Näin uudet valinnat on helppo ottaa osaksi jokapäiväistä arkea. Jokaisella on omat yksilölliset tavoitteensa.

Tässä muutama vinkki, jolla pääset hyvin alkuun

Lue Pakkausmerkintöjä!

Suosi ruokia, joissa on energiaa 120-150 kcal/100 grammassa. Mieti mitkä tuotetiedot ovat sinulle tärkeitä ja tarkista ne pakkauksista. Aina kannattaa vertailla tuotteita keskenään. Lue lisää pakkausmerkinnöistä ja vertaile tuotteita www.syohyvaa.fi

Älä hotki!

Aivot saavat viestin kylläisyydestä vasta 20 minuuttia syömisen aloittamisen jälkeen. Syö siis hitaasti ja pureskele rauhassa. Keskity syömiseen ja nauti ruuasta ja ruokaseurasta.

Lautasmalli ohjaa!

Annoskoolla on suuri merkitys painonhallinnassa. Isolle lautaselle otetaan helposti paljon ruokaa. Vaihda siis lautanen pienempään. Silloin syöt vähemmän, mutta tulet silti kylläiseksi.

Ateriat, välipalat ja eväät kannattaa koota samaa ajatusta mukaillen:

- ¼ annoksesta viljatuotteita tai perunaa
- ¼ kalaa, kananmunaa, papuja, linssejä tai lihaa
- ½ kasviksia, hedelmiä ja marjoja tuoreena, lämpiminä tai ruoan joukossa.

Suosi keittoja!

Keitot sisältävät runsaasti vettä, joten niiden energiapitoisuus on pieni. Keittoja syömällä tulet kylläiseksi vähemmillä kaloreilla.

Ateriarytmi!

Syö säännöllisesti – säännöllinen ateriarytmi pitää verensokerin tasaisena ja hillitsee nälän tunnetta. Se auttaa syömään kohtuullisia annoksia ja vähentää houkutusta napostella aterioiden välillä. Päivässä kannattaa syödä 3-5 ateriaa säännöllisin väliajoin. Jos syö harvemmin, nälkä kasvaa ja illalla tulee ahmittua. Syö kevyt iltapala pari tuntia ennen nukkumaanmenoa.

Halutessasi saat lisätietoa seuraavista linkeistä: www.diabetes.fi
www.terveyskyla.fi
www.sydanliitto.fi
www.hyvis.fi