Mini Review

Julian H. Barth*, Shivani Misra, Kristin Moberg Aakre, Michel R. Langlois, Joseph Watine, Patrick J. Twomey and Wytze P. Oosterhuis

Why are clinical practice guidelines not followed?

The European Federation of Clinical Chemistry and Laboratory Medicine and European Union of Medical Specialists joint working group on Guidelines

DOI 10.1515/cclm-2015-0871
Received September 7, 2015; accepted October 19, 2015; previously published online December 9, 2015

Abstract: Clinical practice guidelines (CPG) are written with the aim of collating the most up to date information into a single document that will aid clinicians in providing the best practice for their patients. There is evidence to suggest that those clinicians who adhere to CPG deliver better outcomes for their patients. Why, therefore, are clinicians so poor at adhering to CPG? The main barriers include awareness, familiarity and agreement with the contents. Secondly, clinicians must feel that they have the skills and are therefore able to deliver on the CPG. Clinicians also need to be able to overcome the inertia of "normal practice" and understand the need for change. Thirdly, the goals of clinicians and patients are not always the same as each other (or the guidelines). Finally, there are a multitude of external barriers including equipment, space, educational materials, time, staff, and financial resource. In view of the considerable energy that has been placed on guidelines, there has been extensive research into their uptake. Laboratory medicine specialists are not immune from these barriers. Most CPG that include laboratory tests do not have sufficient detail for laboratories to provide any added value. However, where appropriate recommendations are made, then it appears that laboratory specialist express the same difficulties in compliance as front-line clinicians.

Keywords: guidelines; quality assurance; quality indicator.

***Corresponding author: Julian H. Barth,** Department of Blood Sciences, Old Medical School, Leeds General Infirmary, Leeds LS1 3EX, UK, E-mail: Julian.barth@nhs.net
Shivani Misra: Clinical Biochemistry and Metabolic Medicine, Imperial Healthcare NHS Trust, London, UK
Kristin Moberg Aakre: Laboratory of Clinical Biochemistry, Haukeland University Hospital, Bergen, Norway
Michel R. Langlois: Department of Laboratory Medicine, AZ St Jan Hospital, Bruges, Belgium
Joseph Watine: Department of Laboratory Medicine, Hôpital La Chartreuse, Villefranche de Rouergue, France
Patrick J. Twomey: Department of Clinical Chemistry, St. Vincent's University Hospital, Dublin, Republic of Ireland
Wytze P. Oosterhuis: Department of Clinical Chemistry, Zuyderland Medical Centre, Heerlen, The Netherlands

Introduction

New clinical knowledge is being published so fast that it is nearly impossible for any individual to keep track of new developments and to place those developments within a coherent framework. This has led to variations in practice and patient outcomes. The movement to develop evidence based clinical guidelines has evolved to help standardise and improve patient care. Clinical practice guidelines are created by a process that starts with a review and evaluation of the available scientific literature which is converted into an output of recommendations that embody both the evidence and expert opinion and may therefore be considered to represent best practice.

Modern medical practice has become more complex and interventional with new knowledge. Inevitably, this has forced a change in clinical practice. The old model of practice with a single specialist and his team of junior staff has been replaced by a team of specialist clinicians all of whom treat a different aspect of a patient's care. Moreover, clinicians now work in defined time shifts rather than being available throughout the patient journey. The value of Clinical Practice Guidelines (CPG) is to maintain consistency and to ensure that everyone knows their role in order to reduce clinical errors. A recent case report has shown how minor infringements in multi-individual processes can lead to disasters [1]. Despite this, it is not always wrong to deviate from a CPG if there are good clinical reasons. Indeed, CPG must always be interpreted in the light of patients' concomitant disease(s) and underlying

risk factors. Deviation from CPG may be appropriate in the context of a patient's unique situation. CPG cannot be written for every clinical scenario and nobody expects 100% concordance. However, this does not condone the poor uptake of advice (see below).

The importance of CPG to clinicians is that healthcare administrators, regulators, and policy-maker payers are starting to consider that CPGs represent standards of care. It behoves us to understand all the reasons for non-compliance.

CPG undergo three separate phases: development, dissemination and implementation. This paper discusses the implementation and why clinicians are non-compliant.

Effect of guidelines on clinical outcomes

A guideline can only describe how the evidence suggests that clinical practice should be undertaken. It has to be digested and implemented. In 1986, a national CPG on caesarean sections was published in Canada. The document was circulated for consultation and accepted by the national specialty association. However, in the years following publication, there was no real change in operation rate despite individual clinicians and organisations declaring that they were compliant with the CPG [2]. This highlights that CPG can only be of value if they are introduced, implemented and audited to ensure that old practices are discontinued.

Do guidelines improve care?

When CPG are adhered to, clinical outcomes improve. This is well-illustrated anecdotally by the steady increase in longevity in patients with myocardial infarction in Sweden. Much of the benefit will have come from improved diagnostics and treatments but it is well recognised that there is a slow translation of research findings into clinical practice. Over the years CPG have been written in an attempt to both speed up the introduction of good practice and also to reduce variability between units. Data from Sweden shows that when CPG are agreed and implemented, there is a steady increase in the uptake of treatments and a consequent steady fall in mortality [3].

The literature on the beneficial effects of CPG is not entirely convincing. Two systematic reviews of the effect on outcomes have been performed. The first showed that 55/59 studies showed improvement but since the review only assessed randomised controlled trials (RCT), it is hardly surprising that there was such a high rate of compliance since they would have been performed under supervision by trial managers [4]. A second studied the outcome of CPG in Holland. This country was chosen as it has a long history of CPG production and it was assumed that CPG were embedded into the consciousness of practitioners. Studies were selected if they measured adherence or outcome and were evidence-based or RCT. A total of 30 studies (some with multiple outcomes) were found but only nine studies assessed patient outcomes; six showed significant improvement in some outcomes; four showed modest improvements in some outcomes; and three showed no effect on patient outcomes. A greater benefit was found on the process of care [5]. From these two reviews it is clear that high quality research on CPG is still necessary.

Not all physicians follow guidelines

Numerous studies have highlighted the failure of clinicians to follow CPG. These have shown that non-compliance is as high as 70% and occurs across most disciplines and countries [2, 6–9]. One important aspect that has not been well studied is that of the age of practitioners. There has been a change in practice over the generations with those clinicians in the second half of their careers practising as individuals according to their experience and knowledge whereas the younger generations are practising in a more collaborative team-based medicine which is more strongly influenced by protocols and guidelines [10].

Consequence of guideline failure

As there have been few good studies of CPG, the evidence for the effects of non-compliance will by necessity be anecdotal. Gupta and Cook explain a situation where an unnoticed glucose infusion influenced finger-prick point-of-care glucose test and resulted in hypoglycaemic brain damage [1]. They noted that there were numerous confounding errors in addition to the primary error. These errors occurred despite guidelines designed to prevent this scenario having been published several years previously. The critical learning point may be that the error was based around a routine procedure with which all staff were comfortable – in this case arterial cannulation on an intensive care unit.

What are the barriers to guideline compliance?

Most of the primary barriers to uptake of guidelines are fairly easy to identify [11]. They include awareness, familiarity and agreement with the contents. Secondly, responsible clinicians must feel that they have the skills and are therefore able to deliver on the CPG. The clinician also needs to be able to overcome the inertia of "normal practice" and understand the need for change. Thirdly, the goals of the clinician and the patient are not always the same as each other (or the guideline). Finally, there are a multitude of external barriers, e.g. equipment, space, educational materials, time, staff, and financial resource. In view of the considerable energy that has been placed on guidelines, there has been extensive research into their uptake.

Barriers identified by clinicians

The Dutch have had the longest history of introducing the culture of CPG into clinical practice and as such they have been the single group who have been most extensively studied. Indeed, a recent survey of Dutch primary care physicians showed that in excess of 94% of respondents believed that CPG are useful sources of advice and based on sound evidence. Ninety percent present believe that the use of CPG would lead to better outcomes. However, 35% reported having difficulty in changing personal routines to adopt CPG and 6% admitted to being resistant to adhering with CPG [12]. A further study of primary care physicians across Europe gave similar results with 90% agreeing with the content of CPG and 80% reporting use of them (see Table 1) [13]. This latter group highlighted barriers of lack of time (38%) and patient compliance (17%). They also reported that improved implementation would require more education for physicians (29%) and patients (25%); publishing and promoting CPG (23%); and simplifying the guidelines. Unfortunately, these clinicians seemed to focus only on barriers that were firmly in other people's domain.

Other barriers (Table 2)

CPG vary in their detail. Some are brief and give clear instructions. Others are complex with multiple rules some of which may conflict with other CPGs. They may give options which are appropriate for the experienced clinician but which can become bewildering for the less skilled or non specialist clinician. This causes confusion and is likely to lead to the CPG not being followed [11, 14]. The need for easily accessible CPG written with short concise summaries has been specifically identified as a requirement by surveys from both primary and secondary care in Spain [15]. An observational study in the UK showed that CPG were less likely to be followed if they contained controversial recommendations or statements that were vague [16]. The latter may be a result of either writing guidance for, or interpreting guidance in, clinical situations that do not clearly match the scenario for which the CPG was written.

Clinicians cannot always agree with guidelines. A good example is the definition of hypothyroidism. This was addressed by the commissioning of a systematic review by all the major endocrine societies in the US – the Endocrine Society, the American Thyroid Association and the American Association of Clinical Endocrinologists and published in 2004 [17]. Unfortunately the officers of the

Table 1: Surveys of primary care physicians on CPG.

	Dutch clinicians (A)	Clinicians from France, Germany, Italy, Sweden and UK (B)
CPG are useful source of advice	97%	89%
CPG based on sound evidence	94%	
Use of CPG would lead to better outcomes	90%	
Difficulty changing personal routines	35%	
Personal skills complicate compliance	14%	
Clinician resistant to adhering to CPG	6%	
Clinicians report use of CPG		81%
Clinicians report lack of time to be compliant		38%
Clinicians report lack of patient compliance		17%

Surveys of primary care physicians regarding their views on CPG. Column A see ref. # 12. Column B see ref. # 13.

Table 2: Reasons for non-compliance.

CPG	CPG are too complex
	Multiple rules in a single CPG
	Disagreement with the CPG
	Multiple (and conflicting) rules between CPG
	Perception that a guideline that is out of date
	Different aspects of a guideline have different reasons for non compliance
Clinicians	Physicians not good at assessing risk [38, 39]
	Overconfidence
	Time pressures [26]
	Information overload
	Difficulty in changing usual practice
	Fragmentation of care
	Case complexity
	Different clinicians have different reasons

specialist societies not only disagreed with the definition of hypothyroidism resulting from the systematic review [18] but subsequently broke into two opposing camps each of which wrote contrasting critiques despite using the same data sources [19, 20]. A further example of different data interpretation is in the field of heart failure where the guideline from the National Institute for Health and Care Excellence (NICE) in England, disagrees with the guidelines of the combined cardiac specialist societies in the US over the diagnostic utilities of BNP and echocardiography in the diagnosis/exclusion of heart failure [21]. Furthermore, a recent editorial in *JAMA* highlighted the problems of governance in the process of writing CPG by specialist societies particularly in the opacity of declaring conflicts of interest [22].

Compliance with guidelines on the use of laboratory blood testing was studied in Holland. This found that in general practice, non-compliance is predominantly caused by adding on extra tests. Van Wijk et al. concluded that the non-compliance might be due to practitioners applying new medical insight before it is incorporated in a revision of that guideline and in fact clinicians were trying to improve a guideline that they perceived as being out of date [23].

The actual reasons for non-compliance with CPG are difficult to generalise as there may be more than one recommendation within a guideline; and the reasons for non-compliance may be different between guidelines. Lugtenberg et al. studied the causes in three guidelines – on red eyes, stroke and thyroid disease. They found that there were different reasons for non-compliance associated with each CPG and, moreover, that clinicians and patients have different views of their non-applicability [14, 24].

Berner and Graber comprehensively reviewed the effect of physician over confidence in their own ability as a cause of diagnostic errors. They state that physicians believe that their practice does conform to consensus recommendations even though it does not. They also show that physicians tend to underestimate clinical risk. They also raise the issue that it is necessary to make the correct diagnosis in order to follow the appropriate CPG. However, they further note that failure to follow a CPG does not necessarily lead to poor patient outcomes [25].

Other reasons for non-compliance include time pressures [26], information overload [27] and difficulty in changing from previous practice to the CPG protocols [16]. Furthermore, in our current pressurised health care systems with multi-disciplinary teams, there is the issue of fragmented care. This occurs when a large team of people are involved in the care of a patient which may result in uncertainty between different professional groups over their responsibility for various actions. This confusion may lead to resentment and subsequently disregard for policies and guidelines [28].

CPG are written for specific symptoms or diseases but as medicine advances, patients no longer fit into the clean categories of the evidence-based trials that the CPG are based upon. Patients age. They develop multiple co-existent diseases and may already have had the first line treatment covered by the CPG. A systematic review of guidelines looking at the effect of case complexity and comorbidities found that few CPG addressed co-morbidities and unconnected combinations of diseases. They concluded that CPG should state their applicability in complex situations [29].

CPG and laboratory medicine

There are relatively few CPG written purely for laboratory medicine but there are many that are written with laboratory tests included. The publication of these CPG should not come as a surprise for laboratories that have good liaison with their clinicians. These guidelines may involve the introduction of new tests and it may take time to make the changes within the laboratory to evaluate new tests and bring them into the routine repertoire. However, it is not always possible to predict how quickly guidelines will be implemented. The implementation of troponin testing in the UK was very slow whilst clinicians learnt how to interpret the new test [30]. In contrast, the NHS in England issued a guideline for the enhanced investigation of cardiovascular disease and diabetes and this had an immediate effect with major increases in laboratory workload

for the prescribed tests (plasma glucose, cholesterol, TFT, HbA_{1c} and urine microalbumin) in primary care – possibly because it included a contract for payment [31].

How well do laboratories follow CPG?

In the absence of many guidelines, there have been many surveys of laboratory practice to determine peer practice. These are mostly descriptive and do not, in themselves, have any impact on laboratory practice. However, a recent report of practice of cardiac testing is valuable as a marker for laboratory compliance with CPG. Guidelines for the investigation of chest pain have been available for many years. Collinson et al. studied laboratories across Europe on two occasions [32]. They reported that whilst laboratories are variably compliant, there has been little change over the 4 years of their study despite the well-publicised CPG and much of the evidence having been published in laboratory medicine journals. This finding mirrors the unexplained huge variability in reference intervals reported by laboratories and suggests that more attention to the clinical interface of the laboratory service is needed.

Are laboratory specialists likely to follow guidelines?

There has been little research on the behaviour of laboratory medicine in regard to CPG. A single study from Norway suggests that laboratory medicine departments are as a poor as clinicians in other disciplines [33]. Therefore, we surveyed senior members of the Association for Clinical Biochemistry and Laboratory Medicine in January 2015 [Barth JH unpublished data 2015]. The survey asked questions regarding the NACB Diabetes Mellitus guideline [34] and NICE Chronic Kidney Disease [35] and also asked about the responsibility for ensuring uptake of guidelines.

The compliance rates and reasons for non-compliance are illustrated in Table 3. The low compliance for the CKD guideline is due to the cost of introducing cystatin C. It is important to note the significant number of individuals who disagree with the (or parts of the) guideline recommendations. The questionnaire did not explore reasons underlying that opinion. Overall the pattern of reasons for non-compliance is similar to the previous reported surveys of clinicians.

The questionnaire asked who was responsible for implementing CPG. There was no clear answer as to whether this should be the laboratory medicine specialist, the senior managing pathologist or the medical director of the hospital. Respondents were clear that national and international guidelines were more important than local CPG.

Laboratory tests in clinical guidelines

It has already been mentioned that CPG are often written without help from laboratory medicine specialists with the result that the laboratory aspects of CPG are difficult to implement in a way that ensures optimal use of laboratory tests. This has been addressed by the Working Group on Guidelines of the European Federation Clinical Chemistry and Laboratory Medicine and the European Union of Medical Specialists. We studied a number of (inter)national guidelines and developed a checklist to help guideline authors. We also determined which aspects of the total testing process were the areas which needed most encouragement [36]. The checklist contains

Table 3: Survey of laboratory medicine specialists.

	Guideline 1 – diabetes	Guideline 2 – CKD
I am complaint with this guideline	40%	12%
Reason for non-compliance	yes (%)	yes (%)
I do not have the time	13	13
Disagree with guidance	32	46
The guidance is irrelevant to my practice	3	2
Not supported by my local management and/or colleagues	24	51
This guidance is too complex to implement	10	18
Guideline is too rigid	33	23
Implementing this guidance would mean wasting resources that could be really useful elsewhere	17	22

Survey of ACB (UK) members in January 2015 regarding CPG. This Table explains the reasons for non compliance.

80 points: 33 pre-analytical, 37 analytical and 10 post-analytical. Only 30% of the items were covered by the guidelines but, encouragingly, those guideline groups with laboratory medicine specialist covered more. It is of note that the important features of patient preparation; biological and analytical variations and sample handling were rarely included. A second study of CPG related to chest pain showed that CPG were similarly poor in these areas [37].

How well do national guidelines provide recommendations for laboratory medicine?

A review of the CPG published by the UK National Institute for Clinical Excellence (NICE) was undertaken as a model for other (inter)national bodies. A total of 39 CPG from NICE were relevant to laboratory medicine. There were relatively few recommendations about laboratory tests; there were five recommendations about tests that should be done and 10 recommendations for tests that might be done; and nine recommendations for tests that should not be done. In fact the only specific recommendations were that decision making values for BNP/NT pro-BNP and CA125 were defined [Barth JH unpublished data 2015].

What do we do now?

CPG do improve patient care and outcomes so laboratory medicine does need to address them. We need to undertake further research into the diagnostic utility of our tests so that these aspects of the testing process are found in literature searches. Secondly, we need to make sure that all guideline committees have a specialist in laboratory testing on the writing committees. This is necessary to ensure that our analytical efforts are rewarded with appropriate samples taken for optimal diagnostic use.

Summary

There is good evidence to suggest that CPG improve patient outcomes and over the past three decades, CPG have been written in many areas of clinical medicine. Few have been written for laboratories and the ones that affect laboratories are inadequate in that respect. We need to change this culture and ensure that we are involved in both the arenas of diagnostic research and guideline writing. Indeed, one of the drivers for CPG in laboratory medicine is to ensure that diseases are not under- or over-diagnosed and therefore patients are not under- or over-treated due to incorrect interpretation of investigations.

Much of the evidence reviewed in this article is based on studies of clinicians but it is pertinent to consider the conclusion that Collinson made regarding current laboratory practice in regard to cardiac markers. "There is no longer a debate about which test should be used for the diagnosis of MI. The question is why do laboratories persist in non-evidence-based behaviour? And why are they not talking with their clinicians?" [32].

Author contributions: All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.
Research funding: None declared.
Employment or leadership: None declared.
Honorarium: None declared.
Competing interests: The funding organisation(s) played no role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the report for publication.

References

1. Gupta KJ, Cook TM. Accidental hypoglycaemia caused by an arterial flush drug error: a case report and contributory causes analysis. Anaesthesia 2013;68:1179–87.
2. Lomas J, Anderson GM, Domnick-Pierre K, Vayda E, Enkin MW, Hannah WJ. Do practice guidelines guide practice? N Engl J Med 1989;321:1306–11.
3. Carlhed R, Bojestig M, Wallentin L, Lindström G, Peterson A, Åberg C, et al., for the QUICC study group. Improved adherence to Swedish national guidelines for acute myocardial infarction: The Quality Improvement in Coronary Care (QUICC) study. Am Heart J 2006;152:1175–82.
4. Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. Lancet 1993;342:1317–22.
5. Lugtenberg M, Burgers JS, Westert GP. Effects of evidence-based clinical practice guidelines on quality of care: a systematic review. Qual Saf Health Care 2009;18:385–92.
6. Graham ID, Stiell IG, Laupacis A, McAuley L, Howell M, Clancy M, et al. Awareness and use of the Ottawa ankle and knee rules in 5 countries: can publication alone be enough to change practice? Ann Emerg Med 2001;37:259–66.
7. Sager HB, Linsel-Nitschke P, Mayer B, Lieb W, Franzel B, Elsasser U, et al. Physicians' perception of guideline-recommended low-density lipoprotein target values: characteristics of misclassified patients. Eur Heart J 2010;31:1266–73.
8. Porter A, Iakobishvili Z, Dictiar R, Behar S, Hod H, Gottlieb S, et al. The implementation of guidelines and prognosis among patients with acute coronary syndromes is influenced by physicians' perception of antecedent physical and cognitive status. Cardiology 2007;107:422–8.

9. McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. The quality of health care delivered to adults in the United States. N Engl J Med 2003;348:2635–45.
10. Adedeji AR, Tumbo J, Govender I. Adherence of doctors to a clinical guideline for hypertension in Bojanala district, North-West Province, South Africa. Afr J Prim Health Care Fam Med 2015;7:E1–6.
11. Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? J Am Med Assoc 1999;282:1458–65.
12. Lugtenberg M, Burgers JS, Besters CF, Han D, Wester GP. Perceived barriers to guideline adherence: a survey among general practitioners. BMC Fam Pract 2011;12:98.
13. Hobbs FD, Erhardt L. Acceptance of guideline recommendations and perceived implementation of coronary heart disease prevention among primary care physicians in five European countries: the Reassessing European Attitudes about Cardiovascular Treatment (REACT) survey. Fam Pract 2002;19:596–604.
14. Lugtenberg M, Zegers-van Schaick JM, Westert GP, Burgers JS. Why don't physicians adhere to guideline recommendations in practice? An analysis of barriers among Dutch general practitioners. Implement Sci 2009;4:54.
15. Kotzeva A, Guillamón I, Gracia J, Díaz del Campo P, Gich I, Calderón E, et al., Spanish CPGs Working Group. Use of clinical practice guidelines and factors related to their uptake: a survey of health professionals in Spain. J Eval Clin Pract 2014;20:216–24.
16. Grol R, Dalhuijsen J, Thomas S, in 't Veld C, Rutten G, Mokkink H. Attributes of clinical guidelines that influence use of guidelines in general practice: observational study. Br Med J 1998;317:858–61.
17. Surks MI, Ortiz E, Daniels GH, Sawin CT, Col NF, Cobin RH, et al. Subclinical thyroid disease: scientific review and guidelines for diagnosis and management. J Am Med Assoc 2004;291:228–38.
18. Ringel MD, Mazzaferri EL. Subclinical thyroid dysfunction – can there be a consensus about the consensus? J Clin Endocrinol Metab 2005;90:588–90.
19. Wartofsky L, Dickey RA. The evidence for a narrower thyrotropin reference range is compelling. J Clin Endocrinol Metab 2005;90:5483–8.
20. Surks MI, Goswami G, Daniels GH. The thyrotropin reference range should remain unchanged. J Clin Endocrinol Metab 2005;90:5489–96.
21. Peterson PN, Rumsfeld JS. The evolving story of guidelines and health care: does being NICE help? Ann Intern Med 2011;155:269–70.
22. Classen DC, Mermel LA. Specialist society clinical practice guidelines: time for evolution or revolution. J Am Med Assoc 2015;314:871–2.
23. van Wijk MA, van der Lei J, Mosseveld M, Bohnen AM, van Bemmel JH. Compliance of general practitioners with a guideline-based decision support system for ordering blood tests. Clin Chem 2002;48:55–60.
24. Fürthauer J, Flamm M, Sönnichsen A. Patient and physician related factors of adherence to evidence based guidelines in diabetes mellitus type 2, cardiovascular disease and prevention: a cross sectional study. BMC Fam Pract 2013;14:47.
25. Berner ES, Graber ML. Overconfidence as a cause of diagnostic error in medicine. Am J Med 2008;121:S2–23.
26. Tsiga E, Panagopoulou E, Sevdalis N, Montgomery A, Benos A. The influence of time pressure on adherence to guidelines in primary care: an experimental study. Br Med J Open 2013;3:e002700.
27. Carthey J, Walker S, Deelchand V, Vincent C, Griffiths WH. Breaking the rules: understanding non-compliance with policies and guidelines. Br Med J 2011;343:d5283.
28. Castro-Sánchez E, Charani E, Drumright LN, Sevdalis N, Shah N, Holmes AH. Fragmentation of care threatens patient safety in peripheral vascular catheter management in acute care – a qualitative study. PLoS One 2014;9:e86167.
29. Lugtenberg M, Burgers JS, Clancy C, Westert GP, Schneider EC. Current guidelines have limited applicability to patients with comorbid conditions: a systematic analysis of evidence-based guidelines. PLoS One 2011;6:e25987.
30. Fox KA, Birkhead J, Wilcox R, Knight C, Barth JH, British Cardiac Society Working Group. British Cardiac Society Working Group on the definition of myocardial infarction. Ann Clin Biochem 2004;41:263–71.
31. Beastall G. The impact of the general medical services contract – national evidence. Bull Roy Coll Pathol 2004;128:24–7.
32. Collinson PO, van Dieijen-Visser MP, Pulkki K, Hammerer-Lercher A, Suvisaari J, Ravkilde J, et al. Evidence-based laboratory medicine: how well do laboratories follow recommendations and guidelines? The cardiac marker guideline uptake in Europe (CARMAGUE) Study. Clin Chem 2012;58:305–6.
33. Aakre KM, Oosterhuis WP, Sandberg S. How do laboratory specialists advise clinicians concerning the use and interpretation of renal tests? Scand J Clin Lab Invest 2012;72:143–51.
34. Sacks DB, Arnold M, Bakris GL, Bruns DE, Horvath AR, Kirkman S, et al. Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus. Diab Care 2011;34:e61–99.
35. Chronic kidney disease: early identification and management of chronic kidney disease in adults in primary and secondary care. 2015 NICE clinical guideline 182 https://www.nice.org.uk/guidance/cg182 accessed 27 July 2015.
36. Aakre KM, Langlois MR, Watine J, Barth JH, Baum H, Collinson P, et al. Critical review of laboratory investigations in clinical practice guidelines; proposals for the description of investigation. Clin Chem Lab Med 2013;51:1217–26.
37. Aakre KM, Langlois MR, Barth JH, Misra S, Watine J, Oosterhuis WP. The quality of laboratory aspects of troponin testing in clinical practice guidelines and consensus documents needs to be improved. Clin Chim Acta 2014;437:58–61.
38. Mosca L, Linfante AH, Benjamin EJ, Berra K, Hayes SN, Walsh BW, et al. National study of physician awareness and adherence to cardiovascular disease prevention guidelines. Circulation 2005;111:499–510.
39. Martínez-St John DR, Palazón-Bru A, Gil-Guillén VF, Sepehri A, Navarro-Cremades F, Ramírez-Prado D, et al. Diagnostic inertia in obesity and the impact on cardiovascular risk in primary care: a cross-sectional study. Br J Gen Pract 2015;65:e454–9.