Predicting medical students' intentions to take up rural practice after graduation

Michael Jones,[1] John Humphreys[2] & David Prideaux[3]

OBJECTIVES Using a novel longitudinal tracking project, this study develops and evaluates the performance of a predictive model and index of rural medical practice intention based on the characteristics of incoming medical students.

METHODS Medical school entry survey data were obtained from the Medical Schools Outcome Database (MSOD) project implemented in all Australian and New Zealand medical schools and coordinated through Medical Deans Australia and New Zealand, the representative body for the Deans of 18 Australian and two New Zealand medical schools and faculties. The medical school commencement survey collects data on students' education and family background, including rural upbringing, personal circumstances and scholarships, and on their practice intentions in terms of location and specialty. The MSOD will also allow tracking of medical graduates after graduation. Logistic regression modelling was used to develop a predictive model of rural practice intention. Split-sample validation was used to gain some insight into the stability of performance of the model.

RESULTS Response rates to the MSOD survey exceeded 90% on average. The model findings confirm and extend previous research examining the association of medical student characteristics with intention to take up rural medical practice. The statistically significant independent factors in the model included students' rural backgrounds, financial arrangements and intentions regarding specialist versus generalist practice upon graduation. Model performance was good, with an area under the receiver-operator characteristics curve of 0.86, and reproducible, with an area in a validation sample of 0.83.

CONCLUSIONS The model and related index provide important insights into individual factors associated with rural practice intention among students commencing medical studies. The model can also provide a means for optimising the use of scarce medical programme resources, thereby helping to improve the supply of rural medical practitioners. This study illustrates the power and potential of a robust, consistent, systematic longitudinal tracking project.

Medical Education 2009: ***43****: 1001–1009*
doi:10.1111/j.1365-2923.2009.03506.x

[1]Department of Psychology, Macquarie University, North Ryde, New South Wales, Australia
[2]School of Rural Health, Monash University, Melbourne, Victoria, Australia
[3]Department of Medical Education, Flinders University, Adelaide, South Australia, Australia

Correspondence: Michael Jones, Department of Psychology, Macquarie University, North Ryde, New South Wales 2109, Australia. Tel: 00 61 2 9850 8601; Fax: 00 61 2 9850 8062; E-mail: mike.jones@psy.mq.edu.au

INTRODUCTION

Australia has a shortage of rural and regional medical practitioners.[1–3] This shortage has manifested as a significant social and political issue for several decades in Australia,[4–6] as it has in other Western countries, such as the USA.[7] Considerable research has been undertaken on the recruitment and retention of rural general practitioners,[8,9] but less has been undertaken around allied health professionals.[10–12] However, despite more than 30 years of such research and many millions of dollars of government expenditure,[13] the problem of how to attract and retain health care professionals to posts outside urban areas persists.[1,14]

The Australian government has implemented several expensive national schemes designed to encourage medical student exposure to rural medical practice during medical training.[15] These schemes include the Rural Undergraduate Support and Coordination (RUSC) programme, initiated under the broader Rural and Remote General Practice Programme (RRGPP).[13] A key element of the RUSC programme is the belief that exposing a student to rural medical practice very early in his or her career increases the likelihood that the student will take up a rural career once qualified. However, such schemes as the RUSC focus on only one aspect of the individual and his or her medical training. In reality medical students experience a broad range of both internal and external influences during their training. The former might relate to their upbringing and personality, whereas the latter might include family obligations and positive or negative life events.

The association of rural exposure during medical training with increased likelihood of rural practice has only been partially demonstrated in Australian[16] and international research,[17,18] for allied health workers as well as for medical practitioners.[19] Because many studies fail to control for confounding variables, Ranmuthugala *et al.*[20] questioned the individual contribution of rural exposure to intention to take up rural practice, and the implications for resource utilisation.

These observations illustrate that, until very recently, rural medical workforce policy and rural medical education training in Australia were largely guided by a somewhat eclectic body of knowledge that emerged from diverse existing international studies and several disparate empirical studies affirming the roles and contribution of various factors to rural workforce outcomes. Hence the concept of selecting rural origin students who already have some affinity with rural areas and encouraging positive rural attachments to change stereotypical preconceptions of rural life have been shown to influence the take-up of rural practice. Specific affirmative workforce funding in Australia to support devolved rural medical education programmes has been predicated on these beliefs.[21] The unique strength of this study is that its findings emanate from a methodologically rigorous analysis of comprehensive national data from all medical schools in Australia.

A proper evaluation of the effectiveness of national programmes requires long-term longitudinal studies of a cohort or cohorts from medical training through graduation and until well into their medical practice careers, based on up-to-date, robust data. In Australia, a few cross-sectional workforce studies have been undertaken.[16] However, a major limitation in utilising such disparate research studies to inform current and future policy is the lack of connection between medical students, current rural practitioners and past rural practitioners. Approximating a true longitudinal study via a series of cross-sectional studies makes strong assumptions that, if not met, might be misleading rather than helpful.

Although some universities engage in local monitoring of the progress of both education and funding initiatives on workforce supply, recent government reviews highlighted the need for a uniform data collection methodology as the basis for tracking the progress of students throughout their training programme and beyond.[22,23] To date, the absence of consistent definitions, agreed protocols and mechanisms for collecting and reporting data precludes comparable outcome analysis over time on a national basis. Moreover, the recent growth in medical schools has increased the interstate movement of medical students to both undergraduate and graduate schools and subsequently into postgraduate training. These factors make a national minimum database essential for future planning. The Medical Schools Outcomes Database (MSOD) and Longitudinal Tracking Project seek to fill this gap.

The MSOD project was established in 2005 under the auspices of the Medical Deans of Australia and New Zealand to design and implement a national process for collecting reliable demographic and education data on medical students in all Australian medical schools, and to establish a national minimum database based on nationally consistent definitions as the

basis for tracking students into take-up of practice. Ethics approval for participation in the project was obtained from the human research ethics committee of each university and student participation is voluntary. Access to MSOD data is regulated by a Scientific Advisory Committee and a Management Committee. This national database allows short- and long-term monitoring of outcomes of medical education programmes, and contributes to evaluating the effectiveness of Commonwealth-funded medical education initiatives designed to achieve improved medical workforce recruitment and retention.

Figure 1 shows how the MSOD and longitudinal data collection target critical areas of medical career decision making (at entry to and exit from medical school, during the intern year and during postgraduate training) and simultaneously record sentinel aspects of training and clinical exposure likely to influence decision making.

Data collection for the MSOD commences on entry to medical school with a questionnaire that elicits a standard set of items on medical students' family background, education and upbringing, current circumstances, medical school and career intentions. Further data are collected from each medical school during the course of training, and an exit questionnaire is administered at the end of university training to collect more information on student experiences and on where students have applied for internship in the first year after graduation from medical school. This information provides important input to medical workforce planning and is designed to link with National Health Workforce Taskforce (NHWT; http://www.nhwt.gov.au/) data to allow long-term follow-up of medical graduates.

This paper seeks to develop and validate a predictive model of medical student intention to practise in rural areas and, in doing so, to provide the first demonstration of the value of the MSOD in a policy-setting environment. Evidence obtained from this study may inform the optimal use of scarce resources relating to current rural placement schemes. Using available data, student intentions are used as the outcome variable in the absence of actual student behaviour. Although it would be optimal to use observed behaviour data, the value to both education and workforce planning of understanding how individual student characteristics relate to student attitudes to rural practice should not be underestimated.

METHODS

The present study utilises the entry questionnaire administered to the first three annual cohorts of incoming medical students to all medical schools in Australia and New Zealand. A copy of the 2007 questionnaire can be accessed online Appendix S1. Earlier questionnaires differ only in minor respects from the 2007 version and are available from the corresponding author.

Completed questionnaires were sent to the secretariat of Medical Deans of Australia and New Zealand for data entry and cleaning. Each medical school received funding to implement the questionnaire dissemination and collection.

As the aim of the study was to determine the extent to which rural practice intention could be predicted from information about individuals at the time of their entry into medical schools, unconditional logistic regression was used with probability of rural practice intention as the outcome and both numeric and qualitative individual characteristics as predictors. Logistic regression relates the probability of an event occurring, such as intending to practise in a rural area, to one or more predictive factors. This model is used extensively in epidemiological research

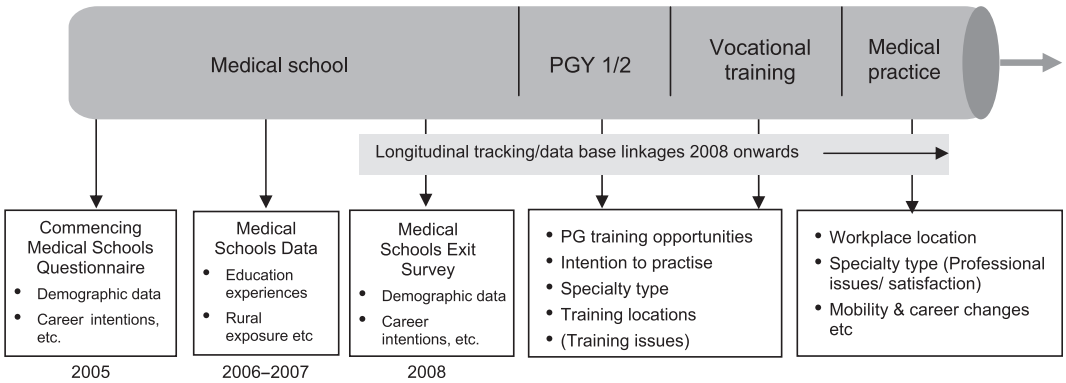

Figure 1 Concept plan. PGY = postgraduate year

to discriminate important outcomes based on easily obtainable information. The current application of the model can be compared with a diagnostic test. Student information obtained from the entry questionnaire can be viewed as the test and the students' reported intentions are the standard against which the test is compared.[24,25] Statistical analyses were undertaken using STATA software (StataCorp LP, College Station, TX, USA). The effects of predictive factors on probability of rural intention are reported in terms of odds ratios (ORs). An OR < 1.0 indicates negative effect (i.e. reduced probability), whereas an OR > 1.0 indicates a positive effect (i.e. higher probability). One potential structural determinant of student intention was the fee basis under which the student entered medical school. These can be classified as 'HECS' (a government-supported Higher Education Contribution Scheme in which the student makes a relatively modest co-payment for tuition), 'bonded' (the student may pay no fees and may receive a stipend during his or her study, but in return agrees to work in areas of need for an agreed period) and 'fee-paying' (the student pays the full cost of his or her tuition). The fee basis of entry may be regarded as a control variable as it may have an effect on graduate destination that is external to the individual. Rural practice intention was gauged from students' preferred practice locations (Question 16.2). Possible responses range from 'capital city' to 'small town (< 10 000)'. Responses of 'regional city' to 'small town' were considered to indicate 'rural', whereas those of 'capital city' or 'major urban centre' were considered 'urban'. Given the well-known phenomenon of over-optimism where the apparent performance of predictive models in the sample on which they were developed exceeds that in future application, the sample was randomly split into approximately equal sized 'training' (n = 2037) and 'validation' (n = 2075) sub-samples.[26] The predictive model was developed on the training sample and then applied independently to the validation sample. Comparing predictive performance across these two samples yields insight into the stability of the model's performance in the face of natural sample variation. Model performance was assessed through receiver-operator characteristic (ROC) curves and by calculating the area under the ROC curve. An area of 1.0 would indicate perfect sensitivity and specificity in prediction, whereas an area of 0.5 would indicate sensitivity and specificity no better than would be expected from a coin toss. (Martin and Jolly[27] give a description in a medical education context.)

Because one application of the model is to derive an index by which new students can be ranked for likelihood of rural practice via the linear predictor of the logistic model

$$I_i = \left(\sum_{j=0}^{p} \beta_j X_{ij} \right)$$

has been evaluated for each student and its practical discriminatory value illustrated graphically. Such an index would not be an independent measure of student propensity to enter rural practice; rather, it derives directly from the logistic model and provides an alternative operationalisation of the model that has the feel of entry schemes using multiple criteria, such as are typically applied in Australian and New Zealand medical schools. An index score of 0 corresponds to a probability of 0.5, whereas scores < 0.0 indicate lesser probabilities and scores > 0.0 indicate higher probabilities. An index derived this way is a weighted summation of each predictive factor such that the correlation between index and observed outcome is maximised. This approach contrasts with that of Rabinowitz *et al.*,[28] whose index has the advantage of simplicity, but will not optimise the relative weights of contributions of individual predictors.

Given the large sample size (> 4000) involved in interpreting quantitative results, particularly in Table 1, a distinction needs to be made between statistical significance (P-value) and practical significance (magnitude of difference) because statistical power is high for even quite subtle and possibly random differences between those intending 'rural' and those intending 'urban' practice.

RESULTS

Sample characteristics

A total of 6292 students responded to this commencement questionnaire. Response rates among medical students increased from 85% in the 2006 cohort to 91% in 2007. Missing data rates per question are generally very low, although the rural intention question was not answered by 1442 students. Taken together with other missing data exclusions, the study has an effective sample size of 4112. The sample was 55% (n = 2296) female. Although the majority of students commenced medical studies shortly after high school, 6% were aged ≥ 30 years, which suggests they had embarked on another career choice before taking up study in graduate medical schools.

Table 1 Descriptive comparison of students intending to enter 'rural' and 'urban' practice after graduation

Factor	Intended location		
	Urban, %	Rural, %	
Gender, % female	54	60	χ^2 = 10.9, P = 0.001
Year of birth			
1953–1961	0	1	χ^2 = 73.6, P < 0.001
1962–1975	5	9	
1976–1991	95	90	
Admission scheme*			
HECS	62	53	χ^2 = 195.4, P < 0.001
Bonded	20	40	
Fee-paying	18	7	
Holding scholarship	9	26	χ^2 = 205.7, P < 0.001
Citizenship			
Australian	92	95	χ^2 = 11.4, P = 0.01
New Zealand	1	1	
Permanent resident	2	1	
Temporary resident	5	3	
Years resided in rural area			
None	83	33	χ^2 = 991.3, P < 0.001
1–5 years	6	12	
> 5 years	11	55	
Years educated in rural area			
None	87	44	χ^2 = 799.9, P < 0.001
1–5 years	8	24	
> 5 years	5	32	
Area of longest residence			
Capital city	79	32	χ^2 = > 1000, P < 0.001
Major urban centre	10	9	
Regional/rural area	11	60	
Self-identifying as rural	11	60	χ^2 > 1000, P < 0.001
Marital status			
Single	92	86	χ^2 = 34.3, P < 0.001
Married	8	13	
Divorced/separated	0	1	
Any dependents	2	6	χ^2 = 47.3, P < 0.001
Financial dependents	1	3	χ^2 = 7.8, P = 0.005
Supported by			
Allowance	25	34	χ^2 = 29.9, P < 0.001
Parents	66	48	χ^2 = 106.0, P < 0.001
Part-time job	35	32	χ^2 = 3.5, P = 0.06
Scholarship	8	26	χ^2 = 232.6, P < 0.001
Own money	7	5	χ^2 = 5.2, P = 0.02
Other	5	7	χ^2 = 9.7, P = 0.002
Intended specialty			
Specialise	60	44	χ^2 = 263.8, P < 0.001
Non-specialist	9	29	
Undecided	32	27	

* *HECS* indicates Higher Education Contribution Scheme in which most of the cost of education is borne by the government but the student makes a co-payment; *bonded* indicates a scholarship arrangement in which the recipient has some obligation to work where directed after graduation; *fee-paying* indicates that the student pays the full cost of his or her own education

Descriptive discrimination of 'rural' from 'urban' intention

Table 1 contrasts students indicating 'rural' versus those indicating 'urban' practice intentions in terms of all potential predictors considered for the predictive model. A number of the individual characteristics reported in Table 1 are expected to be inter-related and therefore it cannot be said, on the basis of Table 1 alone, that all those characteristics are independently discriminatory of 'rural' versus 'urban' practice intention.

Predictive model and its performance

Figure 2 provides a graphic representation of the predictive model developed using the training sample, sorted from most negative to most positive effects. The vertical axis shows the OR, which is a measure of the effect that a given predictor has on the probability of rural practice intention. All factors listed on the horizontal axis of Fig. 2 have statistically significant and independent effects on the probability of intending to practise in rural areas. The negative factors are 'being supported by parents' and 'not having previous rural exposure' or 'not self-identifying as a rural person'. The positive factors appear to be around 'previous exposure to rural life', either 'being undecided about specialty' or 'having decided to be a generalist', and 'being on a scholarship' or 'being bonded'. In case the model was overly influenced by bonded students it was refitted excluding such students, but otherwise remains essentially unchanged.

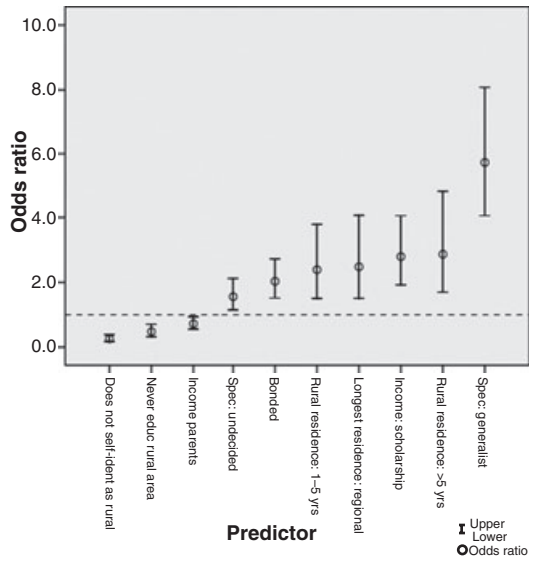

Figure 2 Graphic depiction of predictive model based on the training sample

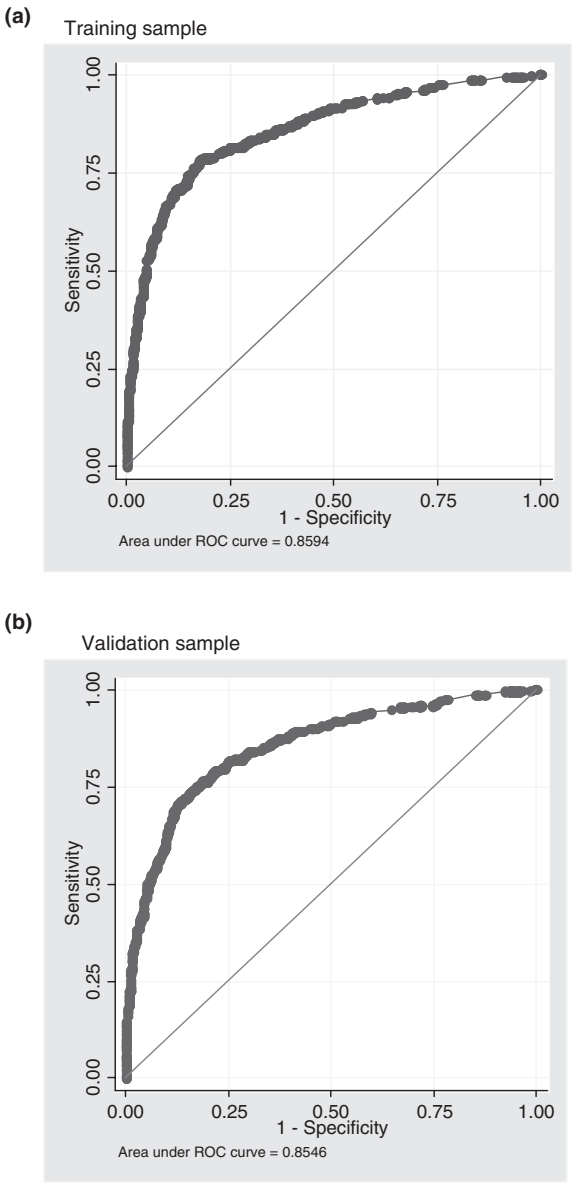

Figure 3 Model performance in the (a) training sample and (b) validation sample. ROC = receiver-operator characteristic

Figure 3(a) suggests the model has useful discriminatory power, with an area under the ROC curve of 0.86 (95% confidence interval [CI] 0.84–0.88). Further, Fig. 3(b) suggests this performance is reproducible because the model developed on the training sample when applied to the validation sample yields an area only slightly lower, at 0.85 (95% CI 0.83–0.87).

Derivation of an index from the model

As noted in the methods, the linear predictor component of the model can be used to form an index of

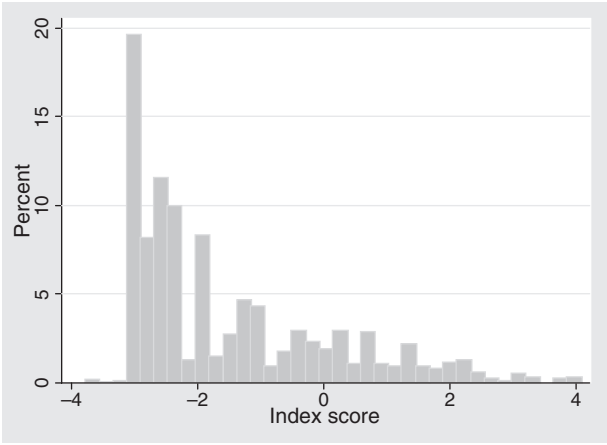

Figure 4 Distribution of index (I) scores in whole sample

Figure 5 Comparison of index distributions between students intending and not intending to enter rural practice

propensity of intention for rural practice. The distribution of index scores is presented in Fig. 4.

As a point of reference, an index of 0 corresponds to a probability of 0.5 (50%). Scores < 0 correspond to lower probabilities and those > 0 correspond to higher probabilities. The distribution described in Fig. 3 corresponds well with our knowledge of the present rural medical workforce situation, with a clear skew towards low scores.

Figure 5 illustrates that the index provides useful discrimination between incoming students whose intention is to practise in rural areas ('Rural') and those who do not so intend ('Urban'). We note that the 25th percentile of the Rural group is higher than the 75th percentile of the Urban group and that the median of the Rural group is almost as high as the 95th percentile of the Urban group.

DISCUSSION

Despite considerable investment by both federal and state governments in Australia to make rural medical practice more attractive to prospective rural doctors, evidence suggests that at best we are maintaining the status quo and arguably are losing ground in terms of ensuring medical coverage outside capital cities and major urban centres.[14] Medical schools themselves also encourage the take-up of rural practice through the provision of rural placement experience and preferential treatment for rural origin students in entry scores. Two universities offer their medical programme entirely at rural locations.

Rural bonding aside, however, none of these schemes are guaranteed to produce medical practitioners who choose to work in rural areas because students experience many other influences during their training that may predispose them towards more positive, or negative, attitudes towards rural practice upon graduation. This paper has outlined the development and initial validation of a predictive model for rural practice intention that might assist in determining which students are more likely to intend to work in rural areas.

The model incorporates a number of statistically independent predictors of rural intention that centre around the students' rural backgrounds, financial arrangements during studies, and intentions regarding specialist versus generalist practice upon graduation. The strongest predictors of rural practice intention were generalist intentions, length of rural residence and holding a scholarship (but not a bonded arrangement). Although the finding of rural background (living or education) as a positive predictor of rural intention confirms previous research,[16,18,28] this paper also adds intentions towards generalist practice and financially supported studies as predictors. By contrast, intentions towards specialist practice or the status of being supported by parents were negative indicators for rural practice intention.

The work reported here refines the approach taken by Rabinowitz *et al.*[28] in a similar study in which the authors calculated a crude index of rural practice intention based on adding up individual 'factors' positively associated with rural practice. In this earlier study, the authors constructed a simple index of likelihood to enter rural medical practice based on summing the number of predictor variable conditions present within any individual. This is effectively equivalent to an unweighted version of the index

derived in our study. The advantage of the weighted index proposed here is that it optimises the index score specifically in relation to rural practice intentions. A potential drawback of such optimisation is over-optimism in index performance. However, the split-sample validation reported for our data suggests that this potential is not realised.

The model provides useful and reproducible prediction of rural practice intention although, not surprisingly, imperfect prediction. The area under the ROC curve was found to be 0.86 in the training sample and 0.85 in the validation sample.

As indicated above, one limitation of this study is the use of intention to take up rural practice rather than actual behaviour as the outcome variable. Until data on actual behaviour become available, however, this is the best available surrogate. This limitation can be overcome in the future because the longitudinal nature of the MSOD project will enable us to monitor the relationship between early stated intentions, medical education experiences, and actual behaviour.

Medical practice has long embraced the theory and application of evidence-based practice, a concept that extends readily to medical education. Some previous studies illustrate this point.[16] Understanding how individual student characteristics and elements of the medical school programme influence medical graduates' decisions to work or not work in rural areas represents a critical link between academic research and policy outcome. Increasingly, academic researchers are under pressure to strengthen the link between research and policy.[29] This is all the more important when policies target considerable public resources to facilitating outcomes deemed to be in the public interest, such as encouraging the recruitment of more doctors to work in areas of workforce shortage such as those in rural and remote Australia. Given that effective knowledge transfer is a continuous process in which knowledge accumulates and influences thinking over time, rather than a one-off event,[30] research such as this has important implications for appropriate and effective policy implementation and the expenditure of scarce resources within medical school education and training. The MSOD and Longitudinal Tracking Project, which form the basis for this study, provide a unique opportunity to collect data from across the medical education–training–practice continuum. Although the MSOD database is important for medical education evaluation activities in its own right, data collected during medical school can play a critical role in identifying the relative roles of specific factors and influences within the totality of incentives and interventions designed to contribute towards an increased orientation to take up rural practice. In addition, it will become an invaluable platform from which to inform a more coordinated approach to medical workforce planning between universities and Commonwealth and state government.

Contributors: MJ contributed to the study design, and data analysis and interpretation, gave important intellectual input and took lead responsibility for the writing of the manuscript. JH and DP contributed to the study conception and design, and data interpretation, gave important intellectual input, and contributed to the writing of the manuscript. All authors approved the final manuscript for publication.
Acknowledgements: the research on which this paper is based was conducted as part of the Medical Schools Outcomes Database (MSOD) project, Medical Deans Australia and New Zealand. The authors would like to thank the medical students who participated, and Bal Kaur and Pippa Markham for their invaluable assistance with the careful and thorough preparation of the data.
Funding: this research was funded from 2004–2007 by the Australian Government Department of Health and Ageing.
Conflicts of interest: none.
Ethical approval: this study was approved by the university ethics committees of all participating medical schools.

REFERENCES

1 Productivity Commission. Australia's Health Workforce, Research Report. Canberra, ACT: Productivity Commission 2005.
2 Wilkinson D. Selected demographic, social and work characteristics of the Australian general medical practitioner workforce: comparing capital cities with regional areas. *Aust J Rural Health* 2000;**8**:327–34.
3 Humphreys J, Jones M, Jones A, Mara P. Workforce retention in rural and remote Australia: determining the factors that influence length of practice. *MJA* 2002;**176**:472–6.
4 Margolis SA. Retaining rural medical practitioners: time for a new paradigm? *Rural Remote Health* 2005;**393**:1–3.
5 National Rural Health Alliance. *Healthy Regions, Healthy People*. Deakin West: National Rural Health Alliance 2006.
6 Sidoti C. Rural health: a human right. *Aust J Rural Health* 1999;**7**:202–5.
7 Rabinowitz H, Paynter N. The rural vs urban practice decision. *JAMA* 2002;**287** (1):113.
8 Alexander C. Why doctors would stay in rural practice in the New England Health area of New South Wales. *Aust J Rural Health* 1998;**6**:136–9.

9 Hays R, Wynd S, Veitch C, Crossland L. Getting the balance right? GPs who chose to stay in rural practice *Aust J Rural Health* 2003;**11**:193–8.
10 Lee S, Mackenzie L. Starting out in rural New South Wales: the experiences of new graduate occupational therapists. *Aust J Rural Health* 2003;**11**:36–43.
11 Lindeke LL, Jukkala A, Tanner M. Perceived barriers to nurse practitioner practice in rural settings. *J Rural Health* 2005;**21** (2):178–81.
12 Stratton TD, Dunkin JW, Szigeti E, Muus KJ. Recruitment barriers in rural community hospitals: a comparison of nursing and non-nursing factors. *Appl Nurs Res* 1998;**11** (4):183–9.
13 Holub L, Williams B. The General Practice Rural Incentives Program, development and implementation: progress to date. *Aust J Rural Health* 1996;**4**:117–27.
14 Australian Medical Workforce Advisory Committee. The Medical Workforce in Rural and Remote Australia. Australian Medical Workforce Advisory Committee: North Sydney, NSW 1996;8.
15 Laven G, Wilkinson D, Beilby J, McElroy H. Empiric validation of the rural Australian medical undergraduate scholarship 'rural background' criterion. *Aust J Rural Health* 2005;**13**:137–41.
16 Wilkinson D, Laven G, Pratt N, Beilby J. Impact of undergraduate and postgraduate rural training, and medical school entry criterion on rural practice among Australian general practitioners: national study of 2414 doctors. *Med Educ* 2003;**37**:809–14.
17 Rabinowitz H, Diamond J, Markham F, Hazelwood C. A programme to increase the number of family physicians in rural and underserved areas. *JAMA* 1999;**281** (3):255–60.
18 Rabinowitz H, Diamond J, Markham F, Paynter N. Critical factors for designing programmes to increase the supply and retention of rural primary care physicians. *JAMA* 2001;**286** (9):1041–8.
19 Playford D, Larson A, Wheatland B. Going Country: placement factors associated with future rural employment in nursing and allied health. *Aust J Rural Health* 2006;**14**:14–9.
20 Ranmuthugala G, Humphreys J, Solarsh B, Walters L, Worley P, Wakerman J, Dunbar J, Solarsh G. Where is the evidence that rural exposure increases uptake of rural medical practice? *Aust J Rural Health* 2007;**15**:285–8.
21 Commonwealth Department of Human Services and Health. *Rural Doctors: Reforming Undergraduate Medical Education for Rural Practice*, Canberra, ACT: Australian Government Publishing Service 1994.
22 Commonwealth Department of Health and Family Services. *The Current State of Undergraduate Medical Education for Rural Practice*. Canberra, ACT: Commonwealth Department of Health and Family Services 1998.
23 Humphreys JS, Mara P, Jones M. *The RUSC Program Review – Enhanced sustainability, accountability and program integration*. Canberra: Department of Health & Aged Care 2000.
24 Bleeker SE, Moll HA, Steyerberg EW, Donders ART, Derksen-Lunsen G, Grobbee DE, Moons KGM. External validation is necessary in prediction research: a clinical example. *J Clin Epidemiol* 2003;**56**:826–32.
25 May M, Kholoud P, Sterne J, Royston P, Egger M. Prognostic model for HIV-1 disease in patients starting antiretroviral therapy was validated using independent data. *J Clin Epidemiol* 2005;**58**:1033–41.
26 Browne MW. Cross-validation methods. *J Math Psychol* 2000;**44**:108–32.
27 Martin I, Jolly B. Predictive validity and estimated cut score of an objective structured clinical examination (OSCE) used as an assessment of clinical skills at the end of the first clinical year. *Med Educ* 2002;**36**:418–25.
28 Rabinowitz H, Diamond J, Veloski J, Gayle J. The impact of multiple predictors on generalist physicians' care of underserved populations. *Am J Public Health* 2000;**90** (8):1225–8.
29 Almeida C, Bascolo E. Use of research results in policy decision-making, formulation and implementation: a review of the literature. *Cad Saude Publica* 2006;**22** (Suppl):7–33.
30 Lavis JN, Posada FB, Haines A, Osei E. Use of research to inform public policy making. *Lancet* 2004;**364**:1615–21.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article.

Appendix S1. 2007 commencing medical student questionnaire.

Please note: Wiley-Blackwell are not responsible for the content or functionality of any supporting materials supplied by the authors. Any queries (other than for missing material) should be directed to the corresponding author for the article.

Received 17 April 2009; editorial comments to authors 26 May 2009; accepted for publication 30 June 2009