Completeness and accuracy of morbidity and repeat prescribing records held on general practice computers in Scotland

F GEORGE WHITELAW ROSS J TAYLOR
SYLVIA L NEVIN MICHAEL W TAYLOR
ROBERT M MILNE ANDREW H WATT

SUMMARY

Background. *A high proportion of Scottish general practices use a standard computer software package (GPASS, general practice administration system for Scotland), and thus, Scotland is uniquely placed to amalgamate primary care data on a national scale. Practices, however, vary widely in the nature and extent of data entered on computer and a major limitation on the use of the collected data is the absence of information on the completeness and accuracy of the computer database.*

Aim. *This study set out to assess the quality of morbidity and repeat prescribing records held on computer by general practices in Scotland.*

Method. *Forty-one practices, with above average levels of morbidity data recorded on computer, were selected on a geographic basis in relation to the national population distribution. Within each practice, 250 patients aged 45–64 years were selected at random. Data relating to 19 diagnoses, six surgical procedures and 40 repeat prescription drugs were extracted from the computer records of these patients and compared with information held on patients' paper records and supplied by patients in response to a postal questionnaire. The completeness and accuracy of computer entries were assessed in terms of sensitivity and positive predictive value, respectively.*

Results. *For the 5567 patients for whom all three sources of data (validated computer records, paper records and questionnaire responses) were available, sensitivity (completeness) of morbidity recording had median values of 0.67 for diagnoses, 0.93 for surgical procedures and 0.75 over all conditions examined. Practices varied both in the completeness of recording of each condition and in their overall performance. The predictive value (accuracy) of morbidity data was uniformly high for all conditions examined (median 1.00). For repeat prescription drugs, recording on* GPASS *was both complete and accurate.*

Conclusion. *The recording of morbidity data on* GPASS *for 45–64-year-old patients in a selected group of 41 highly-computerized practices is about 75% complete and highly accurate. For national morbidity studies, it seems likely that amalgamated data from the best* GPASS *practices will be as complete and accurate as the morbidity statistics currently derived from hospital-based activities in Scotland.*

F G Whitelaw, BSc, MSc, PhD, research fellow; R J Taylor, MD, FRCGP, senior lecturer; S L Nevin, BA, MSc, research assistant; M W Taylor, BSc, FRCPE, FRCGP, senior lecturer; and R M Milne, MRCGP, senior research fellow, Department of General Practice, University of Aberdeen. A H Watt, MD, FRCPE, FFPM, director, Medicines Assessment Research Unit, University of Aberdeen.

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Introduction

A SURVEY of all Scottish general practices in early 1994 showed that 845 practices (78%) were operating the national software package, *GPASS* (general practice administration system for Scotland), supplied by the Scottish Office Home and Health Department.[1] This use of a standard system for the storage of morbidity and repeat prescribing data on computer provides Scotland with an opportunity, unique in the United Kingdom, to amalgamate primary care data on a national scale. If such information, routinely collected, were sufficiently complete and accurate it could form a basis for estimating the prevalence of major disorders and for assessing regional and national health care needs.

Since 1988, the *GPASS* data evaluation project has routinely extracted data on morbidity and repeat prescribing from *GPASS* users.[2] These data are then amalgamated on a regional and national basis: at the time of writing 460 practices contribute data from 2.8 million patients.[3] It has become evident, however, that practices vary widely in the extent of data entry and a major limitation on the interpretation and use of the data collected is the absence of information on the completeness and accuracy of the computer database.

The aim of this study was therefore to assess the completeness and accuracy of the data recorded on practice computers and thus the potential utility of *GPASS* as a source of information on morbidity and repeat prescribing in Scotland.

Method

Selection of practices

The 410 practices collaborating with the *GPASS* data evaluation project in April 1992 were ranked according to the proportion of patients on the practice list having at least one 'clinical' Read code[4] recorded on computer. Of 132 top-ranking practices (those having more than 50% of patients with a clinical Read code), 52 expressed an interest in the project and a final selection of 41 was made from these on the basis of national population distribution. Across these 41 practices the proportion of patients with a Read code varied from 51 to 97%, with a mean of 79% (standard deviation 10.9%). All Scottish health board areas were represented. The selected practices ranged in size from single-handed general practitioners to 12-practitioner establishments (mean 4.2 general practitioners) and had practice populations ranging from 1650 to over 21 000 patients (mean 6334 patients). Each practice was identified by a project code number.

Selection of patients

Within each practice a set of 250 patients aged 45–64 years was selected at random by the use of randomizing software which generated an alphabetical list of the selected patients, numbered 1–250, and duplicate sets of name and address labels for the mailing of questionnaires. Encryption software, which rendered

all patient identifiers indecipherable, other than sex, date of birth and postcode, was then applied to the *GPASS* system at each practice to ensure anonymity of all clinical information removed from the practice.

Project data set

The Delphi technique[5] was used to obtain initial views from a panel of health care professionals on the selection of diagnoses which might be considered representative of the Scottish population. These responses were used to generate an initial data set from which a final set was selected by applying further practical criteria, such as the inclusion of at least one diagnosis for each of the major body systems and the exclusion of evanescent syndromes. The final data set for morbidity recording included 19 diagnoses, which were predominantly chronic diseases, and six surgical procedures undertaken in hospital. A set of 40 repeat prescription drugs in 21 pharmacological groups, chosen to represent a subset of the selected diagnoses, were also included in the data set (Table 1).

Data collection

Computer records. After encryption, all essential *GPASS* data files were copied to magnetic tape and were later used to restore the practice *GPASS* system on a project computer. The restored system was then used to generate a data file which identified, for each patient in the random list, the occurrence of any of the clinical Read codes or repeat prescription drugs specified in the project data set. The Read code template used for this purpose included all likely synonyms of the selected diagnoses and procedures.

Paper records. The scrutiny of paper records was undertaken by a single trained fieldworker during a two and a half day visit to each practice. Each paper record was searched according to pre-agreed criteria for the occurrence of the project data set in three distinct locations in the record: the clinical summary sheet, hospital letters and the continuation sheets which, in most practices, record brief notes on each consultation. Summary sheets and hospital letters were searched completely and the continuation sheets for the preceeding 5 years only: the events recorded are therefore best described as 'lifetime prevalence' of the diagnoses in question. A fourth location was searched for the occurrence of repeat prescription drugs: repeat prescription cards within the paper record, a separate card index or, frequently, in these highly computerized practices, a printout of the patient's computer drug record held within the paper-based record.

As an aid to accurate recording, the field worker carried out all data entry at the practice by means of specially developed software based on barcodes. Each condition and drug in the project data set and its location in the paper medical records was identified by a barcode held on plastic-laminated templates. The fieldworker 'swiped' the appropriate barcode with a light pen attached to a laptop computer as each occurrence was encountered.

Patient questionnaire. A survey instrument containing a series of questions relating to the patient's lifetime experience of morbidity and their current repeat prescription entitlements, smoking and employment status, was distributed by post to the 250 selected patients in each practice. No questions relating to dementia, depression or schizophrenia were included in the questionnaire. Responses received were identified only by patient and practice number but respondents were asked to disclose their sex, year of birth and postcode to allow validation of patient details against those recorded in the other sources of data.

Data validation and analysis

For initial data validation, routines were developed within the statistical package *SPSS*[6] to identify discrepancies between data sources in the sex and/or date of birth of individual patients:

Table 1. Repeat prescription drugs in the project dataset and their associated primary diagnoses.

Diagnosis	Pharmacological agent	Drugs
Angina	Nitrates	Glyceryl trinitrate, isosorbide (mononitrate and dinitrate), Coro-Nitro® (Boehringer Mannheim), GTN® (Martindale), Nitrolingual® (Lipha), Transiderm-Nitro® (Geigy)
Chronic obstructive airways disease	Beclomethasone	Beclomethasone, Becloforte® (A & H), Becotide® (A & H)
	Salbutamol	Salbutamol, Ventolin® (A & H)
	Terbutaline	Terbutaline, Bricanyl® (Astra)
	Aminophylline	Phyllocontin® (Napp)
	Budesondie	Pulmicort® (Astra)
	Sodium cromoglycate	Intal® (Fisons)
Diabetes	Insulin	Insulin (all variants)
Epilepsy	Sodium valproate	Sodium valproate, Epilin® (Sanofi Winthrop)
	Carbamazepine	Carbamazepine, Tegretol® (Geigy)
	Phenytoin	Phenytoin, Epanutin® (P-D)
	Phenobarbitone	Phenobarbitone
Glaucoma	Timolol	Timolol, Timoptol® (MSD)
	Pilocarpine	Pilocarpine
Gout	Allopurinol	Allopurinol, Zyloric® (Wellcome)
Hypothyroidism	Thyroxine	Thyroxine, Eltroxin® (Goldshield)
Parkinsons disease	Levodopa	Madopar® (Roche), Sinemet® (Du Pont)
Peptic ulcer	Ranitidine	Ranitidine, Zantac® (Glaxo)
	Cimetidine	Cimetidine, Tagamet® (SK & F)
Pernicious anaemia	Hydroxocobalamin	Hydroxocobalamin
Tumour (breast)	Tamoxifen	Tamoxifen, Nolvadex® (Zeneca)

where such discrepancies could not be resolved the entire data set relating to that patient was discarded. To assess the completeness and accuracy of computer records, the data were first examined to establish a 'gold standard' reference base from within the other sources of data. Within the paper records it was agreed that any diagnosis/procedure recorded in the clinical summary sheet or a hospital letter was sufficiently reliable to be taken as a confirmed diagnosis, whereas diagnoses recorded on the continuation sheets would be accepted only if confirmed by a clinical entry in the patient questionnaire or, for those conditions for which drug data was collected, by an associated drug entry in either the paper-based drug records or the questionnaire. Similarly, a clinical entry in the patient questionnaire was accepted only if confirmed by a drug entry in either the questionnaire or paper records. For drugs, the gold standard was taken to be the presence of the drug in either the paper-based drug record or the questionnaire. Within each practice the gold standard record of each condition and repeat prescription drug was then compared against the computer records for each patient.

Statistical analysis involved the computation, for each condition and drug, of a sensitivity[7] and positive predictive value[8] to indicate completeness and accuracy, respectively, of the computer record relative to the gold standard. The data were then amalgamated across the 41 practices to provide 'national' values for completeness and accuracy of each of the items in the project data set. Confidence intervals on median values were calculated as described by Gardner and Altman.[9]

Results

Validated computer records were available for 10 244 patients, paper records for 8398 and questionnaire responses for 6642: all three records were present for 5567 patients. Male: female ratios were 1: 0.98, 1: 0.98 and 1: 1.15 for computer records, paper records and questionnaires, respectively. The results presented below relate to the 5567 patients for whom all three sources of data were available.

Morbidity recording

The correspondence between computer records and gold standard occurrences and the computed sensitivity and predictive value of the computer record for each of the conditions examined is shown for a sample practice in Table 2. As the sensitivity values for the various conditions showed a significant positive skew in most practices, the median value over all diagnoses and procedures has been taken to represent the overall sensitivity and predictive value estimates for the practice ('composite' values).

Considerable variation existed both within and between practices in the completeness of recording of the diagnoses and procedures in the project data set. This is illustrated in Figure 1, which shows practice by practice sensitivity values for four conditions, taken to represent the range of variabilities encountered. Similar variability was seen in the composite sensitivity values which ranged from 0.40 to 1.00 over the 41 practices, with an overall median value of 0.75 (95% confidence interval (CI) 0.68 to 0.77).

National values for each diagnosis and procedure, aggregated over all 41 practices, are shown in Table 3. For many conditions,

Table 2. Morbidity recording: sensitivity (completeness) and positive predictive value (accuracy) of the computer records for the 25 conditions in a sample practice. The data relate to 146 patients aged 45–64 years for whom computer records, paper-based records and questionnaire responses were available.

Condition	No. of patients with occurrence[a]			Sensitivity[b]	Positive predictive value[c]
	A	B	C		
Diagnosis					
Angina	2	0	3	0.40	1.00
Chronic obstructive airways disease	4	0	3	0.57	1.00
Dementia	0	0	0	-	-
Depression	16	0	2	0.89	1.00
Diabetes (type I)[d]	1	0	0	1.00	1.00
Epilepsy	4	0	2	0.67	1.00
Glaucoma	0	0	1	0.00	-
Gout	1	0	1	0.50	1.00
Hypertension	15	0	14	0.52	1.00
Hypothyroidism	5	0	1	0.83	1.00
Myocardial infarction	4	0	0	1.00	1.00
Parkinsons disease	0	0	1	0.00	-
Peptic ulcer	9	1	6	0.60	0.90
Pernicious anaemia	1	0	1	0.50	1.00
Rheumatoid arthritis	1	0	0	1.00	1.00
Schizophrenia	1	0	1	0.50	1.00
Stroke	1	0	0	1.00	1.00
Tumour (breast)	12	1	2	0.86	0.92
Tumour (lung)	0	0	0	-	-
Procedure					
Appendectomy	17	0	8	0.68	1.00
Coronary bypass	0	0	0	-	-
Gall bladder removal	4	0	0	1.00	1.00
Hip replacement	1	0	0	1.00	1.00
Hysterectomy	8	0	0	1.00	1.00
Varicose vein ligation	9	0	3	0.75	1.00
Practice median				0.75	1.00

[a]A=present on computer and confirmed by gold standard; B = present on computer, not confirmed by gold standard; C = present in gold standard, not on computer. [b]Sensitivity = A/(A+C). [c]Positive predictive value = A/(A + B). [d]Includes insulin-taking type II diabetic patients.

Table 3. Morbidity recording: national estimates of sensitivity (completeness) and positive predictive value (accuracy) of the computer records for the 25 conditions.

Condition	*n*	Number of occurrences recorded[a]	Median sensitivity (95% CI)		Median positive predictive value (95% CI)	
Diagnosis						
Angina	41	364	0.60	(0.56 to 0.71)	1.00	(1.00 to 1.00)
Chronic obstructive airways disease	41	479	0.72	(0.57 to 0.82)	1.00	(1.00 to 1.00)
Dementia	3	3	0.00	[b]	1.00	[b]
Depression	41	661	0.47	(0.31 to 0.57)	1.00	(1.00 to 1.00)
Diabetes (type I)[c]	24	43	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)
Epilepsy	37	89	1.00	(0.67 to 1.00)	1.00	(1.00 to 1.00)
Glaucoma	26	38	0.83	(0.00 to 1.00)	1.00	(1.00 to 1.00)
Gout	35	74	1.00	(0.50 to 1.00)	1.00	(1.00 to 1.00)
Hypertension	41	1305	0.43	(0.39 to 0.47)	1.00	(1.00 to 1.00)
Hypothyroidism	41	166	0.67	(0.50 to 0.78)	1.00	(1.00 to 1.00)
Myocardial infarction	41	198	0.80	(0.75 to 1.00)	1.00	(1.00 to 1.00)
Parkinsons disease	6	7	0.50	(0.00 to 1.00)	1.00	(1.00 to 1.00)
Peptic ulcer	41	567	0.64	(0.55 to 0.75)	1.00	(1.00 to 1.00)
Pernicious anaemia	15	20	0.75	(0.00 to 1.00)	1.00	(1.00 to 1.00)
Rheumatoid arthritis	35	87	0.67	(0.50 to 1.00)	1.00	(1.00 to 1.00)
Schizophrenia	21	34	0.83	(0.50 to 1.00)	1.00	(1.00 to 1.00)
Stroke	35	61	0.50	(0.00 to 1.00)	1.00	(1.00 to 1.00)
Tumour (breast)	41	546	0.57	(0.42 to 0.67)	1.00	(1.00 to 1.00)
Tumour (lung)	6	6	1.00	(0.00 to 1.00)	1.00	(1.00 to 1.00)
Procedure						
Appendectomy	41	544	0.80	(0.68 to 0.88)	1.00	(1.00 to 1.00)
Coronary bypass	27	50	1.00	(0.80 to 1.00)	1.00	(1.00 to 1.00)
Gall bladder removal	40	165	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)
Hip replacement	24	35	1.00	(1.00 to 1.00)	1.00	(1.00 to 1.00)
Hysterectomy	41	479	1.00	(0.92 to 1.00)	1.00	(1.00 to 1.00)
Varicose vein ligation	41	334	0.73	(0.67 to 0.80)	1.00	(1.00 to 1.00)
Overall median						
Diagnoses	-	-	0.67	(0.62 to 0.70)	1.00	(1.00 to 1.00)
Procedures	-	-	0.93	(0.88 to 1.00)	1.00	(1.00 to 1.00)
All conditions	-	-	0.75	(0.71 to 0.76)	1.00	(1.00 to 1.00)

n = number of practices in which the condition was recorded (maximum 41). CI = confidence interval. [a]Gold standard' occurrences of each condition. [b]Insufficient data for analysis. [c]Includes insulin-taking type II diabetic patients.

both sensitivity and predictive value showed skewed distributions and the data are again presented as median values for each condition, together with their 95% confidence interval. Low values for sensitivity were recorded for dementia, hypertension, depression, parkinsons disease, stroke and breast tumour, whereas high values were associated with diagnoses such as diabetes, epilepsy, glaucoma and gout, all of which have objective diagnostic critiera, and with all of the surgical procedures examined. National estimates of positive predictive value were high for all conditions, indicating consistently high levels of accuracy across practices in the recording of morbidity data on computer. The computed median value for sensitivity aggregated over all practices, was 0.67 for diagnoses, 0.93 for surgical procedures and 0.75 over the full project dataset (Table 3).

Repeat prescription recording

Of the 41 practices examined, 29 (71%) used a *GPASS* printout as the patient's main repeat prescription record and were in the process of phasing out their paper-based drug records. In these circumstances sensitivity and positive predictive value are no longer wholly appropriate as measures of the quality of data recording. However, a comparison (analysis of variance) between the 12 practices which still maintained written drug records and the 29 practices which did not showed that computed sensitivity and predictive value estimates for the 21 pharmacological groupings within the drug data set differed only marginally between the two groups. For all 41 practices combined, the overall median values were 1.00 for both sensitivity and positive predictive value (95% CI 1.00 to 1.00 in each case), indicating that recording of repeat prescriptions on *GPASS* was both complete and accurate.

Discussion

The validation of general practice computer records has previously been examined by Jick and colleagues[10,11] and by Van Staa and Abenhaim,[12] using the VAMP research database, and by Johnson and colleagues[13] using the AHH Meditel system. The studies of Jick and colleagues were concerned primarily with the recording of events occurring in hospital and assessed 'completeness' as the correspondence between hospital consultants' letters and general practice computer records.[10,11] Van Staa and Abenhaim reported on both completeness and validity of computer entries for a range of conditions but their study involved only 500 patients and again was based on hospital discharge letters as the primary source of clinical information.[12] The work of Johnson and colleagues related only to the recording of influenza during the epidemic in 1989.[13] Other studies in which the quality of general practice morbidity and prescribing data has been assessed have involved continuous recording and have required special data entry protocols to ensure the capture on computer of all clinical information.[14] Although Pringle and colleagues[15] have recently evaluated the computer recording of four diagnoses in

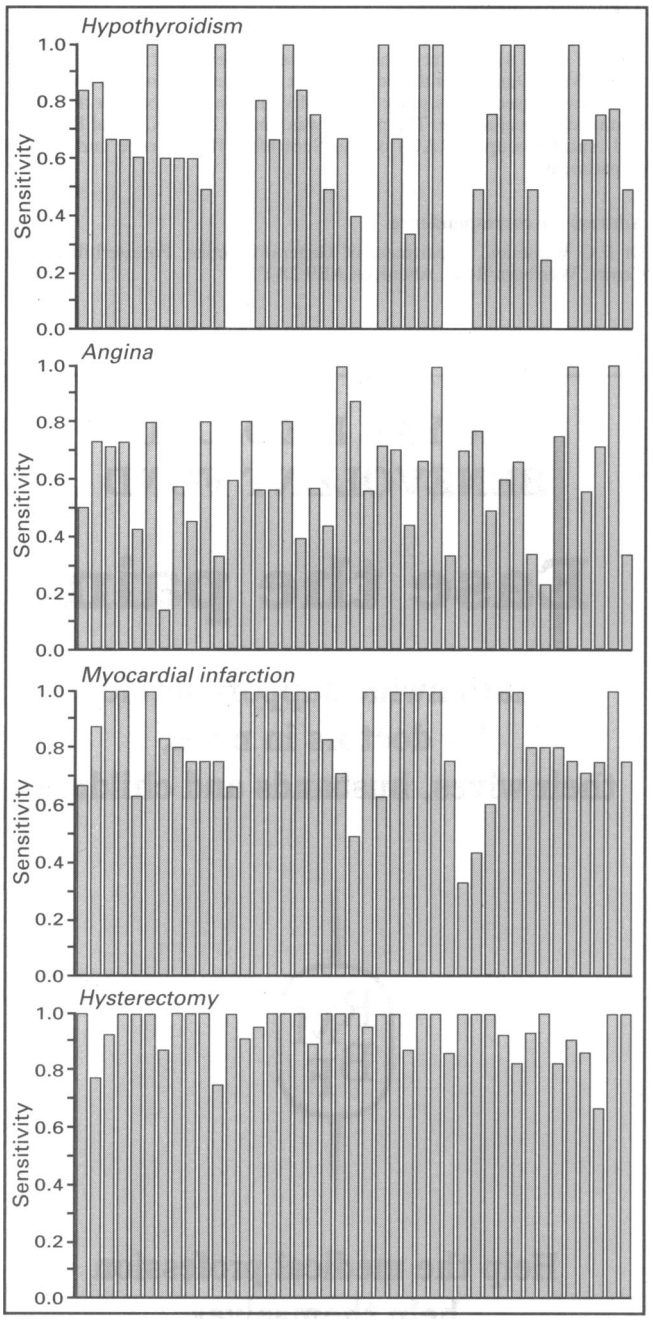

Figure 1. *Variation between practices in the sensitivity (completeness) of computer records for hypothyroidism, angina, myocardial infarction and hysterectomy. Practices are arranged in the same order for each condition to allow within-practice variability between conditions to be assessed.*

four highly computerized practices, it would appear that no previous studies have systematically examined the quality of computer entries made routinely in the course of practice activity.

In the present study, the recording of morbidity over all conditions appeared to be only moderately complete (75%) but to have a high level of accuracy (100%). The median sensitivity taken over all diagnoses was 0.67 but this obviously encompasses some conditions for which the level of recording was distinctly poorer. Some possible reasons for these low values can be given: in the case of hypertension and tumour (breast), for example, the low sensitivity values probably arose as a result of discrepancies between the project search criteria and those adopted by practices. Thus, for hypertension specific values for systolic and diastolic blood pressure were designated in the search criteria and these clearly occurred frequently in the paper records without being classified as hypertension by the practitioners concerned. Similarly, the study protocol for breast tumours included all references to cysts, lumps, lipomas and adenomas and it seems likely that practices adopt a more rigorous definition in committing this diagnosis to computer.

For dementia and parkinsons disease, it is likely that the low sensitivity values were a consequence of the small number of occurrences encountered, since minor errors or omissions in recording could then have a disproportionate effect on the computed values. The sensitivity recorded for these particular diagnoses must therefore be treated with caution. Lung tumour, although apparently well recorded on computer, showed the same low prevalence and is likely to be subject to the same caveats. Depression and stroke also appeared to be poorly recorded in the computer records. For depression, the most likely explanation is that this term was often given as a secondary diagnosis in hospital letters but only the primary diagnosis was routinely highlighted for adding to the computer record. There was no obvious explanation for the low level of recording for stroke.

In contrast to the low levels of recording for some of the diagnoses examined, the results suggest, overall, that surgical procedures undertaken in hospital are extremely well recorded on practice *GPASS* systems (93%). This is one area of the present work where direct comparison with other published work is possible and it would appear that the level of recording within *GPASS* for hospital-based procedures is at least as good as that reported for other systems.[10-12] Presumably the high level of recording of these conditions arises because the presence of a hospital letter acts as a direct prompt to surgery staff to make a computer entry.

It would appear that the recording of repeat prescription information on computer is both complete and accurate within these more highly-computerized Scottish practices. This is not altogether surprising, considering the origins of *GPASS* as an administrative and prescribing utility[16] and the tendency in recent years for the more progressive practices to adopt the computer record as the definitive source of repeat prescribing information. It seems likely that this trend will continue and that *GPASS* will soon be the only source of prescribing information in many practices.

The estimates of completeness and accuracy of computer records reported here were derived from *GPASS* practices which were known to have above average levels of morbidity data recorded on computer. From the information given above, it is estimated that the practices in this study represented at least the top third (132 of 410) of all Scottish practices participating in the *GPASS* data evaluation project. This being so, it is disquieting to observe the variation in the recording of individual conditions reported in Figure 1, particularly so in relation to the variations seen within individual practices. A few practices with consistently high levels of recording across all conditions can be identified in Figure 1, but these are undoubtedly the exceptions. Presumably, the variability stems both from differences in the clincial interests of individual practitioners, which might determine the specific diagnoses which receive priority for computer entry, and from differences in the extent to which older patients' clinical histories have been updated. In this context, it must be emphasized that the data reported here relate only to the 45–64 years age group within the practice populations. This age group, both in terms of numbers and in relation to the extent of their medical histories, would have presented the greatest challenge to

practice staff in effecting the transfer of patient records to computer. Their medical records would have started with Lloyd-George (A5) folders in the late 1940s, followed by A4 record sheets in the mid-1970s and final transfer to computer from the late 1980s onward. Thus, it is likely that the completeness of computer entries of morbidity for younger age groups will be higher than that recorded here.

The utility of the information presented here will relate in particular to the monitoring of prevalence rates of specific chronic conditions and the extrapolation of these to the areas of health needs assessment and resource allocation. Despite the observed variation in sensitivity of recording between conditions and between practices, it seems likely that practices in Scotland having more than 80% of their practice list with a clinical Read code on computers will also have computer records which are more than 75% complete for the major chronic diagnoses. Such practices can be identified from the *GPASS* data evaluation exercises described earlier and in April 1992 represented the top 10% of all respondents. The only comprehensive estimates of morbidity in Scotland routinely published are the Scottish morbidity records (SMR1) data, which are limited to hospital inpatient and day cases.

These have recently been reported as having a 'crude agreement' with casenotes of 74% for gastrointestinal diagnoses.[17] Amalgamated data on morbidity derived from the top *GPASS* practices are thus likely to be as complete as the standards currently available for Scotland and will certainly be more representative of practice populations.

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Address for correspondence

Dr F G Whitelaw, Department of General Practice, Foresterhill Health Centre, Westburn Road, Aberdeen AB9 2AY.