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A . . . generalization about the experience of being a surgeon in the twentieth century is that, at the beginning of the century, surgical experience was diverse and that, at the end, experiences were more uniform (Lawrence and Treasure 2000:653).

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## Is there a time trend in medical practice variations? A review of the literature and a critical analysis of theoretical approaches

### ABSTRACT

The aim of this study was to review the research evidence for a decreasing time trend in medical practice variation and to contribute to our theoretical understanding of trends in medical practice variations. We searched PubMed for articles reporting on time trends in medical practice variations. Eleven relevant articles were identified. The studies we found tend to show a downward trend in practice variation. Six of the eleven studies show a decrease in practice variation, three studies report more or less stable variation, and only two show increasing variation. The number of studies is, however, small and the aspects of medical practice that were studied in these articles are diverse. A trend in medical practice variation can probably best be explained by institutional changes within and outside health care, which on the one hand directly lead to decreased practice variation and on the other hand make the working environment of physicians more uniform.

### INTRODUCTION

The first studies of medical practice variations stem from the 1930s when Glover (1938) analysed geographical variations in tonsillectomy rates in British school children. The high days of medical practice variations research was in the 1980s, some 10 years after Wennberg and Gittelsohn published their seminal article ‘Small area variations in health care delivery’ (1973). Although numerous studies have been done during the past few decades (see Ham 1988; Paul-Shaheen 1987; Anderson and Mooney 1990 for reviews), time trends in medical practice variations have only seldom been studied (see Weide et al. 1999, for an exception). In this article we review the literature on time trends in medical practice variations.

Why are we interested in medical practice variations and its development over time? Medical practice variations are important from several points of view. Medical practice has at least the public image of being based on solid scientific grounds (Anderson and Mooney 1990), although the evidence base of many interventions is weak. Progress has been made in understanding the causes of disease and its treatment, leading to increased life expectancy. Although the role of medicine in this

achievement has been doubted (McKeown 1976), improved health care has significantly contributed to the increase in life expectancy (Mackenbach 1992, 1996). Patients expect medical practitioners to apply the best possible care there is. They expect that what is the best possible care will be the same irrespective of the physician they visit and that comparable patients will be treated equally. Because of the difficulty for patients to judge the necessity and quality of medical care, the professional status of medicine depends on reliable and high-quality services, irrespective of the particular physician consulted (Akerlof 1970; Lulofs 1983). However, patients have become more knowledgeable and the nature of professional control has changed. Public awareness of medical practice variations has increased through mass media attention, access to the internet and even institutionalised second opinion programmes in some countries. The nature of professional control has changed from collegial control of ethical rules and norms of good practice towards standardisation of care processes (Broadbent and Laughlin 2002). Thirdparty payers have a vivid interest in practice variations because of the costs associated with different procedures or practice styles. Inducing physicians to adopt the most cost-effective treatment might save them large amounts of money.

Although medical practice variations are of interest in themselves, time trends in this domain are especially interesting. Western societies have shown a general and ongoing process of rationalisation and unification during the past centuries. As an example, regional differences in culture and language within countries have gradually disappeared, particularly quickly from the late nineteenth century onwards (Knippenberg and De Pater 1988). Economic activities have benefited from more efficient ways of production and distribution of goods and services (North and Thomas 1973). In these broad societal changes, medical practice has also evolved.

Medical practice is influenced both by the globalisation of knowledge and by the global activity of the pharmaceutical and medical devices industry. On the level of health care systems, this process is summarised in the convergence thesis (Mechanic 1975; Lian 2003).

More specifically, new ways of professional control and external attempts at cost containment have pushed the medical profession towards standardisation (Lomas et al. 1989; Ritzer and Walczak 1988; Brunsson and Jacobsson 2000). The production of guidelines, protocols, consensus statements and critical pathways has increased tremendously during the past few decades. As an example, in Dutch general practice, by the end of the 1980s the first guidelines were introduced; by now, the total number of guidelines developed by the Dutch Society of General Practice is 80 (<http://www.nhg.artsennet.nl/guidelines>). Although numerous studies show that availability of guidelines does not automatically mean that doctors follow them (Grilli and Lomas 1994; Grol and Jones. 2000), it is expected that this movement towards standardisation has had an impact on medical practice variations. Another example is the managerial approach in the form of so-called critical pathways, which has been shown to reduce variation in length of hospital stay in general (Westert and Lagoe 1995) and in specific patient groups (Ilag et al. 2003).

External pressures come from third-party payers who set standards to which procedures and how many hospital days they base reimbursement on. The introduction of prospective payment systems and their diffusion (Kimberly and De Pouvourville 1993) and managed care practices have greatly restricted the freedom of choice of physicians (Kerr et al. 1995; Mechanic 2000; Simon et al. 1998; De Jong et al. 2004).

Based on these developments, we expect to find in the literature on medical practice variations a trend towards less variation over time. This article presents an overview of the literature describing time trends in practice variations. The reviewed literature in some cases hints at explanations for time trends. In the second part of this article, we will elaborate the different approaches to explaining time trends in practice variations.

## **DEFINITIONS, SELECTION OF THE LITERATURE**

By medical practice variations we mean variations between individual physicians and variations between higher level units that are composed of physicians and reflecting the decisions made by physicians. Examples of higher level units are hospitals, regions, and countries. Rates of interventions differ between these units.

Practice variation studies can be distinguished from health service utilisation studies, which focus on variation between population groups, e.g. defined by age, gender, or socio-economic background. In

the latter case, grouping is based on characteristics of patients and not on units that are served by the same (groups of) physicians. Both types of studies are two sides of a coin (see also Stano 1993) and in studies that group patients by place of residence they largely coincide. However, the emphasis here is on variations between doctors and not on variation in health service utilisation.

Which aspects of medical practice are we looking at? Basically, all professional activities in direct contact with patients can be meaningfully studied as medical practice variations. In the literature, however, there is a tendency to focus on surgical interventions. We see no reason to restrict this review to surgical interventions and therefore allowed all activities of physicians to enter in our review: diagnosis, prescriptions, surgical and other treatment, hospital admission and length of stay. A boundary case is probably office consultations, which might be viewed primarily as a patient decision. However, that is mostly true in primary care settings, but in specialist care settings office consultations are more often the consequence of physician decisions.

To be able to establish a trend in practice variation at least three points in time should be compared.

### Search strategy

We have searched PubMed for journal articles published after January 1, 1990. We have used combinations of the following key words: the MESH-terms 'small area variation' and 'physician practice pattern' and the terms 'variation' and 'trend'. This resulted in 70 references, seven of which actually gave information about the development of variation over time. Two further relevant studies were found through references in the other articles and two articles 'in press' that the authors were aware of, were added. The number of included studies therefore totalled eleven. In two cases the trend in variation was calculated by the authors on the basis of tables in the original publications (without taking confidence intervals into account).

### RESULTS

Most of the studies we found in our search concern trends and changes in medical interventions over time as such but not trends in variation. New operation techniques, for example, may be used more frequently in the course of time, consequently showing a trend in medical intervention. However, this does not necessarily involve a trend in variation. Trends in application of new medical interventions have been described in numerous fields: e.g. breast-conserving treatment for breast cancer (Hill et al. 1994), the introduction of laparoscopic techniques (Cohen et al. 1996), and the introduction of new drugs and drug-based disease management (Gerdtham et al. 1996). Trends in the incidence of certain diagnoses have been attributed to developments in diagnostic techniques or even to new treatment policies, making it more interesting for physicians to find cases (Lu-Yao and Greenberg 1994).

Only eleven studies turned out to contain information about medical practice variation at different points in time. We have summarised these studies in Table 1. On the whole we can conclude that the trend is more often towards decreasing variation than the other way around. This observation is in line with what we expected to find. Most of the studies concern variation between geographical regions. The time period studied is usually rather short, the longest being some 20 years.

[ TABLE 1 ]

### THEORETICAL APPROACHES

Our review only found a few studies that directly address time trends in practice variations. The majority of these studies point towards a decrease in variation. In this section we will venture deeper into the discussion about the explanation of trends in medical practice variation. We will start by briefly describing the approaches to the explanation of medical practice variations in general. After that we make the step to explaining trends in practice variation.

### Explaining medical practice variation

Existing explanations of medical practice variations are predominantly based on the idea of physicians having different preferences for certain treatments. The practice style hypothesis, the most

commonly accepted hypothesis to explain medical practice variations, is an example of this approach. The explanation of variations in medical procedures between areas or hospitals with the practice style hypothesis consists of two parts. The first part concerns the micro-level problem of the origins of widely differing practice styles among individual physicians. The second part concerns the explanation of differences between larger units, such as (small) geographical areas or hospitals.

For the first part, it is supposed that physicians differ in the kind of procedures they apply, because they have learned to value them differently and consequently adhere to a different practice style. Differences in practice style are assumed to emerge because of professional uncertainty about the value of a certain level of medical care and of individual procedures (Wennberg and Gittelsohn 1982). They come to the fore where there is not one generally accepted standard. Uncertainty is sometimes conceived of as a personality trait, in the sense that practice style variations are caused by differences between physicians in their tolerance for uncertainty (Gerrity et al. 1990). If physicians feel uncertain about how to proceed in a given case, and if they feel unhappy about that, they will try to reduce uncertainty, for example by over-prescribing diagnostic tests or by following the lead of colleagues (Eddy 1986). For the second part of the explanation, the mechanism that propagates differences between areas or hospitals is selective attraction or retention of physicians in the local medical system or enthusiasm for certain procedures (Chassin 1993; Wright et al. 1999), leading to a surgical signature that tends to be consistent over many years (Wennberg and Gittelsohn 1982).

In addition to explanations based on preferences of physicians, practice variations can be explained from differences in (local) circumstances that provide incentives and constraints on physicians' decisions (Westert and Groenewegen 1999). In this approach, physicians are assumed to be goal-oriented and (as in principal-agent theory) they try to advocate the interests of their patients as well as their own goals (e.g. an acceptable level of income). Constraints and incentives are the same for groups of physicians who, for example, share the same working environment such as the same hospital. Because of the shared use of resources, they develop local standards, whether explicitly laid down or as informal norms (Westert 1992). Local circumstances also include the social structure of the community where physicians work and knowledge and attitudes of patients (Greer et al. 2002).

### **Interpretations in the reviewed articles**

In the interpretations that were given in the articles, we have reviewed in the previous section, a number of times professional uncertainty was mentioned as a possible explanation of decreasing variation (Bisset 1997). However, it was also cited to account for the fact that considerable variation remained (Katz et al. 1996; Lu-Yao et al. 1993).

External constraints have also been mentioned; patient preferences for certain treatments were mentioned by Lu-Yao et al. (1993) in the case of radical prostatectomy. Patient preferences were also mentioned by Gilligan et al. (2002) in an analysis of utilisation patterns of breastconserving surgery (not in Table 1). The growth in managed care and constraints on health care expenditures were mentioned as a reason to expect a decrease in practice variation in numbers of office consultations (where actually an increase was found; Criswell et al. 1997).

The diffusion of new knowledge and practices has also been cited as a cause of changes in practice variation over time. The reduction in variation in antibiotics prescribing was attributed to media attention to multi-resistant bacteria (Halasa et al. 2002). The introduction of a new surgical intervention was mentioned in relation to radical prostatectomy (nerve-sparing techniques, Lu-Yao et al. 1994); how this new intervention diffused in the medical community was, however, not discussed. Also related to prostatectomy was the observation by Sejr et al. (1991) that variation at first might increase as a result of different rates of adoption between specialised and non-specialised hospital departments, while variation decreases again in the later phases of diffusion. Gilligan et al. (2002) hypothesised that the diffusion of knowledge to individual physicians is important in the early phase of the process of diffusion, but that in later phases the organisation of the medical community and patient preferences become more important.

The interpretations given in the articles that we reviewed can be grouped into three categories: those related to professional uncertainty, to external constraints, and to diffusion of new knowledge and practices. The suitability of each of these interpretations to explain trends in medical practice variations can be questioned.

Firstly, does professional uncertainty decrease over time? One can imagine that the translation of new medical insights into guidelines and protocols (which is on the increase) affects professional uncertainty at the collective level. However, as Evans (1990) argued, if uncertainty (being an unfavourable psychological state at the individual level) was the problem, guidelines would be much more easily and quickly accepted than they actually are. Moreover, guidelines have been shown in some cases to have only a temporal effect on what physicians do (Brownell 2002). It is, however, clear that the increased popularity of guidelines, protocols, best practices, etc. should have a place in an explanation of time trends in medical practice variations.

Secondly, what about external constraints? There seem to be some clear trends in the circumstances that physicians work in. Although managed care and constraints on health care expenditure seemed difficult to reconcile with increased variation in office consultations (as in Criswell et al. 1997), the reason might have been that trends in these circumstances are stronger in hospitals or insurance market areas with more managed care penetration.

Thirdly, it is difficult to imagine how changing preferences would lead to decreased variation. Medical knowledge grows, and established ideas are challenged, but they are replaced by new orthodoxies. Diffusion of new treatment ideas, which change the preferences of individual physicians, leads to wave motions in practice variation, but not necessarily to a decreasing trend. In the next section, we will attempt to develop a more elaborated explanation for decreasing variation in medical practice.

### **Explaining trends in practice variation**

We see the trend towards decreased practice variation as a consequence of institutional changes in the health care field. Some of these changes have been alluded to earlier: the shift from professional to managerial control, the increase in managed care and market forces in health care, and the globalisation of knowledge and activities. As schematically depicted in Fig. 1, these changes directly affect physicians as the central decision-makers in health care, and they also affect the structures in which physicians work. The latter affects the interdependency of physicians. Finally, a feedback loop is hypothesised: information about practice variation becomes part of the management tools and is used to regulate physician behaviour.

#### **[ FIGURE 1 ]**

Institutional changes have three aspects: regulative, normative and cultural-cognitive (Scott 2001). The regulative aspect is related to rule-setting, monitoring of performance and sanctioning. Third parties are increasingly able to constrain physician decision-making. Moreover, there is a trend from professional (or normative) control to managerial (or regulative) control (Scott et al. 2000; Brock et al. 1999). This leads to more uniformity between units at those levels where rules are set, monitored and sanctioned, such as hospital (chains) and managed care organisations.

Normative aspects relate to peer and patient expectations and to concepts of appropriateness of care. Parallel to the change from professional to managerial control, the organised profession has lost weight as the normative community. What is seen as appropriate care gradually shifts from implicit intra-professional consensus to evidence-based medicine, according to guidelines. Still, guidelines are (at least formally) voluntary rules (Brunsson and Jacobsson 2000). There is, however, a link between normative and regulative aspects: consensus and guidelines are increasingly explicit and written down. That makes them available to third parties, who can use them to legitimate their rules. Guidelines are also available to (organised) patient groups who can use them to monitor performance of physicians. According to Greer et al. (2002), shared decision-making between patients and physicians would lead to lower practice variation. One pathway to this relationship could be the use of guidelines by (organised) patient groups.

Cognitive-cultural aspects relate to shared understanding and support. At a general societal level, technological development coincides with more emphasis on equity and a democratic ideology (Arts and Van Wijck 1994; Lenski 1966). This tendency legitimates equality of treatment. In a more specific sense, modern medicine increasingly uses coding systems of patient characteristics, patient history,

diagnoses, disease staging, etc. for record keeping and administrative purposes. When these systems are shared, they contribute to uniform cognitive representations. These representations are hypothesised in turn to contribute to more uniform treatment decisions.

These aspects of institutional change provide the circumstances that directly and indirectly (via the working environment of physicians) lead to decreased practice variation. The direct influence follows attempts to make medical practice more uniform by stimulating managerial interventions such as best practices and critical pathways. Also the incorporation of guidelines (as basically voluntary, profession-guided strategies) into the regulative framework of third parties contributes to more uniformity. Indirectly and probably as important are trends towards a more uniform environment in which physicians work. Hospital size and structure have become more uniform (Scott et al. 2000; Meloen et al. 2000). Funding and payment systems of hospitals and physicians show more uniformity, for example with the diffusion of systems based on diagnosis-related groups (Kimberly and De Pouvourville 1993). The quality movement has reached the health care field with quality systems and certification and accreditation rules (Cole and Scott 2000; Sluijs and Wagner 2003). There is a strong link between the trend towards more uniform environments and physician behaviour: the increased mutual dependency of hospitals and physicians, necessitating co-ordination through organisational integration (Groenewegen and Van Lindert 2001; Scott et al. 2000).

In a number of studies and in practical initiatives of hospitals and third-party payers, information about practice variations has been fed back to physicians. Although the effectiveness of these interventions is unequivocal, feed back of information about practice variations seems to have effects on the behaviour of physicians. Information about practice variations is at the heart of attempts by hospitals and third-party payers to influence physician decision-making through physician profiling (Evans et al. 1995; Lagoe and Westert 2004)

Some implications of this line of reasoning are the following. As managerial control replaces professional control, shared standards within the work environment (local standards) become more important determinants of physicians' decisions than shared standards within the profession and less variation is to be expected within organisations (i.e. hospital, managed care organisation, provider group). As noted earlier, diffusion of innovations might (temporarily) lead to increased variation. However, we expect this variation between organisations and less so within organisations. The reason is that the diffusion of innovations is increasingly based on group or organisational decisions, caused by dependency on, for example, computer-based expert systems that can only be reasonably introduced organisation-wide, or by the size of investments in technology that are necessary for the introduction of new treatments. Hence, innovation cannot be seen as an individual decision of a physician but is an organisational decision (Greer 1988; Kroneman et al. 2003). Consequently, lower variation within organisations may coincide with equal or even increasing variation between organisations. However, given the tendency of the working environment of physicians to also become more uniform, on the whole, more uniformity in practice patterns is to be expected.

## DISCUSSION

There is an abundance of studies on medical practice variations at single points in time. However, time trends in medical practice variations have seldom been the subject of systematic theoretical and empirical analysis. Information on time trends in variation is often a sideproduct rather than the primary focus of studies. The studies we found mainly concern time trends in geographical variation. More information is needed about time trends at lower levels of aggregation, especially hospitals and (group) practices.

As expected, the studies we found tend to show a downward trend in practice variation. Six of the eleven studies show a decrease in practice variation, three studies report more or less stable variation, and only two show increasing variation. The number of studies is, however, small and the aspects of medical practice that were studied in these articles are diverse. Studies on trends in interventions are more common. Researchers in this field should be stimulated also to present trends in variation and not only trends in the numbers of specific interventions.

Our expectation was based on general societal trends that also permeate the field of health care. In some fields of medical practice, variations might be expected to decrease for the simple reason that

processes are increasingly automated. In the field of diagnostics, image and signal analysis could replace the individual physician's judgement (Healthcare Panel 2000).

In the second part of this article, we have developed a theoretical framework that explains the decreasing trend in medical practice variation. From this theoretical framework more specific hypotheses can be derived. As an example, it might be hypothesised that local standards gradually gain importance compared to the shared standards of a profession, but at the same time local standards become more uniform.

Much theoretical and empirical work is waiting, first to specify conditions under which decreasing variation occurs or stability or even an increase in variation, and second to test these hypotheses empirically.

We have only reviewed articles published in journals, found through a search in PubMed, and references to other relevant articles we found in the original set. We did not include research reports, primarily because it is very difficult to arrive at a complete set of research reports. Administrative data sets and published tables from these data sets also contain information that can be used to calculate practice variation and time trends. We have not done secondary analyses for this article. However, these data sets might contain the information to test the general expectation of decreasing practice variation over time, as well as some of the more specific hypotheses that can be derived from the framework developed in this article. A lot of work remains to be done in this field.

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### TABLES AND FIGURES

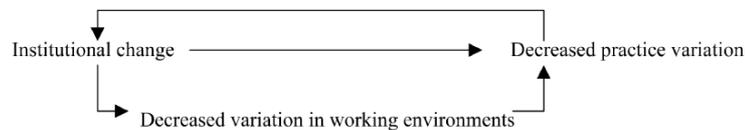


Fig. 1 Relationship between institutional change and decreased medical practice variation

**Table 1** . Overview of the selected studies, reporting time trends in medical practice variations

Authors	Variation in	Variation between:	Time period covered	Method of analysis	Case mix correction	Results
Bisset 1997	Appendectomy in children 0–14 years	Health Boards in Scotland (12)	1973–1993	Simple rates and confidence intervals	None	Marked decrease of variation
Criswell et al. 1997	Frequency of office visits for RA	45 rheumatologists, treating 918 patients who participated in a longitudinal study	1984–1993	Multilevel analysis	Disease severity, age, sex, race, education, disease duration, rheumatoid factor, comorbidity	Significant increase in the variation in the number of office visits
Du et al. 1999	Breast-conserving surgery	Population-based cancer registries (9) in USA	1983–1995	Simple rates for three age groups (variation calculated by the authors)	Tabulation by age group	Geographic variation continues, but seems to be slightly decreased
Halasa et al. 2002	prescription of antibiotics for children less than 5 years	US regions (4), and between blacks and whites	1993–1999	Analysis of variance, t-test, rate-ratios	none	Differences between regions are stated to be diminished, not shown in tables, number of regions is very small
Holdsworth and Paterson 2001	Distal arterial reconstruction	Health Boards in Scotland (12)	1989–1999	Tabulation of rates (variation calculated by the authors)	None	Fluctuations but no trend
Lu-Yao et al. 1993	Radical prostatectomy	Regions in the US (9), Medicare hospital data	1984–1990	Comparison of rates ratios and SCV	Age- and race-adjusted	Slight increase in variation between regions
Lu-Yao and Greenberg 1994	Incidence of prostate cancer, radical prostatectomy	Population-based cancer registries (9) in USA	1983–1989	Simple rates and confidence intervals	Age-adjusted	More or less stable variation in treatment
Katz e.a., 1996	Knee replacement	Large regions used by Health Care Financing Administration (10) in USA	1985–1990	Log-linear Poisson regression	Age, sex, race	Decrease in regional variation
Kroneman and Sieger in press	Hospital admissions and length of stay	European countries (10)	1975–1994	Multilevel time series analysis	Age, technology change	Decrease in variation
Sejr et al. 1991	Prostatectomy	Hospital catchment areas (72) in Denmark	1977–1985	Multiplicative Poisson regression	Age standardization	Decrease in variation as measured by SCV (systematic component of variation)
Westert et al. 2004	Hospital admissions for 12 diagnostic and surgical categories	Health care regions (25) in the Netherlands	1980–1997	Multilevel time series analysis	Age, sex	Significant decline in variation for combined categories; 11 separate categories downward trend of which 4 statistically significant.

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