AN ASPECT OF TECHNOLOGICAL ASSESSMENT OF DIAGNOSTIC PROCEDURES OF THE UPPER GASTROINTESTINAL TRACT*

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This paper is concerned with one aspect of the assessment of a new technology — describing the temporal utilisation of the technology in use. The technologies that are considered here are barium meal radiology and fibre optic endoscopy, two major diagnostic procedures for the upper gastrointenstinal tract. The data employed relate to private fee-for-service medicine in Australia and have been collected under Australia's health insurance arrangements. Statistically significant differences in utilisation rates for these diagnostic procedures are found between the states of Australia. Also it is shown that per capita use of these procedures is rising at an annual rate of 2.4 per cent per annum. Although it is not possible from the data employed here to specify what factors have determined these utilisation rates, some possible explanations are considered. A secondary aspect of the paper is that it demonstrates how data from the Health Insurance Collection can be analysed despite the changes to health insurance arrangements introduced by the Commonwealth government since 1975-76.

Keywords: Technology assessment, medical diagnosis, temporal utilisation, fee-for-service medicine

INTRODUCTION

New technologies in the health sector are of interest to a number of groups, for example, patients, clinicians, medical researchers and third party payers such as health insurance funds and governments. Their interests, of course, may not coincide. In fact, the role of medical technology has now become a policy issue in a number of countries, including Australia.[1] Apart from various ethical and legal issues associated with technological change,[2] the contribution of technology to the rising cost of health services has been considered.[3]

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In a recent paper, Banta, from the Office of Technology Assessment of the US Congress, surveyed social science research on medical technology.[4] While his major conclusion was that there was lack of research findings, he also pointed out the absence of information on such important matters as efficacy. With respect to technology assessment, there are several issues that must be clearly addressed. First, the nature of the output of the technology must be identified, measured and compared with an alternative technology. This point relates to Banta's concern with efficacy. Second, it is important to describe the utilisation of the new technologies. Banta considers this matter in his discussion of adoption of medical technologies. Third, from such an analysis it is possible to construct hypotheses that can be tested. A commonly tested hypothesis is that diffusion of a new technology follows the logistic curve.[5] Other issues relate to physician use of the new technology. Questions such as whether the new technology displaces an old technology or whether doctors employ both, and whether there are differences in technological adoption between industrial sectors (such as fee-for-service and salaried medicine) may be relevant. Fourth, questions of economic efficiency can be addressed.[6]

While it is not suggested that the above comments comprise a complete list of the components of technology assessment, they can be regarded as necessary conditions. This paper is concerned with only the second issue, *viz.* a description of utilisation in Australia of a new technology. The specification and measurement of the output of diagnostic tests have been considered elsewhere.[7] The technology that is the subject matter of this paper is fibre optic endoscopy, a new technology for diagnosing diseases/conditions of the upper gastro-intenstinal tract.

DIAGNOSIS OF THE UPPER GASTROINTESTINAL TRACT

Diagnosis in medicine experienced a quantum leap forward in 1895 when Roentgen discovered a new form of radiation. At first it was thought that the use of what are now commonly called X-rays would be limited to the skeleton and search for metallic foreign objects. However, within months of Roentgen's announcement and demonstrations, attempts were being made to visualise soft tissues. The first success was by Becker in March 1896 when he visualised the stomach of a guinea pig by using a solution of lead subacetate.[8] Later that same year two undergraduate medical students in the United States, Cannon and Moser, used bismuth subnitrate and bismuth mixed with bread to demonstrate the mechanism of swallowing in a goose by these contrast media and fluoroscopy. Within months Cannon had successfully used bismuth to examine the stomach of a

cat.[9] The use of barium salts as the dominant contrast medium became widespread after 1910.

The technique of contrast radiology of the upper gastrointestinal tract dominated diagnosis until the advent of fibre optic endoscopy. Radiological diagnoses could not be verified unless patients came to surgery or autopsy and, in the absence of an alternative, radiology "reigned supreme".[10]

Fibre optic endoscopy was a development on the rigid and later semi-flexible gastroscopes which were first used in the mid-nineteenth century.[11] The fibre optic age of endoscopy began in 1954 when it was argued that flexible endoscopes could be developed using fibre optic principles. Hopkins and Kapany wrote as follows:

> . . . an optical unit has been devised which will convey optical images along a flexible axis. The unit comprises a bundle of fibres of glass, or other transparent material, and it therefore appears appropriate to introduce the term 'fibrescope' to denote it. An obvious use of the unit is to replace the train of lenses employed in conventional endoscopes.[12]

By 1958 a fully flexible fibre optic gastroscope had been demonstrated.[13]

The major physical characteristic of fibre optic endoscopes is flexibility. The instrument is not simply a device for 'having a look'. Modern instruments have facilities for removing tissue specimens, using biopsy forceps, cytology brushes and snare loops. Photographic and/or cinematic records can be made of the conditions observed.[14] Fibre optic endoscopes are no longer used only for diagnosis, although therapeutic uses are in the infancy.[15] Snare diathermy can be used in the management of polyps. The new generation of instruments also enables the removal of foreign bodies, sphinterotomy for duct stones, dilation of oesophageal strictures and the treatment of bleeding lesions by diathermy or laser photocoagulation.[16]

Fibre optic endoscopy has been successfully demonstrated in children[17] and the elderly,[18] and the indications for the procedure are very wide. Generally the indications can be described as any suspected complication of the upper gastrointestinal tract, such as dysphagia, bleeding, vomiting, epigastric pain, dyspepsia, etc. Contraindications relate to patients who are unco-operative or who have an infectious disease.[19]

Attention is now directed to a description of the temporal utilisation of these diagnostic technologies in the states of Australia and the country as a whole. Although fibre optic endoscopy was first employed in Australia in the 1960s,[20] and barium meal radiology long before that, data availability restrict attention to the period since 1975-76. Non-linear functions, particularly the logistic curve, are

often applied to time-series data on innovations. However, in this case linear equations will be estimated on the data as the purpose is description rather than to test the hypothesis that diffusion follows a sigmoid-type curve.

UTILISATION OF DIAGNOSTIC TESTS ON THE UPPER GASTROINTESTINAL TRACT

Since 1975-76, the Commonwealth Department of Health has compiled, by computer, data on all medical services (coded by reference to the various editions of the *Medical Benefits Schedule Book*) for which a Commonwealth medical benefit was recorded as being paid. The data set does not provide a count of all medical services provided in Australia. It has been estimated that, in 1975-76, these data represented 72 per cent of all medical services rendered in Australia.[21] The principal omissions relate to medical services provided at zero user charger in recognised hospitals, medical services for insurance or employment purposes, medical services covered by third party or workers compensation legislation, and medical services provided to defence personnel and Department of Veteran Affairs (Repatriation) beneficiaries. Some other minor omissions relate to screening services and services provided under Health Program Grants. Generally the data relate to services rendered by private medical practice in Australia, operating on a fee-for-service basis.

The data are an administrative by-product of medical services provided under Commonwealth health insurance arrangements. As such, the data are affected by those arrangements. Since 1975-76 the omissions which arise from these arrangements relate to 'services with a schedule fee of $20 or less rendered in the period 1 September 1979 to 31 August 1981 to uninsured persons where the doctor did not bulk bill' and, since 1 September 1981, all medical services provided to persons without registered medical insurance policies. The omissions since 1 September 1981 are likely to be by far the most important. The data are not perfect. For the years 1975-76, 1977-78 and 1978-79 full counts of the available data were not undertaken. The estimates have been derived by various samples. No data at all are available for the year 1976-77. These reservations are relevant in drawing conclusions from the data.

The temporal recording of the data relates to the time at which a patient claim is made. If a person has a medical service in February of year 1 and delays making a claim, say for six months, then the service will be recorded in year 2. Such time lags will be important only if the lags vary during the period under study.

Table 1 indicates the numbers of 17 separate medical procedures (as defined by the *Medical Benefits Schedule Book*) for seven of the eight

years from 1975-76 to 1982-83. Total medical procedures are indicated in the last line of the Table. All specific procedures relate to the upper gastrointestinal tract. It is clear that the specific procedures listed in the Table do not comprise a major sub-set of total medical procedures provided in Australia, as recorded in the Health Insurance Collection. The 17 specific medical procedures represent, in total, 277,789 of the 96.245 million medical services provided in Australia under Commonwealth health insurance arrangements in 1982-83. This is approximately 0.28 per cent of all medical services (as defined). Note that there are large variations in the total numbers of medical procedures in some years, particularly 1979-80 and 1981-82. These variations arise from changes in health insurance arrangements introduced by the Fraser government in those years. These changes and their effects on the Commonwealth Health Insurance Collection, are discussed in detail below.

The 17 specific procedures in Table 1 fall into four distinct categories, *viz.* rigid oesophagoscopy, barium meal radiography, diagnostic and therapeutic fibre optic endoscopy. It is clear that barium meal radiography and diagnostic endoscopy are by far the most important categories in terms of numbers of procedures. It is interesting to observe the relative importance of the fibre optic technology for diagnosis and therapy. In 1975-76 diagnostic applications of this technology represented 97.5 per cent of all procedures, and in 1982-83, still represented 95.9 per cent. Relatively speaking, therapeutic applications of fibre optic endoscopes are not numerically important. Table 1 provides only an aggregate picture of the medical services with which this paper is concerned. In fact, the data relating to the diagnostic services considered here are available, not simply for Australia as a whole, but also for the six states.

It is important to note that the decline in total medical services between 1978-79 and 1979-80 has resulted from an important change in health insurance arrangements which came into effect on 1 September 1979 and lasted until 31 August 1981. During this period it was not compulsory for people to have health insurance cover. However, the Commonwealth government paid, to uninsured people through the various health insurance funds, a medical benefit if the schedule fee was greater than $20. Medical services for which such a benefit was paid are included in the Health Insurance Collection. There are two categories of medical services when the schedule fee is less than $20. If the doctor did not bulk bill the Commonwealth government for such services to uninsured patients, then such services have not been included in the data set. If the doctor did bulk bill the Commonwealth, then the services have been included. In other words, there is an inconsistency between the data for the period 1975-76 to 1978-79 and those for 1979-80 and 1980-81 with respect to services for

TABLE 1

Rigid Oesophagoscopy, Radiological and Fibre optic Endoscopic Procedures of the Upper Gastrointestinal Tract, and Total Medical Procedures for which a Commonwealth Medical Benefit was paid, Australia, 1975-76 to 1982-83

Medical Procedure[1]	1975-76	1976-77[2]	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Rigid Oesophagoscopy (5464, 5470, 5480, 5486)	3,442	n.a.	4,051	3,603	3,831	3,775	4,216	4,212
Barium Meal (2706, 2709, 2711, 2714)	177,890	n.a.	218,437	200,154	187,376	188,282	214,016	211,389
Endoscopic Pancreatocholangiography (3860)	319	n.a.	979	1,104	1,168	1,299	1,821	1,955
Endoscopic Sphincterotomy (3862)	0	n.a.	0	0	0	0	0	145
Oesophagoscopy, Gastroscopy, Duodenoscopy or Panendoscopy (3846, 3847, 3857)	8,186	n.a.	17,495	24,983	25,915	29,600	37,225	43,215
Oesophagoscopy, Gastroscopy, Duodenoscopy or Panendoscopy with biopsy (2849, 3855, 3858)	4,384	n.a.	7,438	9,917	10,022	10,980	14,606	16,452

Oesophagoscopy, Gastroscopy, Duodenoscopy or Panendoscopy with Polypectomy or removal of foreign body or diathermy (3851)	0	n.a.	0	0	0	0	416	421
Diagnostic Endoscopic Procedures[3]	12,570	n.a.	24,933	34,900	35,937	40,580	51,831	59,667
Diagnostic and Therapeutic Endoscopic Procedures[4]	12,889	n.a.	25,912	36,004	37,105	41,879	54,068	62,188
Total Medical Procedures	76.651m	n.a.	82.431m	84.431m	77.826m	81.067m	93.180m	96.245m

Source: Commonwealth Health Insurance Collection (1984).

Notes:
1. Figures in brackets refer to the relevant code numbers in the various editions of the *Medical Benefits Schedule Book* in the period 1975-76 to 1982-83.
2. Data for 1976-77 are not available.
3. Diagnostic Endoscopic Procedures are defined as the sum of medical services coded as 3846, 3847, 3849, 3855, 3857 and 3858.
4. Therapeutic Endoscopic Procedures are defined as the sum of medical procedures coded as 3860, 3862 and 3851.

those people who did not hold insurance cover from 1 September 1979 and for which the schedule fee was less than $20.

It is relevant to note that all the diagnostic services listed in Table 1 fall into the category of having a schedule fee greater than $20. Thus they have been included in the data set. In other words, the enumeration of the specific services in Table 1 is consistent from 1975-76 to 1980-81, even though the enumeration of total medical services is not consistent in this period.

Another change to health insurance, which took effect from 1 September 1981 (and lasted until 31 January 1984), has affected the data. This change was that the Commonwealth government paid no medical benefit to persons who received a medical service unless they held insurance cover with an approved health insurance fund. No medical benefit was payable for services rendered to uninsured persons. This decision by the (then) Commonwealth government marked the end of the universal health coverage which had existed in Australia since 1975-76, the financial costs and entitlements of which had been constantly varied by the Commonwealth government. With respect to the Health Insurance Collection, all medical services rendered to uninsured persons from 1 September 1981 to 31 January 1984 have not been counted. This means that the data relating to the diagnostic services listed in Table 1 are non-comparable between the periods 1975-76 to 1980-81 and 1981-82 to 1982-83.

To determine time trends in the diagnostic services which are the subject of this paper, linear regression equations were fitted to the numbers of procedures per 10,000 population in each state, and the nation as a whole. Generally, the results were not satisfactory. These poor results were expected because the coverage of the data is inconsistent in the manner outlined above.

Given that universal health insurance cover (the financial terms of which were varied several times) existed from 1975-76 to 31 August 1981, the coverage of the Health Insurance Collection (for services with a schedule fee greater than $20) is the total population during that period. With the changes of 1 September 1981 this was no longer the case. Coverage must be calculated by aggregating the numbers in various groups of the population. Apart from the people with health insurance, there are two major groups to be considered. For the disadvantaged (as defined by the Commonwealth), Health Care Cards, which provided the holder and dependents with cover for health expenditures, were introduced. The second group provided with Commonwealth cover was pensioners via the Pensioner Health Benefit.

To determine coverage under these circumstances, the persons covered by voluntary health insurance, Pensioner Health Cards and Health Care Cards have been summed by state. Health insurance data

are recorded by reference to the state of registration of the health fund to which people belong. The problem that this creates is that there are no funds registered in the Australian Capital Territory and the Northern Territory, whereas the Department of Social Security, which administered Pensioner Health Cards and Health Care Cards, records separate data for these two regions. This matter has been handled by allocating all persons covered by both cards in the ACT to New South Wales and one-half of persons covered in the Northern Territory to South Australia and the other half to Queensland. Table 2 indicates the results of these calculations for 1981-82 and 1982-83. Note the atypical percentage of the Queensland population covered by health insurance and the two Commonwealth-funded schemes of health cover for the two categorical groups, that is, pensioners and the disadvantaged. This low coverage in Queensland is explicable when it is recognised that the Queensland government operates a system of public hospitals that provides both in- and out-patient medical services to residents in the state at zero price to those residents.

TABLE 2

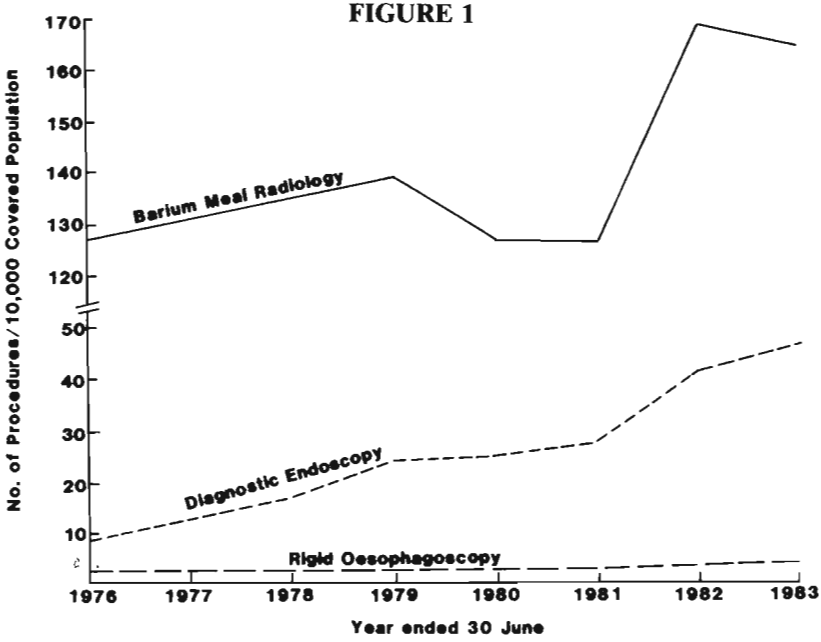
Coverage of Health Insurance Collection, by State and for Australia, 1981-82 and 1982-83

	Pensioner Health Card	Health Care Card	Health Insurance	Population Covered	Percentage of Total Population Covered
			1981-82		
NSW	751,669	335,122	3,706,000	4,792,791	90.95
Vic	495,225	205,783	2,775,000	3,476,008	87.56
Qld	321,902	130,601	1,046,000	1,498,503	62.85
SA	200,965	106,701	941,000	1,248,666	94.32
WA	160,658	89,708	847,000	1,124,366	85.23
Tas	61,920	39,559	274,000	375,479	87.63
Aust	1,992,339	907,473	9,616,000	12,515,812	83.15
			1982-83		
NSW	778,275	518,968	3,658,000	4,955,243	92.89
Vic	518,748	288,254	2,682,000	3,489,002	86.90
Qld	335,076	216,146	1,037,000	1,588,222	64.83
SA	211,212	141,053	907,000	1,259,265	94.36
WA	172,628	129,108	890,000	1,191,736	88.17
Tas	64,125	46,414	265,000	375,541	87.19
Aust	2,080,064	1,339,946	9,439,000	12,859,009	84.14

Source: Calculated from information supplied by Department of Social Security and from Commonwealth Department of Health, *Annual Report of the Director-General of Health 1981-82, 1982-83,* AGPS, Canberra, 1982, 1983; Australian Bureau of Statistics, *Australian Demographic Statistics Quarterly December 1982,* Canberra, 1983.

With these data, and total population data for the states for the previous years to 1975-76, rates were calculated for the six states (as defined) and Australia as a whole. Figure 1 indicates these rates for barium meal radiography, diagnostic fibre optic endoscopy and rigid oesophagosocopy for Australia from 1975-76 to 1982-83. It appears that the observations for 1981-82 and 1982-83 are atypical compared with the observations for the years 1975-76 to 1980-81.

FIGURE 1



Legend: Number of Procedures (Barium Meal Radiology, Diagnostic Fibre Optic Endoscopy and Rigid Oesophagoscopy) per 10,000 People Covered by Various Health Insurance Arrangements for Medical Costs Incurred with Private Medical Practitioners, Australia, 1975-76 to 1982-83.

These data, *inter alia,* were fitted to a multiple regression equation of the form

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \xi$$

where y = relevant rate (per 10,000 population covered)

x_1 = dummy variable relating to health insurance coverage
x_2 = time
β_0 = y intercept
β_1 = regresion coefficient for x_1
β_2 = regression coefficient for x_2
ε = error term.

The variable x_1 in this equation deserves some comment. A dummy variable is an independent variable designed to measure the effect of a qualitative factor in a regression analysis. In this case the dummy variable relates to the fact that the data from the Health Insurance Collection are universal in coverage to 1980-81, whereas the collection for the years 1981-82 and 1982-83 relates to the voluntary health insurance arrangements prevailing in those years.

TABLE 3

Estimated Multiple Regression Equations for Three Types of Diagnostic Procedures of the Upper Gastrointestinal Tract, and Two Types Combined, Australia, 1975-76 to 1982-83

Type of Diagnostic Procedure	Estimated Equations	
Rigid Oesophagoscopy	$y = 2.582 + 0.719x_1^{***} + 0.003x_2$ (0.193) (0.039)	($\bar{R}^2 = 0.8359$)
Barium Meal Radiology	$y = 133.823 + 41.738x_1^{***} - 0.605x_2$ (8.353) (1.691)	($\bar{R}^2 = 0.9075$)
Diagnostic Endoscopy	$y = 6.131 + 9.355x_1^{***} + 3.789x_2^{***}$ (2.215) (0.448)	($\bar{R}^2 = 0.9819$)
Barium Meal Radiology and Diagnostic Endoscopy	$y = 140.828 + 51.065x_1^{***} + 3.341x_2$ (12.036) (2.437)	($\bar{R}^2 = 0.9266$)

Source: Calculated from Australian Bureau of Statistics, *Australian Demographic Statistics Quarterly December 1982*, Canberra, 1983 and Tables 1 and 2 above.

Notes:
(i) The statistical package used (SPSS, Version H) does not generate the standard errors for the estimated y-intercept.
(ii) Standard errors of the estimated regression coefficients are given in parentheses.
(iii) The datum for barium meal radiology in 1977-78 has been treated as an outlier and has not been included in the analysis.
(iv) *** Significant at the one per cent level.
** Significant at the five per cent level.
* Significant at the ten per cent level.

The estimated equations for Australia as a whole are indicated in Table 3 for rigid oesophagoscopy, barium meal radiology, diagnostic endoscopy and the latter two combined. The most important aspect of these equations is that the inclusion of a dummy variable for health insurance coverage has produced a marked improvement in the estimated equations compared with the linear equations first fitted to rates defined as number of procedures per 10,000 total population. These latter rates implicitly assumed that the variable coverage of the Health Insurance Collection did not matter. Note that all coefficients for the health insurance variable in the equations in Table 3 are significant at the one per cent level. An indication that these equations are 'better' than the simple linear equations which were initially fitted can be obtained by comparing the value of R^2 for the linear equation (0.483) for barium meal radiology with the value for R^2 (0.9075) reported for that same technology in the multiple regression equation in Table 3.

Three of the time coefficients in Table 3 are positive and one is negative. The positive slope coefficient on rigid oesophagoscopy is not signifcantly different from zero and hence the rate for this procedure can be taken as constant in the period 1975-76 to 1982-83. The slope coefficient for barium meal radiology is negative with a t statistic of 0.3578: this indicates that this coefficient is also not significantly different from zero. Thus the rate for barium meal radiology can also be regarded as constant in the period under consideration. The t statistic for the (positive) time coefficient for diagnostic endoscopy is 8.4576, which is significant at the one per cent level. The third positive slope coefficient, that for barium meal and diagnostic endoscopy combined, is almost significant at the ten per cent level. Note that all coefficients on the dummy variable are significant at the one per cent level.

At this aggregate level of analysis (the country as a whole), the results indicate that rigid oesophagoscopy, in a numerical sense, is not an important procedure. As a result of this, attention will be directed to the technologies of barium meal radiology and fibre optic endoscopy. If these two technologies are regarded as the major means of diagnosis of the upper gastrointestinal tract, then their sum can be regarded as representing total diagnostic procedures. It is for this reason that the last equation in Table 3 has been estimated.

These results indicate that total diagnostic procedures of the upper gastrointestinal tract (as defined above) per 10,000 covered population, are rising by approximately 3.34 per annum. This rise is dominated by the increase in the number of diagnostic endoscopic procedures, approximately 3.79 annually. Barium meal radiology is decreasing by approximately 0.61 procedures per 10,000 covered population per annum. During the period under consideration, the per

capita utilisation of total diagnostic procedures has risen by approximately 2.4 per cent per annum, and the utilisation rate of barium meal radiology fell by approximately 0.45 per cent per annum. The difference between these two rates is explained by the rapid growth in the use of diagnostic fibre optic endoscopy.

It is of value to consider these issues at a more disaggregated level than the country as a whole. Tables 4-7 present comparable equations to those indicated in Table 3 for the six states of Australia. For ease of comparison the estimated equations for Australia are reproduced as the last entry in each Table.

Table 4, which indicates the results for rigid oesophagoscopy, is not particularly noteworthy. No slope coefficients are statistically significant and the equations for the states are much the same. The utilisation rates are all quite low and for this reason these results will not be considered further.

Table 5 indicates the estimated equations for barium meal radiology and the most notable aspect is the statistical significance of the dummy variable for health insurance coverage. Note the extremely large value for Queensland: this is explained by the quite different

TABLE 4

Estimated Multiple Regression Equations for Rigid Oesophagoscopy (Number of Procedures/10,000 covered population) for Six States and Australia, 1975-76 to 1982-83

Region	Intercept	Health Insurance	Time	$\bar{R}^2$
NSW	2.975	0.7635***	−0.037	0.6672
		(0.257)	(0.052)	
Vic	2.745	0.646**	−0.058	0.3695
		(0.303)	(0.061)	
Qld	1.689	1.026**	0.109**	0.9402
		(0.226)	(0.046)	
SA	3.987	0.416	0.005	−0.1976
		(0.652)	(0.132)	
WA	1.586	−0.221	0.070	−0.0644
		(0.274)	(0.055)	
Tas	1.845	0.697**	0.064	0.8737
		(0.219)	(0.044)	
Aust	2.582	0.719***	0.003	0.8359
		(0.193)	(0.039)	

Source: As for Table 3.
Notes: As for Table 3.

TABLE 5

Estimated Multiple Regression Equations for Barium Meal Radiology (Number of Procedures/10,000 covered population) for Six States and Australia, 1975-76 to 1982-83

Region	Intercept	Health Insurance	Time	$\bar{R}^2$
NSW	149.133	28.308**	0.251	0.6979
		(11,993)	(2.484)	
Vic	137.525	29.728**	−2.120	0.4611
		(13.829)	(2.800)	
Qld	134.688	102.246***	−2.547***	0.9978
		(2.943)	(0.596)	
SA	145.833	17.281	−0.631	0.6367
		(6.942)	(1.405)	
WA	90.915	34.274**	5.103*	0.8875
		(13.065)	(2.645)	
Tas	89.654	27.227***	−2.275***	0.9985
		(0.529)	(0.107)	
Aust	133.823	41.738***	−0.605	0.9075
		(8.353)	(1.691)	

Source: As for Table 3.
Notes: As for Table 3.

TABLE 6

Estimated Multiple Regression Equations for Diagnostic Endoscopy (Number of Procedures/10,000 covered population) for Six States and Australia, 1975-76 to 1982-83

Region	Intercept	Health Insurance	Time	$\bar{R}^2$
NSW	9.078	6.892*	4.427***	0.9578
		(3.520)	(0.713)	
Vic	6.555	6.865***	3.159***	0.9780
		(1.957)	(0.396)	
Qld	2.412	25.982***	4.567***	0.9883
		(3.037)	(0.615)	
SA	4.432	2.179	4.751***	0.9888
		(1.649)	(0.334)	
WA	4.020	4.502**	2.888***	0.9815
		(1.508)	(0.305)	
Tas	0.411	3.515	1.042	0.6276
		(3.522)	(0.713)	
Aust	6.131	9.355***	3.789***	0.9818
		(2.215)	(0.448)	

Source: As for Table 3.
Notes: As for Table 3.

TABLE 7

Estimated Multiple Regression Equations for Barium Meal Radiology and Diagnostic Endoscopy (Number of Procedures/10,000 covered population) for Six States and Australia, 1975-76 to 1982-83

Region	Intercept	Health Insurance	Time	$\bar{R}^2$
NSW	159.263	34.782*	4.859	0.8196
		(16.728)	(3.386)	
Vic	143.823	36.466**	1.309	0.7274
		(16.002)	(3.240)	
Qld	140.442	129.634***	1.879	0.9912
		(8.683)	(1.758)	
SA	150.576	18.501**	4.430**	0.8980
		(8.409)	(1.702)	
WA	95.331	38.499**	8.150**	0.9077
		(15.539)	(3.146)	
Tas	89.211	30.809***	−1.037	0.9006
		(5.967)	(1.208)	
Aust	140.828	51.065***	3.341	0.9266
		(12.036)	(2.437)	

Source: As for Table 3.
Notes: As for Table 3.

proportion of the population in this state holding health insurance policies. Since 1942 the Queensland Department of Health has administered a state-wide network of public hospitals in which both in- and out-patient services have been provided free to all persons unless they prefer to be treated on a fee-for-service basis by a private medical practitioner of their own choice. This comprehensive system of public medicine has the effect that a considerably lower proportion of the state's population hold health insurance. Queensland's public medical system can be regarded as a tax-financed health insurance system operated by the Queensland government. Being tax-financed, Queensland residents are required to pay a zero premium and being a 'free' system there are zero deductibles and co-insurance rates for all services provided by the system for the residents of the state.

There are some notable differences between the time trends for the states. Queensland and Tasmania have statistically significant negative time coefficients, whereas Western Australia's time coefficient is almost significant at the five per cent level. For all other states, and Australia as a whole, the time coefficients are not significantly different from zero, which can be interpreted to mean

that the utilisation rates for barium meal radiography can be regarded as constant during the study period.

Table 6, which reports the results for diagnostic endoscopy, is most notable for the significant time coefficients (at the one per cent level) for all states, with the exception of Tasmania. Note also that the dummy variable is, once again, quite important, particularly for Queensland.

Table 7, indicating the results for the summation of the rates for barium meal radiology and diagnostic endoscopy, is most notable for the significance of the health insurance coverage variable. With respect to the time coefficients, both South Australia's and Western Australia's are such as to indicate a rising utilisation rate. Given the statistical non-significance of the time coefficients for the other states, and Australia as a whole, the utilisation rates for these regions can be interpreted as being constant during the period 1975-76 to 1982-83.

This analysis is subject to a number of limitations. First, the regression equations have been estimated on a relatively small number of observations (just seven), which leaves relatively few degrees of freedom. Second, the observations are based on annual data and the changes in health insurance have not been introduced on any occasion which corresponds to the financial year recording employed here.

The procedures adopted in this study have also been applied to quarterly data, for the period from the June quarter 1979 to the December quarter 1983. This gives a total of 19 observations for each estimated multiple regression equation, 10 being in the universal coverage period of the Health Insurance Collection and 9 being in the non-universal period. The use of quarterly data, as well as increasing the number of observations, enables a more accurate specification of the break in universal coverage in the Health Insurance Collection for the specific procedures examined here. The details of the statistical analysis of these quarterly data, by state and for Australia, are not reported here. Some brief comments on the results will be reported.

These quarterly data also indicate that the health insurance variable is very important in the statistical analysis. With respect to the time coefficients for barium meal in Queensland and Tasmania, the data for the more recent period indicate positive and significant coefficients (at the five per cent level) compared with the negative and significant coefficients reported in Table 5. The positive time coefficient for diagnostic endoscopy in Tasmania (see Table 6) became significant at the one per cent level. In addition, the results from the more recent period for total diagnostic procedures have statistically significant positive time coefficients in New South Wales, Queensland, Tasmania and Australia as a whole. These results can be contrasted with those, in Table 7 for these regions, which indicate that the time coefficients are not significantly different from zero. In

general, the analysis for the more recent period indicates some higher utilisation rates than are reported here from 1975-76.

Apart from the factors mentioned previously for interpreting these data with caution, it is also relevant to point out that time series data are often subject to autocorrelation. Given the missing observation in the annual data, it is not clear that the Durbin-Watson statistic can be considered reliable in this context. Also, with quarterly data little significance can be attached to the Durbin-Watson test as it is likely that quarterly data exhibit a fourth order autoregressive process. The Wallis D_4 statistic has been calculated and the tests indicate that the quarterly data exhibit some serial correlation.[22] Thus the results reported here, althouth unbiased and consistent, are not as efficient as they would be if there were no autocorrelation present in the data.[23]

CONCLUSION

This paper has been concerned with giving a descriptive account of the temporal utilisation of diagnostic procedures for the upper gastrointestinal tract in fee-for-service medicine in Australia for the years since 1975-76. The purpose of undertaking a profile of the utilisation of these services arises from a consideration of the components of technology assessment. In particular, the technology of interest is diagnostic fibre optic endoscopy.

If the sum of diagnostic fibre optic endoscopy and barium meal radiology is regarded as being an appropriate measure of total diagnostic procedures of the upper gastrointestinal tract, then this study has shown that the per capita utilisation of such procedures, in Australia, has been rising at an annual rate of 2.4 per cent per annum. This national rate of increase conceals wide variations in the temporal increases in the utilisation rate of these procedures in the various states, ranging from a high of 8.55 per cent per annum in Western Australia to a slight decrease of 1.2 per cent per annum in Tasmania. These differing rates of increase reflect the different patterns of utilisation of both barium meal radiology and diagnostic fibre optic endoscopy in the states of Australia.

It is relevant to consider what one might expect, *ceteris paribus,* the temporal trend in the utilisation rate of all diagnostic procedures of the upper gastrointestinal tract to be. If the incidence rates of diseases of the upper gastrointestinal tract were rising, then one would expect that the relevant diagnostic procedures would also be rising. An analysis of peptic ulcer in Queensland for the period since 1969 can shed some light on this matter.[24] This study has shown that the incidence of peptic ulcer since 1969 has fallen and furthermore that, on the basis of an analysis of mortality data, there is some reason to believe that the Queensland results may be applicable to Australia as a whole. It is clear that barium meal radiology and diagnostic fibre optic

endoscopy are alternative, but not perfectly substitutable, means of diagnosis. The data analysed here cannot indicate whether the new technology has substituted for the old technology, or whether medical practitioners have responded to the advent of the new technology by employing both procedures on some patients.

There is now evidence to indicate that the markets for medical services do not operate in a way described by the standard model of competition.[25] A study by Richardson has indicated that Australian data provide some support for the supplier-induced demand hypothesis — that medical practitioners can generate demand for their own services.[26] This study has not, of course, been concerned with this matter. A descriptive analysis of utilisation rates can indicate nothing with respect to the factors that have determined those rates.

The empirical results on utilisation rates have, however, presented a puzzle which is worthy of further analysis. In this context it is worth noting the following statement by Richardson:

> After allowing for other relevant variables, there was a strong and significant association between the supply of doctors and the demand for their services. The association was much stronger for specialists than for general practitioners.[27]

It is noteworthy that the subject matter of this paper relates only to services provided by specialists. It is possible that some trends in the time-series data analysed here are a manifestation of supplier-induced demand, an hypothesis that has been typically tested on cross-section data. An alternative possibility is that the explanation may lie in the clinical decision-making processes employed by medical practitioners.[28]

A relevant aspect of this study has also been to indicate how time-series data from the Commonwealth Health Insurance Collection can be analysed. Being an administrative by-product of the Commonwealth government's health insurance arrangements, the data set has been affected by the various changes that the Commonwealth has made, particularly in 1979 and 1981. However, for the services analysed in this paper, the changes in health insurance have been incorporated into the analysis by using a health insurance variable in a multiple regression equation.

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