Treatment and blood pressure control in 47,964 people with diabetes and hypertension: A systematic review of observational studies

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BACKGROUND: Many patients with diabetes also have hypertension, greatly increasing their risk for cardiovascular disease. It has been suggested that hypertension is poorly treated in those with diabetes.

OBJECTIVE: To examine treatment and control of hypertension in people with diabetes.

DATA SOURCES: Data sources included MEDLINE, EMBASE, HealthSTAR, CINAHL, Web of Science, clinical evidence and government health and statistical Web sites.

METHOD: Databases were systematically reviewed and hand searches of the bibliographies of relevant studies (1990 to 2004) were conducted. Two investigators selected studies and extracted the data independently.

RESULTS: A total of 44 studies (77,649 subjects with diabetes, 47,964 [62%] of whom also had hypertension) were included. While 83% (range 32% to 100%) of patients with hypertension received drug therapy, only 12% (range 6% to 30%) had their blood pressure (BP) controlled to 130/85 mmHg or less. While BP control rates differed by definition of control (those studies with the least stringent definitions for BP control – 160/90 mmHg or less – reported mean control rates of 37%), treatment and control rates did not differ appreciably between countries or health care settings.

CONCLUSIONS: Fewer than one in eight people with diabetes and hypertension have adequately controlled BP, with remarkable uniformity across studies conducted in a variety of settings. There is an urgent need for multidisciplinary, community-based approaches to manage these high-risk patients.

Key Words: Blood pressure; Diabetes mellitus; Hypertension; Systematic review

In 2000, there were 171 million people with diabetes worldwide, and by 2030, this figure is expected to more than double (1-3). Diabetes is a strong risk factor for atherosclerosis; approximately 50% to 75% of deaths in patients with diabetes are cardiovascular (4,5).

More than 50% of North Americans with diabetes also have elevated blood pressure (BP), or hypertension. Reducing BP reduces the risks of both cardiovascular disease and renal dysfunction in patients with diabetes (6). There is a direct relationship between systolic or diastolic BP and cardiovascular

Traitement et maîtrise de l'hypertension chez 47 964 diabétiques hypertendus : Revue systématique des études d'observation

HISTORIQUE : De nombreux diabétiques hypertendus se trouvent exposés à un risque beaucoup plus grand de maladie cardiovasculaire et selon certains, l'hypertension serait mal maîtrisée chez les sujets diabétiques.

OBJECTIF : Analyser le traitement et la maîtrise de l'hypertension chez les diabétiques.

SOURCES DES DONNÉES : Parmi les sources des données, mentionnons MEDLINE, EMBASE, HealthSTAR, CINAHL, Web of Science, les résultats d'études cliniques et les statistiques de santé présentées dans divers sites Web gouvernementaux.

MÉTHODE : Les auteurs ont interrogé les bases de données de manière systématique et ont procédé à des recherches manuelles à partir des bibliographies des études pertinentes (1990 à 2004). Deux chercheurs se sont chargés de sélectionner les études et d'en extraire les données de manière indépendante.

RÉSULTATS : En tout, 44 études (77 649 sujets diabétiques, dont 47 964 [62 %] souffraient aussi d'hypertension) ont été incluses. Bien que 83 % (entre 32 % et 100 %) des patients hypertendus aient été sous traitement médicamenteux, 12 % seulement (entre 6 % et 30 %) présentaient une tension artérielle (TA) maîtrisée, soit 130/85 mm Hg ou moins. Malgré le fait que le degré de « contrôle de la TA » ait différé selon la définition donnée dans chaque étude (celles dont la définition du contrôle de la TA était la moins stricte, soit 160/90 mm Hg ou moins, ont signalé des taux de contrôle moyen de 37 %), les taux de traitement et de maîtrise n'ont pas différé de manière notable entre les pays ou les types d'établissements de soins de santé.

CONCLUSION : Moins d'une personne sur huit souffrant à la fois de diabète et d'hypertension présentait une TA adéquatement maîtrisée et ce, avec une homogénéité remarquable entre les études réalisées dans des milieux divers. Il faut donc de toute urgence mettre en œuvre des approches pluridisciplinaires dans les collectivités si l'on veut arriver à prendre efficacement en charge ces patients à haut risque.

risk in individuals with diabetes, and antihypertensive therapy reduces the RR of cardiovascular events by approximately 25% to 30% in those with BPs exceeding 130/80 mmHg (6-10). Many clinicians believe that BP control actually confers greater cardiovascular benefits in patients with diabetes than does control of blood glucose (6-13). However, we suspect that the management of diabetes in clinical practice continues to be largely focused on achieving glycemic control. For example, data from the Canadian Heart Health Survey (CHHS) (11) suggested that less than 9% of individuals with

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Figure 1) Flow diagram of study inclusion and exclusion criteria

diabetes had a BP less than 140/90 mmHg (compared with 13% of nondiabetics).

The first step in addressing any gap between the evidence of a condition and its application in clinical practice is to accurately describe the extent of the problem. As such, we performed a systematic review to examine the contemporary management of hypertension in patients with diabetes from 1990 to 2004, including a comparison of BP treatment and control rates between health care settings and countries.

METHODS

All studies published in any language between January 1, 1990, and June 30, 2004, that reported BP treatment or control rates in adult patients with diabetes were included. Because the investigators were interested in BP control rates in clinical practice, studies were excluded if they only reported data from clinical trials, only included patients with gestational diabetes or if they did not contain original data (that is, editorials, review articles or guidelines were excluded). Because the investigators were also interested in exploring whether gaps were unique to particular health care settings or providers, all relevant articles, irrespective of setting, were sought.

Literature search

A search of MEDLINE (1966 to 2004), EMBASE (1980 to 2004), CINAHL, HealthSTAR, Web of Science, clinical evidence and

Definition of 'controlled BP'	Treated *	Controlled *
≤160/90 mmHg 5 studies n=11,339	68% (range 53-97%)	37% (range 31-60%)
≤140/90 mmHg 26 studies n=66,833	83% (range 32-100%)	29% (range 5-59%)
≤130/85 mmHg 24 studies n=49,420	87% (range 53-100%)	12% (range 6-30%)

Figure 2) Overall treatment and blood pressure (BP) control in subjects with diabetes and hypertension. *Weighted average of all patients with diabetes

government health and statistical Web sites was conducted using the following key words: 'diabetes', 'hypertension' and 'epidemiology' (see Appendix for full search strategy). The reference lists of retrieved articles were hand-searched for other relevant studies, and content experts were consulted. All articles potentially meeting the inclusion criteria were independently reviewed by two investigators (DLM and SHS); disagreements were resolved by consensus. Both reviewers also independently extracted the data from the included publications.

Analysis

The definitions of BP control specified among the studies (160/90 mmHg, 140/90 mmHg and 130/85 mmHg) were used. Weighted averages (by number of subjects with diabetes) and observed ranges are reported. Studies were stratified by type of practice (general or specialty) and region.

RESULTS

Of 3803 publications initially identified, 44 met the inclusion criteria (14-57) (Figure 1). These 44 studies were from 19 countries and included data from 12 different health care settings; these studies enrolled 77,649 subjects with diabetes, 47,964 (62%) of whom had hypertension. The characteristics of each study are outlined in Table 1.

In five studies (11,339 patients) that used a BP of 160/90 mmHg or less to define control, 68% (range 53% to 97%) of patients received antihypertensive drug therapy and 37% (range 31% to 60%) achieved target BP. In 26 studies (66,833 patients) that used a BP of 140/90 mmHg or less to define control, 83% (range 32% to 100%) of patients received antihypertensive drug therapy and 29% (range 5% to 59%) achieved target BP. In 24 studies (49,420 patients) with the most stringent definition of BP control (130/85 mmHg or less), 87% (range 53% to 100%) of patients received antihypertensive drug therapy and 12% (range 6% to 30%) achieved target BP (Figure 2). BP treatment and control rates did not differ appreciably between countries or health care settings (Table 2).

DISCUSSION

Despite evidence that aggressive lowering of BP in people with diabetes reduces cardiovascular morbidity and mortality, we found that BP control in individuals with diabetes is suboptimal, with fewer than one in eight patients having BPs controlled to the levels currently suggested by hypertension and diabetes

TABLE 1
Study characteristics

First author (reference)	Years data collected	Location*	Patients with diabetes	Male, %	Age, years	Diabetes type†	Definition of BP control, mmHg
Population-based surveys							
Geiss (36)	1988–1994	US	1507	44	NR	Both	140/90; 130/85
Deepa (30)	1989–1996	Other	152	NR	54±15	NR	140/90
Lloyd-Jones (41)	1990–1995	US	146	49	NR	NR	140/90
Colhoun (27)	1991–1994	UK	970	NR	NR	Both	160/90
Smith (53)	1996–1997	US	526	46	78.2	Both	130/85
Nilsson (43)	1996–1999	Europe	10,057	NR	NR	Type 1	140/90
	1996–1999	Europe	10,057	NR	NR	Type 1	130/85
	1996–1999	Europe	19,613	NR	NR	Type 1	140/90
	1996–1999	Europe	19,613	NR	NR	Type 1	130/85
de Pablos-Velasco (46)	1999	Europe	136	NR	NR	Type 1	140/90
Hypertension Study Group (48)	1999–2000	Other	156	NR	70	Both	160/90
Aguilar-Salinas (15)	2000	Other	3597	30	55.2±13.5	Type 1	140/90
Silvera (51)	NR	Europe	1590	NR	NR	Type 1	140/90
Auseon (17)	NR	US	182	NR	NR	NR	160/90
Primary care practice setting‡							
Berlowitz (20)	1990–1995	US	274	100	65.9±8.3	Type 2	140/90
Elliott (33)	1995–1996	US	126	34	66	Both	140/90; 130/85
Grant (37)	1996–1997	US	601	58	65±12	Type 2	130/85
DiTusa (31)	1998	US	29	NR	NR	NR	140/90; 130/85
Jackson (38)	1998–2001	US	138	NR	60±11	Type 2	130/85
Borzecki (23)	1999	US	596	46	65.3±11.1	Type 2	140/90; 130/85
Coon (28)	1999–2000	US	399	41	69±11.5	NR	130/85
Toth (55)	2000	Canada	368	44	63.4	Type 2	130/85
Boero (22)	2000	Europe	171	55	66.6±8	Type 2	130/85
Specialist setting‡							
Soedamah-Muthu (54)	1989–1990	Europe	1866	NR	33	Type 1	130/85
Moore (42)	1994	US	1443	44	64.3	Type 2	140/90
Pellegrini (47)	1998	Europe	3449	25	62.7±10.7	Type 2	160/90
Singer (52)	1998–2000	US	87	NR	61±13	NR	130/85
Chamontin (25)	1999	Europe	877	NR	NR	NR	140/90; 130/85
Katayama (40)	1999	Other	954	54	64.6	Type 2	140/90; 130/85
Nunes de Faria Stamm (44)	1999	Europe	5518	58	NR	Type 2	140/90
Rotchford (49)	1999	Other	253	5	56.5	Both	140/90
Joseph (39)	2000	UK	220	21	38.2	Type 1	140/90
	2000	UK	1411	5	55.5	Type 2	140/90
	2000	UK	1631	NR	NR	Both	140/90
Bobb-Liverpool (21)	2001	Other	40	0	NR	NR	130/85
Sequeira (50)	2001	Other	266	31	NR	Both	130/85
Akbar (16)	2000–2001	Other	230	50	61	NR	130/85
Buysschaert (24)	2000–2001	Europe	318	19	63	Type 2	140/90
Charpentier (26)	2000–2001	Europe	4930	53	61.8	Type 2	140/90
Fagnani (34)	2000–2001	Europe	5518	58	NR	Type 2	140/90
Yamamoto (57)	2000–2001	Other	150	NR	66.7±10.8	Both	140/90
Baskar (19)	2002	UK	6485	NR	60±15	Type 2	140/90
Adigun (14)	NR	Other	33	42	NR	Both	140/90; 130/85
Bahia (18)	NR	Other	55	42	59.9	Type 2	140/90
de la Calle (29)	NR	Europe	371	NR	NR	Type 2	130/85
Donnelly (32)	NR	Other	2331	52	59.75	Type 2	140/90
Freitas (35)	NR	Other	290	NR	NR	Type 2	140/90
Osuga (45)	NR	Other	91	NR	NR	NR	140/90
Garcia Vallejo (56)	NR	Europe	875	NR	64±11.8	NR	130/85

*Study location: 'Other' includes Australia, Mexico, India, Japan, Brazil, Nigeria, South Africa, Saudi Arabia and Jamaica; †Diabetes type both refers to both type 1 and 2; ‡Setting: 'Primary care practice setting' includes general practitioner offices (health centres, rural settings, outpatient clinics) and general internal medicine offices in the United States (US); 'Specialist setting' includes general internal medicine offices in countries other than the US and hypertension or diabetes clinics in all other locations. BP Blood pressure; NR Not reported; UK United Kingdom

TABLE 2
Studies on hypertension treatment and achievement of target BP in patients with diabetes and hypertension

Type of setting (reference)	On hypertension treatment, % (weighted average, range)	Achievement of target BP, % (weighted average, range)		
		160/90 mmHg	140/90 mmHg	130/85 mmHg
North American				
Population-based surveys (17,36,41,53)	67.5 (57.0–96.5)	60.1	45.0	15.1 (12.0–24.2)
Primary care practice setting* (20,23,28,31,33,37,38,55)	76.9 (62.4–93.3)	–	35.2 (27.0–44.8)	21.3 (10.3–29.8)
Specialist setting† (42,52)	61.3	–	30.8 (29.6–51.7)	21.8
European				
Population-based surveys (27,43,46,51)	95.0 (51.9–96.4)	30.9	37.7 (4.6–51.0)	11.8
Primary care practice setting* (22)	63.7	–	–	8.3
Specialist setting† (19,24,25,26,29,34,39,44,47,54,56)	78.2 (53.0–94.5)	36.7 (30.6–48.0)	17.9 (12.3–49.0)	9.6 (6.0–28.0)
Other countries				
Population-based surveys (15,30,48)	47.2 (32.4–62.5)	–	20.6 (15.5–20.8)	11.7
Primary care practice setting*	–	–	–	–
Specialist setting† (14,16,18,21,32,35,40,45,49,50,57)	72.8 (51.3–100)	43.6	23.5 (9.9–59.4)	10.1 (6.1–24.2)

Primary care practice setting includes general practitioner offices (health centres, rural settings, outpatient clinics) and general internal medicine offices in the United States; †Specialist setting† includes general internal medicine offices in countries other than the United States and hypertension or diabetes clinics in all other locations

guidelines (1,58). Further, our systematic review revealed that this suboptimal treatment pattern, at least in the 44 studies from 19 countries we identified, is not restricted to certain locales or physician specialties.

The two best known North American population studies of BP treatment and control are the Third National Health and Nutrition Examination Survey (NHANES III, 1988 to 1991) (59) and the CHHS (1986 to 1992) (60). NHANES III enrolled 1440 patients with diabetes and reported that 71% were treated for hypertension (42). The CHHS suggested that control was even poorer in individuals with diabetes and hypertension, with only 9% having a BP of 140/90 mmHg or less compared with 13% of nondiabetics (11). This study could not be included in the present analysis because we were unable to extract the number of diabetic individuals or the proportion of hypertensive subjects treated.

It is sobering to note that control in diabetes may even be worse than our figures suggest, because in Canada, only approximately two-thirds of people with diabetes are diagnosed (61), and one can surmise that those with undiagnosed diabetes have poorer BP control.

Poor achievement of BP control in people with diabetes could be due to a number of factors, including the possibility that a strong emphasis on glucose control has resulted in an inadvertent underemphasis of treatment for associated risk factors (such as hypertension) in these patients. In addition, inadequate access to follow-up care and prescription medications, inappropriate or ineffective treatments, poor adherence to prescription medication and lifestyle modifications or a combination of these factors may be responsible (62,63). Given that randomized trials have proven that most patients will require two or three agents to control their BP (10,64,65), physician concerns over the potential for polypharmacy in patients who are already on medications for other conditions may also be a relevant factor (66). It is difficult to control BP in patients with diabetes. Several randomized controlled trials suggest that three or four antihypertensive medications are required to control BP in diabetics (13,67). Some clinicians and patients may be weighing the risk of polypharmacy against optimal BP control.

Although we used Cochrane methodology, two independent reviewers and explicit case definitions to ensure the validity of our systematic review, we cannot exclude the possibility of publication bias. However, we anticipate that unpublished studies may well have shown worse control rates than published studies (although one could argue that there may be more of a bias toward publishing those studies that document small area variations or the underuse of proven efficacious therapies in health services research).

While we used the authors' definitions of control (because we did not have access to individual patient data), we also recognized that BP goals are a 'moving target' with lower targets recently recommended. Nevertheless, this further highlights the need for strategies to help attain these new lower targets.

Having demonstrated that BP control in individuals with diabetes is infrequently achieved in all settings, we believe that improvements in BP control will require novel approaches that extend beyond the four walls of the primary care physician's office. Interdisciplinary, community-based programs hold particular promise for chronic and common conditions such as diabetes. For example, patients at high risk for cardiovascular disease could be identified when they present with marker medications to their community pharmacists and would be enrolled into interdisciplinary risk reduction programs. This model has been used very successfully in the Study of Cardiovascular Risk Intervention by Pharmacists (SCRIP), a 52-centre randomized trial of cholesterol risk management by community pharmacists for patients at high cardiovascular risk (68). Given our data, the development of such programs for the management of other cardiovascular risk factors in patients with diabetes is a research and public health imperative.

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APPENDIX

Search strategy for identification of studies

1. DIABETES MELLITUS, TYPE II/ OR DIABETES MELLITUS/ OR DIABETES MELLITUS, TYPE I/
2. diabetes.ti,ab,hw.
3. 1 or 2
4. Hypertension/
5. hypertens\$ (ti,ab,hw)
6. blood pressure.ti,ab,hw.
7. 4 or 5 or 6
8. 3 and 7
9. limit 8 to (all adult <19 plus years> or adult <19 to 44 years> or middle age <45 to 64 years> or middle aged <45 plus years> or aging <65 to 79 years> or "all aged <65 and over>" or "aged <80 and over>")
10. exp Adult/
11. 8 and 10
12. Epidemiology/
13. exp Morbidity/
14. (epidemiol\$ or prevalen\$ or inciden\$).ti,ab,hw.
15. exp Population Surveillance/
16. "Epidemiologic Methods"/
17. epidemiologic studies/ or case-control studies/ or cohort studies/ or cross-sectional studies/
18. (population studies or population study).mp. [mp=title, abstract, name of substance, mesh subject heading]
19. ep.fs.
20. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. 11 and 20
22. 12 or 13 or 14 or 19
23. 22 and 11
24. 15 or 16 or 17 or 18
25. 23 and 24
26. (pc or th or dt or dh).fs.
27. (control\$ or manag\$ or detect\$ or treat\$ or aware\$ or determin\$).ti,ab,hw.
28. 26 or 27
29. 25 and 28
30. 29 not pregnan\$.ti,ab,hw.
31. limit 30 to yr=1990–2004

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