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Research paper

Effect of computerisation on Australian general practice: does it improve the quality of care?

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ABSTRACT

Background There is an assumption expressed in literature that computer use for clinical activity will improve the quality of general practice care, but there is little evidence to support or refute this assumption.

Aim This study compares general practitioners (GPs) who use a computer to prescribe, order tests or keep patient records, with GPs who do not, using a set of validated quality indicators.

Methods BEACH (Bettering the Evaluation and Care of Health) is a continuous national cross-sectional survey of general practice activity in Australia. A sub-sample of 1257 BEACH participants between November 2003 and March 2005 were grouped according to their computer use for test ordering, prescribing and/or medical records. Linear and logistic regression analysis was used to compare the two groups on a set of 34 quality indicators.

Results Univariate analyses showed that computerised GPs managed more problems; provided fewer medications; ordered more pathology; performed more Pap smear tests; provided more immunisations; ordered more HbA1c tests and provided more referrals to ophthalmologists and allied health workers for diabetes patients; provided less lifestyle counselling, and had fewer consultations with Health Care Card (HCC) holders. After adjustment, differences attributable solely to computer use were prescribed medication rates, lifestyle counselling, HCC holders and referrals to ophthalmologists. Three other differences emerged – computerised GPs provided fewer referrals to allied health workers and detected fewer new cases of depression, and fewer of them prescribed anti-depressants. Twenty-three measures failed to discriminate before or after adjustment.

Conclusion Deciding on 'best quality' is subjective. While literature and guidelines provide clear parameters for many measures, others are difficult to judge. Overall, there was little difference between these two groups. This study has found little evidence to support the claim that computerisation of general practice in Australia has improved the quality of care provided to patients.

Keywords: clinical computer use, family practice, quality indicators, quality of health care

How this fits in with quality in primary care

What do we know?
There is an assumption that using a computer will improve the provision of care in many areas of the health system, including general practice. To date there is little evidence that this is the case, and US studies have produced little support for this claim.

What does this paper add?
This paper applies a set of quality indicators to national representative general practice (GP) activity data to compare the practice behaviour of GPs who incorporate a computer in their clinical activity with those who do not. The results from the Australian setting support those so far reported from the USA – that to date, the use of a computer for clinical activity has done little to improve the quality of primary care.

Introduction

There is an underlying premise apparent from the literature of the past three decades that using a computer will improve the provision of care in many areas of the health system, including general practice. Current claims reference previous work, which paper trails often show to be based on suppositions made some 15 to 20 years earlier; for example Garrido *et al* (2005) state that 'Electronic health records reduce uncertainty by providing greater accessibility, accuracy and completeness of clinical information than their paper counterparts', referencing a 1991 General Accounting Office (GAO) report.[1] The GAO report (p. 25) actually concluded that 'automated systems show promise', that speed of record transfer and accuracy of information 'should improve the quality of care' and adds that 'no fully automated medical record system exists, so the strengths and weaknesses of such a system have not been documented and are not clearly understood'.[2]

In Australia, practice computerisation has been encouraged since the 1990s through incentives and accreditation processes, and a variety of clinical software products is available. Computers may be used for a range of functions from use for administrative purposes only, to being fully incorporated into all levels of clinical activity.[3,4] The use of computers (at all), and the level of use for clinical activity, is entirely discretionary both between and within practices.

However, in 1999 Richards *et al* reported that they had found little hard evidence that the general use of computers in Australia improves efficiency at individual practice level or benefits the health sector generally, or that improving outcomes was an aim when designing information systems.[5] This is not just a local trend. Healthfield *et al* proposed that decision makers in the UK and the USA may be being 'swayed by the general presumption that technology is of benefit to health care and should be wholeheartedly embraced' while the evidence to either support or oppose this supposition is still scarce.[6]

Mitchell and Sullivan (2001) undertook a systematic review of world literature on primary care computing from 1980 to 1997.[7] Most studies identified some positive effects of computerisation in selected areas, but they found only 17 assessing the impact of computers on patient outcomes, a number they concluded insufficient to measure the real benefits for patients.[7] While there is some evidence that computer use is associated with individual improvements to the quality of care,[8–10] there is also emerging evidence that the computer, while solving problems in some areas, is causing or accentuating problems in others.[11–14]

Recently, there has been increasing demand for information on health care quality by health economists, policy makers, health professionals and consumers.[15] While this is an international trend, the approach to quality measurement and the capacity to validly assess quality varies widely between countries.[16,17] The use of quality indicators has become accepted as a reasonable approach for assessing quality. The focus has shifted in recent times, from process measures which reflect what was done, to outcome measures, which show the *effect* of what was done.[18]

Over the past 15 years, computer use by Australian GPs has increased such that over 97% have a computer available at their practice,[19] and it is therefore timely to investigate how the incorporation of the computer into clinical activity affects the quality of care provided by GPs. In a previous study we reported the extent and utilisation of computer use in Australian general practice.[3] This study aims to compare GPs who use a computer in their clinical activity with those who do not, on a range of quality indicators developed for use with primary care data, to determine whether the use of the computer has improved the quality of care provided to patients.

Methods

This study is an analysis of data from the national BEACH (Bettering the Evaluation And Care of Health) program. The BEACH methods are reported in detail elsewhere, but in summary BEACH is a continuous, national, paper-based, cross-sectional survey of general practice activity in Australia. Approximately 1000 GPs participate annually, recruited from a national rolling random sample drawn by the Australian Government Department of Health and Ageing (DoHA). Participating GPs provide demographic information about themselves and their practices, including questions about their computer use, on a GP profile questionnaire. They also provide patient demographics and encounter information for 100 consecutive, consenting, unidentified patients. The age–sex distribution of patients at BEACH encounters is compared with that of all GP encounters claimed through Medicare, Australia's universal healthcare scheme, and shows excellent precision.[20]

The 1319 GP participants who completed the BEACH survey between November 2003 and March 2005 were divided into two groups as follows:

1 **Clinical computer users** Defined as those who use a computer for clinical functions, e.g. prescribing and/or test ordering and/or medical records, with or without internet and/or email.
2 **Non-clinical computer users** Defined as those who use a computer for administrative functions and/or internet and/or email only, without use of clinical components available in the medical software (prescribing, test ordering, medical records).

Those GPs who did not use a computer at all were also included in the latter group. Following univariate analysis, the extent to which resulting differences between the two groups were explained by other variables was identified through a series of adjustments using logistic and multiple regression.

Quality indicators

In the absence of an evidence-based model for determining how computers would alter behaviour and affect quality, we approached the problem from the perspective of 'best quality' and compared clinical computer users and non-clinical computer users to see which group performed 'best'. To make this assessment, we measured their behaviour against a set of quality indicators applicable in a primary care setting. A set of 36 quality indicators validated in a previous study using BEACH data[21] were used to compare the practice behaviour of GPs assigned to the two groups.

Hypotheses

Based on the assumption that the use of computers will improve health outcomes, the overall hypothesis was that clinical computer users would provide a 'better' standard of care. The individual hypothesis and rationale for each domain of care was also based on this assumption. Arrows in Tables 1(a) and 1(b) specify the direction hypothesised as 'better' quality for each indicator.

The average length of consultation in minutes was calculated from recorded start and finish times for a sub-sample of patient consultations with GPs in each group. Encounters were designated as either long or prolonged based on their Medicare Benefits item number.[22] Problems managed by GPs were classified according to the International Classification of Primary Care, Version 2.[23] Medications were classified using an in-house system called the Coding Atlas for Pharmaceutical Substances (CAPS).

Statistical analysis

Conventional simple random sample methods were used for the GP-based statistical analyses. Results are reported as proportions when describing events that can occur only once per GP or per patient encounter, but as rates per 100 encounters where events can occur more than once per consultation. As the patient encounters were a cluster-based sample, we adjusted the 95% confidence intervals and *P* values for the single-stage clustered study design using procedures in SAS version 8.2[24] and STATA version 8.0.[25]

We made univariate comparisons of characteristics of the GPs in each group (listed in Box 1), eliminated those highly correlated with others, and used simple logistic regression to identify those associated ($P < 0.10$) with clinical computer use. We used stepwise procedures in logistic regression analysis to identify characteristics independently related to clinical computer use ($P < 0.05$). A series of models were built on a hierarchical basis with predictors fitted depending on the outcome of interest. Predictors included GP and practice characteristic outcomes, patient, morbidity and treatment outcomes. Models used for outcomes are specified in the footnotes to Tables 1(a) and 1(b). Logistic regression was used to analyse categorical outcomes, and linear regression for continuous and ordinal outcomes, after adjusting for potential confounding variables.

Test ordering

The denominator for clinical computer users included GPs who used a computer for any clinical purpose, but there were a number of GPs in this group who did not use the test ordering function of their clinical software.

Box 1 GP and practice characteristics compared in simple logistic regression analysis and then used in step-wise logistic regression analyses

GP characteristics

Age (<45, 45–54, 55+ years)	*	‡
Sex	*	‡
Place of graduation (Australia/other)	*	‡
FRACGP status (yes/no)	*	‡
Years in general practice (<10, 10–19, 20+)	†	§
Years since graduation (<20,20–29, 30+)	†	§
Sessions per week (<6, 6–10, 11+)		‡
Direct patient care hours per week (<31, 31–40, 41–50, 51+)		
Work in past 4 weeks –		
in residential aged care facility (yes/no)	*	‡
as a locum (yes/no)		
as salaried/session hospital medical officer (yes/no)	*	
in a deputising service (yes/no)	*	
Whether all patients are bulk-billed (yes/no)	*	‡
Any consultations in language other than English (yes/no)	*	‡
Registered with Department of Veterans' Affairs (yes/no)		‡
Registrar status (in GP training) (yes/no)		

Practice characteristics

Size of practice (solo, 2–4, 5–10, 11+ GPs)	*	‡
Practice location by RRMA[1] (metropolitan/rural)		
Practice location by ASGC[2] (major city/not major city)	*	‡
Practice location by State		‡
Socio-economic status by SEIFA[3] (disadvantaged <4 SEIFA/less disadvantaged SEIFA 4–11)		‡
Practice accreditation status (yes/no)	*	‡
Practice nurse at major practice address (yes/no)	*	‡
After-hours patient care arrangements (own or cooperative/deputising service)		
Status as a teaching practice for undergraduates or registrars		

† Variables that were found to be highly correlated with other variables and were therefore not retained in the modelling process for clinical computer use

* Variables that showed some association ($P<0.10$) with use of a computer for clinical purposes, and were therefore included in the logistic regression analysis for clinical computer use

§ Variables that were found to be highly correlated with other variables and were therefore not retained in the modelling process for computer use for test ordering

‡ Variables that showed some association ($P<0.10$) with use of a computer for clinical purposes, and were therefore included in the logistic regression analysis for computer use for test ordering

Note: FRACGP = Fellowship of the Royal Australian College of General Practitioners

[1] Australian Government Department of Health and Ageing. Rural, Remote and Metropolitan Areas (RRMA) classification. www.health.gov.au/internet/wcms/publishing.nsf/content/work-bmp-where-rrma

[2] Australian Bureau of Statistics (ABS). Australian Standard Geographical Classification (ASGC[T]). Canberra: Australian Bureau of Statistics, 2004.

[3] Australian Bureau of Statistics. Census of population and housing: Socio-Economic Indexes for Areas (SEIFA), Australia. Canberra: Australian Bureau of Statistics, 2001.

Table1(a) Univariate and multivariate analysis of quality indicators

	GPs using a computer for clinical purposes		GPs not using a computer for clinical purposes		Unadjusted*		Adjusted[a]	
Quality indicator	*n*	Mean	*n*	Mean	Regression coefficient	*P* value	Regression coefficient	*P* value
Consultation length (in minutes)	34 633	15.0	6084	15.0	0.05	0.90	–0.38	0.40
	n	Rate per 100 of (*n*)	*n*	Rate per 100 of (*n*)	Regression coefficient	*P* value	Regression coefficient	*P* value
Long consultations per 100 encounters (↑)	99 153	12.2	17 478	10.7	1.50	0.14	–0.41[e]	0.70
Prolonged consultations per 100 encounters (↑)	99 153	1.0	17 478	1.1	1.37	0.24	–0.37[e]	0.76
Reasons for encounter per 100 encounters (↑)	106 900	150.7	18 800	150.1	0.54	0.81	0.59[d]	0.82
Problems managed per 100 encounters (↑)	106 900	150.5	18 800	144.1	**6.42**	**0.003**	3.44[d]	0.12
Clinical treatments per 100 encounters (↑)	106 900	39.7	18 800	40.1	–0.40	0.88	–2.72[e]	0.32
Procedural treatments per 100 encounters (↑)	106 900	17.6	18 800	18.4	–0.82	0.57	–1.26[e]	0.31
Prescribed medications per 100 encounters (↓)	106 900	81.9	18 800	89.8	**–7.96**	**0.01**	**–6.54[e]**	**0.02**
Allied health referrals per 100 encounters (↑)	106 900	3.0	18 800	2.7	0.28	0.29	**–0.55[e]**	**0.03**
Hospital referrals per 100 encounters (↓)	106 900	0.6	18 800	0.7	–0.17	0.23	–0.14[e]	0.47

Table1(a) Continued

Specialist referrals per 100 encounters (↓)	106 900	8.3	18 800	7.5	0.83	0.06	–0.01[e]	0.98
Total investigations per 100 encounters (↓)	106 900	51.3	18 800	41.7	**9.6**	**<0.001**	–0.60 [e]	0.82
Pathology test orders per 100 encounters (↓)	106 900	41.6	18 800	32.6	**8.96**	**<0.001**	–0.11[e]	0.96
Imaging test orders per 100 encounters (↓)	106 900	8.6	18 800	8.2	0.44	0.38	–0.53[e]	0.35
Other investigations per 100 encounters (↓)	106 900	1.1	18 800	0.9	0.22	0.05	0.04[e]	0.78
Pap smear per 100 encounters with females aged 15–70 yrs (↑)	43 090	5.7	7095	4.1	**1.58**	**0.045**	–0.16[c]	0.82
All immun-isations per 100 encounters with patients < 5 years old (↑)	6740	20.5	868	15.2	**5.24**	**0.036**	3.50[b]	0.34
Lifestyle counselling per 100 encounters (↑)	106 900	7.2	18 800	8.9	**–1.70**	**0.03**	**–1.72[d]**	**0.03**
PSA tests per 100 screening contacts with males > 50 years old (↓)	1674	9.8	214	13.1	–3.29	0.19	–4.85[b]	0.08
HbA1c per 100 contacts with diabetes (↑)	3432	25.1	688	17.6	**7.53**	**0.001**	3.10[b]	0.24
Referrals to ophthalmologist or allied health per 100 contacts with diabetes (↑)	3432	7.1	688	3.6	**3.50**	**<0.001**	**2.94[b]**	**0.002**

Table1(a) Continued

	n	Rate per 100 of (*n*)	*n*	Rate per 100 of (*n*)	Regression coefficient	*P* value	Regression coefficient	*P* value
ACE inhibitors per 100 contacts with LVF, IHD, diabetes or cerebrovascular disease (↑)	5838	5.9	1075	4.5	1.48	0.07	0.16[(b)]	0.86
Aspirin or clopidogrel per 100 contacts with LVF, IHD, diabetes or cerebrovascular disease (↑)	5838	8.7	1075	9.6	–0.90	0.46	–1.93[(b)]	0.14
Warfarin per 100 contacts with atrial fibrillation (↑)	906	35.4	145	40.0	–4.57	0.42	–5.23[(b)]	0.42
Imaging per 100 contacts with lower back pain or strain/sprain (↓)	5036	14.8	917	16.3	–1.48	0.37	–2.73[(b)]	0.15
NSAIDs per 100 contacts with arthritis (all types) and >65 (↓)	2347	38.0	394	39.6	–1.59	0.66	–1.18[(b)]	0.77
Analgesics (non NSAID) per 100 contacts with arthritis and >65	2347	27.2	394	29.7	–2.51	0.41	–3.51[(b)]	0.38
Antibiotics prescriptions per 100 contacts with URTI (↓)	5072	34.7	912	41.2	–6.49	0.08	2.66[(b)]	0.54
Antibiotics prescriptions per 100 contacts with new URTI (↓)	3841	36.9	714	41.7	–4.82	0.24	3.65[(b)]	0.44
Antibiotics prescriptions per 100 contacts with URTI in children aged <5 (↓)	1122	20.4	154	24.7	–4.27	0.42	0.60[(b)]	0.92

Table1(a) Continued

New diagnosis of depression per 100 encounters (↑)	106 900	0.7	18 800	0.8	–0.07	0.39	**–0.21[(d)]**	**0.043**
Counselling per 100 contacts with depression (↑)	4342	13.5	716	12.0	1.53	0.41	1.87[(b)]	0.39
Antidepressants per 100 contacts with depression (↓)	4342	61.3	716	66.6	–5.31	0.07	**–7.57[(b)]**	**0.02**
Benzodiazepine per 100 contacts with insomnia (↓)	1719	57.6	284	60.6	–2.97	0.53	–0.16[(b)]	0.97

*Missing data removed.
(a) Adjusted using one of the following models:
(b) Model controlling for GP age; GP sex; FRACGP status; work in deputising service in preceding 4 weeks; bulk-billing for all patients; practice accreditation status; presence of a practice nurse at the major practice address
(c) Model controlling for all variables in (b) plus patient age
(d) Model controlling for patient age; patient sex; Commonwealth Health Care Benefits Cardholder status; Veterans' Affairs card holder status; NESB status; Aboriginal or Torres Strait Islander status; 'new patient' status; GP and practice characteristics included in (b)
(e) Model controlling for the presence or absence of problems managed by ICPC-2 Chapter at the encounter; the GP, practice and patient characteristics included in (d)
Note: (↑) and (↓) denotes the direction hypothesised as 'better' quality for each indicator; bold = statistically significant difference; PSA = prostate specific antigen; LVF = left ventricular failure; IHD = ischaemic heart disease; HbA1c = haemoglobin, type A1c; ACE = angiotensin converting enzyme; URTI = upper respiratory tract infection; NSAID = non-steroidal anti-inflammatory drug

Therefore, we compared test ordering behaviour for the set of all clinical computer users and their counterparts in the first instance, and then repeated the investigation for the eight test ordering quality indicators, with the GPs grouped according to their use of the test ordering function of their software.

Results

Individual computer use was determined for 1257 of the 1319 GPs. There were 1069 GPs in the clinical computer use group (106 900 patient encounters) and 188 in the comparison group (18 800 encounters). There were 901 GPs who reported using computers for test ordering, and 356 who did not. The sub-sets of consultations with start and finish times recorded included 34 633 consultations with clinical computer users and 6084 consultations with non-clinical computer users. Using the sample sizes for 106 900 and 18 800 encounters, the intra-cluster correlation was calculated as 0.079 with a variance inflation factor of 8.821. The result for a two-sample comparison of proportions was a power of 0.8002 (80%) to detect a 3.3% difference between estimates, and of 0.8987 (90%) to detect a 3.8% difference between estimates.

GP and practice characteristics

Compared with their counterparts, GPs who used a computer for clinical activity were significantly more likely to: be female ($P = 0.001$); younger ($P < 0.001$); have had fewer years in general practice ($P < 0.001$); have trained for their primary medical degree in Australia rather than overseas ($P = 0.001$); be Fellows of the RACGP ($P < 0.001$); work in larger practices (with five or more GPs; $P < 0.001$); work in accredited practices ($P < 0.001$); and have a practice nurse at their major practice address ($P < 0.001$). They were significantly less likely to: bulk-bill Medicare for all their patients ($P < 0.001$); work in solo practices ($P < 0.001$); or work in major cities or in other metropolitan areas ($P = 0.0002$).

Table 1(b) Univariate and multivariate analysis of quality indicators

	GPs using a computer for test ordering		GPs not using a computer for test ordering		Unadjusted*		Adjusted[(a)]	
	n	Rate per 100 of (*n*)	*n*	Rate per 100 of (*n*)	Regression coefficient	*P* value	Regression coefficient	*P* value
Pathology test orders per 100 encounters (↓)	90 100	42.6	35 600	34.3	**8.25**	**<0.001**	1.28[(e)]	0.41
Imaging test orders per 100 encounters (↓)	90 100	8.6	35 600	8.4	0.19	0.62	–0.59[(e)]	0.15
Other investigations per 100 encounters (↓)	90 100	1.1	35 600	1.0	**0.18**	**0.046**	0.04[(e)]	0.69
Total investigations per 100 encounters (↓)	90 100	52.3	35 600	43.7	**8.62**	**<0.001**	0.73[(e)]	0.68
Pap smear per 100 encounters with females aged 15–70 yrs (↑)	36 751	5.9	13 434	4.3	**1.57**	**0.006**	–0.09[(c)]	0.85
PSA tests per 100 screening contacts with males > 50 years old (↓)	1408	9.7	480	11.5	–1.73	0.34	–2.22[(b)]	0.27
HbA1c per 100 contacts with diabetes (↑)	2838	26.3	1282	18.6	**7.69**	**<0.001**	**4.72[(b)]**	**0.015**
Imaging per 100 contacts with lower back pain or strain/sprain (↓)	4182	14.8	1771	15.4	–0.59	0.64	–1.32[(b)]	0.34

* Missing data removed
(a) Adjusted using one of the following models:
(b) Model controlling for GP age; GP sex; FRACGP status; work in deputising service in preceding 4 weeks; bulk-billing for all patients; practice accreditation status; presence of a practice nurse at the major practice address
(c) Model controlling for all variables in (b) plus patient age
(d) Model controlling for patient age; patient sex; Commonwealth Health Care Benefits Cardholder status; Veterans' Affairs card holder status; NESB status; Aboriginal or Torres Strait Islander status; 'new patient' status; GP and practice characteristics included in (b)
(e) Model controlling for the presence or absence of problems managed by ICPC-2 Chapter at the encounter; the GP, practice and patient characteristics included in (d)
Note: (↑) and (↓) denotes the direction hypothesised as 'better' quality for each indicator; bold = statistically significant difference; PSA = prostate specific antigen; LVF = left ventricular failure; IHD = ischaemic heart disease; HbA1c = haemoglobin, type A1c; ACE = angiotensin converting enzyme; URTI = upper respiratory tract infection; NSAID = non-steroidal anti-inflammatory drug

Quality indicators

Results of the univariate and multivariate analyses for the quality indicators are shown in Table 1(a) for clinical computer users and for non-users. Table 1(b) shows the indicators reanalysed according to GPs' computer use for test ordering.

In total the GPs who used a computer in their clinical activity differed from GPs who did not on only seven indicators. The unadjusted regression coefficients showed almost twice as many differences, but for many of these results, the adjusted regression coefficients showed that the differences were explained by influences other than the GP's use of a computer. Significant differences attributable to clinical computer use included: consultations with Commonwealth Health Care Benefits Card holders (adjusted odds ratio 0.83; $P = 0.035$, results not tabulated); overall prescribing rate; antidepressant prescribing; detecting new cases of depression; referrals to ophthalmologists for diabetes patients; referrals to allied health professionals and provision of lifestyle counselling.

Tables 2(a) and 2(b) provide an overview of all the quality indicators examined, including the hypothesis for each. It shows the indicators that did not discriminate at either univariate or multivariate levels of analysis, or both (marked with a single X). For other indicators, the use of a tick (✓) shows where differentiation occurred between clinical computer users and their counterparts, by showing that the indicator discriminated and the hypothesis was accepted in either the unadjusted results or after statistical adjustments were made, or both. For some indicators, the hypothesis was accepted at the univariate level (as indicated with a tick (✓)), but ultimately rejected following adjustment (marked with a single X). Where the hypothesis was rejected, and the outcome was a reversal of the hypothesis, the result is marked with a double X (XX).

Discussion

On balance these results suggest that the use of a computer has had little effect on the quality of care provided by the GPs to their patients. After adjustment for other characteristics, clinical computer users performed 'better' on three of 34 quality indicators, and 'worse' on four. There was no difference in their performance over the remaining 29. Where the indicators were used to compare test ordering behaviour through the computer, only one difference emerged; in this instance, those ordering tests through their software performed 'better' than their counterparts. In total, from 44 indicators, clinical computer users performed 'better' on four and 'worse' on four, while no differences were discernible for the remaining 36.

What was different?

Why the groups differed on these particular indicators and not others is not readily apparent. One explanation for the lower overall prescribing rate of clinical computer users is that some clinical software in Australia defaults to the maximum number of repeats allowed under Pharmaceutical Benefits Scheme rules when a prescription is written.[12] Unless the default is manually overridden, patients would be given the maximum number of medication repeats allowable, and would not need to return for prescriptions as frequently. However, why these GPs prescribe fewer antidepressant medications for patients with depression, but do not differ on rates for other medications, is unclear.

Decision support tools may have influenced the computer users to provide more referrals to ophthalmologists for patients with diabetes, yet the referral rate to allied health professionals overall was lower for computerised GPs, and it would seem unlikely that these tools would single out ophthalmologists over other healthcare providers. Added to their higher ordering of HbA1c tests, it could be inferred that the clinical use of a computer results in a GP providing better care for diabetic patients. Electronic reminders are effective in modifying physician behaviour[26] and it might follow that GPs who are exposed to electronic reminders for diabetic patients in their software respond and therefore act differently. However, GPs who do not use the test ordering function of their software would still be exposed to these reminders, so electronic flags alone are unlikely to have caused this difference in test ordering behaviour.

We hypothesised that clinical computer users would detect more cases of depression, yet they detected fewer new cases – a reversal of the hypothesis. However, their overall management rate of depression did not differ; neither did their rate of counselling of patients with depression. Depression is an illness which is not easily detected, particularly in situations where the patient may have difficulty disclosing the full extent of their symptoms.[27] Managing a problem once it has been diagnosed and making a new diagnosis are two different scenarios and in this case perhaps the division of consultation time between patient and computer, and the diversion of attention from the patient, reduces the opportunity to detect the unspoken signals which GPs often rely on in these situations.

Computer proficiency should also be considered with regard to the length of consultation. The GP groups were identical on this indicator, suggesting no

Table 2(a) Summary of results for quality of care indicators – clinical vs non-clinical computer use

Domain of care	Measure of quality hypothesis: when compared to GPs not using computers clinically, clinical computer users will:	Descriptive result	Adjusted result
Consultation length and complexity	1 Have a longer mean consultation length (in minutes)	X	X
	2 Have a greater proportion of long consultations	X	X
	3 Have a greater proportion of prolonged consultations	X	X
	4 Report more patient reasons for encounter	X	X
	5 Manage more problems per encounter	✓	X
Non-pharmacological management	6 Provide more clinical treatments	X	X
	7 Perform more procedural work	X	X
Pharmacological management	8 Prescribe fewer medications overall	✓	✓
Referrals	9 Refer more often to allied health services	X	XX
	10 Refer less often to hospitals	X	X
	11 Refer less to specialists	X	X
Tests and investigations	12 Order fewer investigations in total	X X	X
	13 Order fewer pathology tests	X X	X
	14 Order fewer imaging tests	X	X
	15 Order fewer other investigations	X	X
Social disadvantage	16 Have relatively more consultations with indigenous persons	X	X
	17 Have relatively more consultations with holders of a Commonwealth Health Care Benefits card	XX	XX
Appropriate preventive care	18 Perform relatively more Papanicolau tests for 15–70-yr-old women	✓	X
	19 Perform more immunisations for children < 5 yrs of age	✓	X
	20 Provide lifestyle counselling more often	XX	XX
Inappropriate preventive care	21 Order relatively fewer PSA tests for males aged > 50 yrs old	X	X
Diabetes management	22 Order relatively more HbA1c tests for patients with diabetes	✓	X
	23 Refer patients with diabetes more often to ophthalmologists and allied health services	✓	✓

Table 2(a) Continued

Cardiovascular disease management	24	Prescribe ACE inhibitors for IHD, heart failure, diabetes and cardiovascular disease at a higher rate	X	X
	25	Prescribe aspirin or clopidogrel for patients with heart failure, IHD, diabetes or cerebrovascular disease at a higher rate	X	X
	26	Prescribe warfarin for atrial fibrillation at a relatively higher rate	X	X
Musculoskeletal disease	27	Order relatively less imaging for low back pain and sprains/strains (any site)	X	X
	28	Prescribe relatively fewer NSAIDs for arthritis patients > 65 yrs old	X	X
	29	Prescribe more simple and compound analgesics for these patients	X	X
Infection management	30	Prescribe antibiotics less often for upper respiratory tract infection	X	X
	31	Prescribe antibiotics less often for new cases of URTI	X	X
	32	Prescribe antibiotics less often for URTI in children <5 yrs old	X	X
Psychological problem management	33	Detect new cases of depression more often	X	XX
	34	Have higher counselling rates for depression	X	X
	35	Have lower antidepressant prescribing rates for depression	X	✓
	36	Have lower benzodiazepine prescribing rates for depression	X	X

Note: ✓ – hypothesis accepted; X – hypothesis rejected, there being no significant differences between the groups; XX – hypothesis rejected, result reversed from that hypothesised

difference in the level of quality given to the patients, but this may also mean that the extra time involved in dealing with the computer means less 'quality' time spent with the patient over the same duration by the less computer proficient GPs.

Similar studies

A similar cross-sectional study in the USA examined the association of electronic health record (EHR) use with 17 ambulatory care quality indicators, with similar results.[28] For 14 of the 17 indicators, there was no difference in performance between visits with or without the use of an EHR. On two indicators, the clinicians using EHRs performed 'better' and on one indicator they performed 'worse'. Other US studies examining the relationship between EHR use and quality of care also found no assocation.[29,30]

Strengths and limitations

This study employs a method for collection of nationally representative data, which has proved to be a valid and reliable approach to providing an accurate picture of the behaviour of Australian GPs.[31] The large number of observations allows good statistical power for most outcomes. We have reported no difference between the GP groups for some of the variables measured but acknowledge that where differences are very small, there may have been too few

Table 2(b) Summary of results for quality of care indicators – computerised vs non-computerised test ordering

Domain of care	Measure of quality hypothesis: when compared to GPs not using computers to order tests, GPs ordering tests via computer will:		Descriptive result	Adjusted result
Tests and investigations	1	Order fewer investigations in total	XX	X
	2	Order fewer pathology tests	XX	X
	3	Order fewer imaging tests	X	X
	4	Order fewer other investigations	XX	X
Appropriate preventive care	5	Perform relatively more Papanicolau tests for 15–70 yr old women	✓	X
Inappropriate preventive care	6	Order relatively fewer PSA tests for males aged > 50 yrs old	X	X
Diabetes management	7	Order relatively more HbA1c tests for patients with diabetes	✓	✓
Musculoskeletal disease	8	Order relatively less imaging for low back pain and sprains/strains (any site)	X	X

Note: ✓ – hypothesis accepted; X – hypothesis rejected, there being no significant differences between the groups; XX – hypothesis rejected, result reversed from that hypothesised

cases to be able to make a reliable acceptance of a null hypothesis. For example, the rate of other investigations (see Table 1(a)) compared 1201 cases in the clinical computer user group to 169 cases in the group of their counterparts. These investigations occurred in each group at the comparatively low rate of only 11 in every 1000, and nine in every 1000 patient encounters respectively.

Computer use was self-reported in this survey, and some GPs may have inaccurately reported their level of usage, through recall bias or perceived desirable responding. However, the questions about computer use were incorporated within a larger set of questions about a variety of GP characteristics and we have no reason to assume that their responses were inaccurate to a degree that may have compromised this research.

As an entity, quality is difficult to measure. The use of quality indicators is an inexact science at best, and the incorrect application of inappropriate quality indicators cannot produce a valid or reliable result.[32] However, the set of indicators used in this study were designed originally in consultation with the Royal Australian College of General Practitioners (RACGP) National Manager, Quality Care and Research and the RACGP National Standing Committee, Research, drawing from Australian and international guidelines for preventive activities. These included the RACGP 'Red Book', the Canadian guide to clinical preventive health care and guidelines for National Health Priority areas such as the National Heart Foundation cardiovascular disease guidelines.[21] The quality indicators were validated in previous work done for the RACGP[21] and are suitable for use with the BEACH data source used in this study.

Future implications

One of the difficulties in clearly assessing the relationship between the inclusion of computers in the clinical process and quality of care is that GPs are not using the computer to its full potential. In many instances Australian GPs do use the computer to print prescriptions and order tests or referral letters, but do not use the electronic health record function available through their software, for a variety of reasons. Many are still heavily reliant on paper records.[3,4] The situation appears similar in the USA.[33]

We were able to examine GP practice behaviour where computers had been included in the clinical process, but within the computer use group there was wide variation in usage levels. It may simply be that computer use has so far made little difference to the quality of care because the computer is not used by many individuals to its full capacity. The cross-sectional data available via the BEACH method, while applicable to the process measures utilised in this study, cannot provide individual patient outcomes. Complete, longitudinal data would be needed to allow the application of indicators that could provide outcome measures – ironically, information that might become available once GPs use their computers exclusively and comprehensively. At such a time, this type of investigation could be repeated, but given the improbability of finding a comparison group of non-clinical computer users, other methods will need to be devised.

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CONFLICTS OF INTEREST

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