Aggressive Management of Blood Glucose

a report by
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Today, there is no doubt that a determined management of blood glucose control to achieve a goal of hemoglobin A_{1c} less than 6% is attainable. That is an average plasma blood glucose of approximately 136mg/dl. The therapeutic goal we recommend also includes aggressive treatment of lipids, blood pressure, body weight, cessation of cigarette and tobacco use, and alcohol in moderation. That was our position in 1971 and continues today.

We definitely have the personnel, tools, and resources to achieve our goals. Once the diagnosis of diabetes is established, we must provide a diabetic meal plan to achieve or approach desirable body weight. The rule of thumb to determine ideal body weight depends on the sex, height,

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body frame, weight, and daily physical activity of the individual. A five-feet-tall man should weigh 106 pounds; add six pounds for each additional inch. A five-feet-tall woman should weigh 100 pounds; add five pounds for each additional inch. Ten percent of ideal weight can be added or subtracted for a large or small body frame. Additional calories are estimated for increased exercise or physical activity at work or play. To maintain ideal body weight, prescribe 12 calories per pound. For weight

Table 1: Risk of Associated Disease According to Body Mass Index and Waist Size

Body Mass Index	Weight Classification	Waist ≤40 inches (men) or ≤35 inches (women)	Waist >40 inches (men) or >35 inches (women)
18.5 or less	Underweight	—	n/a
18.5–24.9	Normal	—	n/a
25.0–29.9	Overweight	Increased	High
30.0–34.9	Obese	High	Very high
35.0–39.9	Obese	Very high	Very high
40 or greater	Extremely obese	Extremely high	Extremely high

reduction, prescribe 10 calories per pound of ideal body weight and for weight gain prescribe 15–20 calories per pound. A reduction of 500 calories per day (3,500 calories per week) will decrease body weight by one pound per week. Your office scale will determine the patient's adherence to your weight loss or gain prescription.

First, a copy of your, or the diabetes educator's or dietician's, diabetic meal plan must be explained to the patient and family member or significant other. The importance of body weight, body mass index, and waist circumference needs to be emphasized to the patient (see *Table 1*).

The second step is an exercise program to help with weight reduction or weight maintenance. Additional benefits include lower blood glucose and triglycerides, improved endothelial function, and decreased inflammation and blood viscosity. A major advantage of exercise is an improved sense of wellbeing and confidence and can include walking, bike riding, swimming, running, or an exercise of the patient's choice. It is best to exercise at the same time daily, at least five times per week.

The third step is self-monitoring of blood glucose. Current meters measure whole blood and convert the value to plasma glucose. In the early stages of glucose self-monitoring, the whole-blood A_{1c} was an average of 6% or an average of 120mg/dl. The plasma glucose value A_{1c} of 6% is an average of 136mg/dl. Since we strive to achieve a fasting plasma glucose of 110mg/dl, it is clear we need to set an A_{1c} goal of <6%.

I recommend obtaining blood sugars before each meal and before bedtime. Occasionally, an early-morning glucose measurement is obtained if hypoglycemia is suspected or when using an insulin protocol, insulin pump, or inhaled insulin. If the patient is in hospital or a nursing home, the blood glucose should be obtained when the meal tray enters the room and not at a fixed time schedule. The obtained glucose results

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Table 2: Body Mass Index

BMI (kg/m²)	19	20	21	22	23	24	25	26	27	28	29	30	35	40
Height							Weight (lb)							
4'8"	91	96	100	105	110	115	119	124	129	134	138	143	167	191
4'9"	94	99	104	109	114	119	124	128	133	138	143	148	173	198
5'0"	97	102	107	112	118	123	128	133	138	143	148	153	179	204
5'1"	100	106	111	116	122	127	132	137	143	148	153	158	185	211
5'2"	104	109	115	120	126	131	136	142	147	153	158	164	191	218
5'3"	107	113	118	124	130	135	141	146	152	158	163	169	197	225
5'4"	110	116	122	128	134	140	145	151	157	163	169	174	204	232
5'5"	114	120	126	132	138	144	150	156	162	168	174	180	210	240
5'6"	118	124	130	136	142	148	155	161	167	173	179	186	216	247
5'7"	121	127	134	140	146	153	159	166	172	178	185	191	223	255
5'8"	125	131	138	144	151	158	164	171	177	184	190	197	230	262
5'9"	128	135	142	149	155	162	169	176	182	189	196	203	236	270
5'10"	132	139	146	153	160	167	174	181	188	195	202	207	243	278
5'11"	136	143	150	157	165	172	179	186	193	200	208	215	250	286
6'0"	140	147	154	162	169	177	184	191	199	206	213	221	258	294
6'1"	144	151	159	166	174	182	189	197	204	212	219	227	265	302
6'2"	148	155	163	171	179	186	194	202	210	218	225	233	272	311
6'3"	152	160	168	176	184	192	200	208	216	224	232	240	279	319
6'4"	156	164	172	180	189	197	205	213	221	230	238	246	287	328

should be plotted on a graph by the patient and the results evaluated by the patient, physician, and/or diabetes educator. The graphing and analysis of the blood glucose pattern will help in identifying the high peaks and avoid low blood glucose. An adjustment in the meal plan, meal scheduling, physical activity, or medication will help solve the problem and improve blood glucose control. Once control is improved, blood glucose testing can be gradually reduced to twice daily. Monitoring can be before breakfast and evening meals and some days before lunch and before bedtime.

The fourth step is the selection of oral hypoglycemic agents and/or insulin or gastrointestinal hormones. Your monitoring results and

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evaluation of the glucose graph's patterns will help determine if changes need to be made to achieve an A_{1c} goal of <6%. I recommend starting with metformin and add a thiazolidinedione, then a dipeptidyl peptidase-4 (DPP-4) inhibitor or glucagon-like peptide-1 (GLP-1), byetta. If A_{1c} goal is not reached, add supplemental insulin or convert to insulin-alone protocol.

The management of diabetes and cardiovascular risk factors by the physician alone is very difficult and labor-intensive. Therefore, we must utilize the services of a diabetes educator or dietician and other healthcare

professionals to aid in the care, education, and management of the diabetic patient.[1–5]

The value of achieving an A_{1c} of <6% is not questioned today. Many functional, biochemical, and morphological changes occur in diabetes in animal models and humans. The response to blood glucose control indicates that these changes are induced by the diabetes milieu and are a direct consequence of insulin deficiency and/or hyperglycemia.[6–7]

There is evidence presented by my colleague Dr Joseph Williamson that stimulation of the sorbitol pathway by hyperglycemia and the resultant reductive stress is a major contributor to the micro-vascular, macro-vascular, and neurological complications.[8–9] There is also evidence that the complications are related to the duration of diabetes and degree of blood glucose control. If we follow the principle of diabetes management, we can normalize blood glucose levels for prolonged periods of time because of the development of more effective treatment modalities, improved patient education programs, diabetes educators, increased physician education, and the rapidly expanding use of blood glucose monitoring.

Unfortunately, the criteria for A_{1c} goals for diabetes management varies from <7% to <6%. That is an approximate difference of 36mg/dl plasma glucose, which is considerable. The goal for fasting blood glucose varies from <110mg/dl to 126mg/dl depending on the differing criteria of the American Diabetes Association (ADA), the American Association of Clinical Endocrinologists (AACE), or the Endocrine Society.

There are physicians who refuse to believe that an A_{1c} <6% must be their goal and that they can help delay or prevent diabetic vascular and/or neurological complications. One major reason is the highly publicized University Group Diabetes Program (UGDP), in which I was a principal investigator. The study, which began in 1959, was designed to evaluate the

relationship between blood glucose control and vascular complications in patients with newly diagnosed type 2 diabetes. In the 1970s, the investigators concluded that blood glucose control was ineffective in preventing small- and large-vessel and neurological complications regardless of the type 2 therapy: Orinase®, phenformin or insulin. The UGDP study was refuted by Kilo and Williamson.[10–13]

Another significant study involved the work of Dr Marvin Siperstein. He provided evidence suggesting that diabetic complications are unrelated to metabolic abnormalities, duration, or severity, but in some way are

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genetically pre-determined. Therefore, therapy should be designed to reduce the diabetic symptoms.[14] The UGDP Study and Siperstein's conclusions set diabetes management back by over a decade. The lack of blood glucose control is evidenced by numerous surveys, especially by the AACE,[15] which reported that two out of three type 2 diabetics have A_{1c} values >6.5%. We need more aggressive physicians and consumer education.

The cost of diabetes is also a serious matter. It has been reported that life expectancy of type 2 diabetics is shortened by about seven years.[16] We have a type 2 diabetes epidemic in the US of over 21,000,000 people plus at least 54,000,000 pre-diabetics. The total direct and indirect cost of diabetes is approximately US$160 billion. One of every five dollars allocated by the National Institutes of Health is for diabetes. Diabetes is the most expensive chronic disease with most of the money spent on the vascular and neurological complications. Diabetes is a cardiovascular coronary artery disease risk equivalent. Heart attacks and stroke are two to six times more common. Diabetes is the leading cause of new adult blindness, end-stage renal disease, dialysis, and non-traumatic limb amputations. We know that diabetes accelerates the atherosclerotic process. Arteriosclerotic disease

occurs at a younger age, is more widespread, and is more severe.[17] Recent surveys indicate one of every three coronary intensive care patients has diabetes and one of every four hospitalized patients has diabetes. The cost of medication is only about 10–11% of total cost. We should be able to prescribe the best medication required to control diabetes and cardiovascular risk factors. The real challenge is to use this information and the guidelines to improve diabetes care with a goal of A_{1c} <6%, reduce complications, decrease the cost of diabetes management and cardiovascular disease, and improve health and health-related quality of life. ■

A version of this article with an additional graph can be found on the website supporting this briefing (www.touchbriefings.com).

Table 3: A_{1C} Test Results (%) and Their Plasma Blood Glucose Equivalents (mg/dl)

A_{1C}	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0
Glucose	65	101	136	172	207	243	279	314	350	386
A_{1C}	4.1	5.1	6.1	7.1	8.1	9.1	10.1	11.1	12.1	13.1
Glucose	69	103	140	175	211	247	282	318	353	389
A_{1C}	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2	12.2	13.2
Glucose	72	108	143	179	215	250	286	321	357	393
A_{1C}	4.3	5.3	6.3	7.3	8.3	9.3	10.3	11.3	12.3	13.3
Glucose	76	111	137	183	218	254	289	325	361	396
A_{1C}	4.4	5.4	6.4	7.4	8.4	9.4	10.4	11.4	12.4	13.4
Glucose	79	115	151	186	222	257	293	329	364	400
A_{1C}	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
Glucose	83	118	154	190	225	261	297	332	368	403
A_{1C}	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	12.6	13.6
Glucose	86	122	158	193	229	264	300	336	371	307
A_{1C}	4.7	5.7	6.7	7.7	8.7	9.7	10.7	11.7	12.7	13.7
Glucose	90	126	161	197	232	268	304	339	375	410
A_{1C}	4.8	5.8	6.8	7.8	8.8	9.8	10.8	11.8	12.8	13.8
Glucose	93	129	165	200	236	272	307	343	378	414
A_{1C}	4.9	5.9	6.9	7.9	8.9	9.9	10.9	11.9	12.9	13.9
Glucose	97	133	168	204	240	275	311	346	382	418

Table 4: Aerobic Exercise Time and Calories Burned

Activity	Calories/min	Calories/hr
Walking (2mph)	3.3	198
Walking (3.5mph)	5.2	312
Swimming (20 yards/min)	4.8	288
Bicycling (5mph)	2.9	174
Jogging (20 min/mile)	5.4	324
Running	19.4	1164

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