

## Right Care 1



## Evidence for overuse of medical services around the world

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Overuse, which is defined as the provision of medical services that are more likely to cause harm than good, is a pervasive problem. Direct measurement of overuse through documentation of delivery of inappropriate services is challenging given the difficulty of defining appropriate care for patients with individual preferences and needs; overuse can also be measured indirectly through examination of unwarranted geographical variations in prevalence of procedures and care intensity. Despite the challenges, the high prevalence of overuse is well documented in high-income countries across a wide range of services and is increasingly recognised in low-income countries. Overuse of unneeded services can harm patients physically and psychologically, and can harm health systems by wasting resources and deflecting investments in both public health and social spending, which is known to contribute to health. Although harms from overuse have not been well quantified and trends have not been well described, overuse is likely to be increasing worldwide.

## Introduction

Overuse, which Chassin and Galvin defined as ‘the provision of medical services for which the potential for harm exceeds the potential for benefit’,<sup>1</sup> is increasingly recognised around the world. Directly measuring overuse requires a definition of appropriate care, which is often challenging. In the USA, estimates of spending on overuse vary widely: conservative estimates based on the direct measurement of individual services range from 6% to 8% of total health-care spending,<sup>2</sup> whereas studies of geographical variation (an indirect measure) indicate that the proportion of Medicare spending on overuse is closer to 29%.<sup>3</sup> Worldwide, overuse of individual services can be as high as 89% in certain populations.<sup>4</sup> Although overuse has mainly been documented in high-income countries (HICs), low- and middle-income countries (LMICs) are not immune. Evidence suggests widespread overuse is occurring in countries as diverse as Australia,<sup>5</sup> Brazil,<sup>6</sup> Iran,<sup>7</sup> Israel,<sup>8</sup> and Spain.<sup>9</sup> Overuse can coexist with unmet health-care needs, particularly in LMICs.

We aimed to highlight the significance of the problem of overuse and explore what is known regarding the scope and consequences of such, around the world. We have drawn on five systematic reviews (one unpublished)<sup>4,10–12</sup> of overuse to help inform this paper, supplemented with reference tracking and additional structured searches of scientific and grey literature. Subsequent papers in this Series<sup>13–15</sup> examine the underuse of medical services worldwide, the causes of overuse and underuse, and potential solutions for both.

## What is overuse?

“Though the doctors treated him, let his blood, and gave him medications to drink, he nevertheless recovered.”

Leo Tolstoy, *War and Peace*

Although Chassin and Galvin’s definition of overuse is succinct, and may have broad intuitive appeal, it is

difficult to address. To directly measure overuse, a definition for the appropriateness of a service is required, based on evidence that considers the balance between benefits and harms for a population or individuals. However, quantifying benefits and harms is often problematic, because evidence regarding benefits is often incomplete, and for many services harms are poorly documented.<sup>16</sup> Furthermore, the threshold between appropriate and inappropriate care can vary among patients or patient groups. Additionally, the role of cost in defining low-value services varies in different settings (panel).

Ultimately, overuse can be considered to occur along a continuum. At one end of the continuum lie tests and treatments that are universally beneficial when used on the appropriate patient, such as blood cultures in a young, otherwise healthy patient with sepsis, and insulin for patients with type 1 diabetes. At the other end of the continuum are services that are entirely ineffective, futile, or pose such a high risk of harm to all patients that they should never be delivered, such as the drug combination fenfluramine-phentermine for obesity.<sup>22</sup> However, the majority of tests and treatments

## Key messages

- Overuse is difficult to measure and has not been well characterised
- Most studies of overuse have been done in high-income countries, but there is growing evidence that overuse is a global problem
- Overuse is likely to cause physical, psychological and financial harm to patients
- Overuse deflects resources from public health and other social spending in both low-income and high-income countries
- Overuse occurs across a wide range of medical specialties

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### Panel: The role of cost in defining overuse and low-value services

The elimination of clearly ineffective services would reduce both potential harm to patients and excess costs. However, clearly ineffective services are greatly outnumbered by grey zone interventions. Many grey zone interventions benefit very few patients or provide only small benefit relative to costs, and thus are not cost effective. Funding such low-value services poses an opportunity cost; less money is available to address unmet health needs, which subsequently reduces the funds available to improve the socio-economic determinants of health. Whereas cost-effectiveness analysis, which can quantify these tradeoffs, is formally considered in coverage decisions in HICs, such as Australia, Canada, and the UK,<sup>17-19</sup> and an increasing number of LMICs,<sup>20</sup> it is not included in appropriateness determinations in the USA.<sup>21</sup>

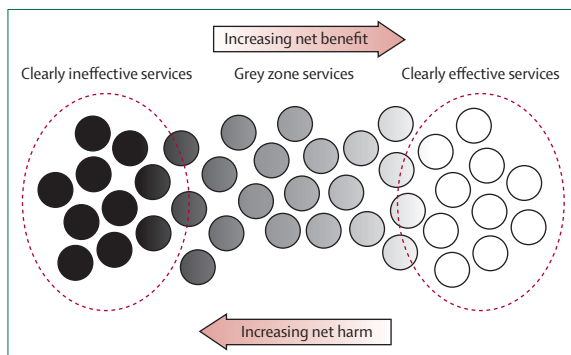


Figure 1: Grey zone services

fall into a more ambiguous grey zone,<sup>23,24</sup> which includes: services that offer little benefit to most patients (eg, glucosamine for osteoarthritis of the knee); those for which the balance between benefits and harms varies substantially among patients (eg, opioids for chronic pain, antidepressant medications for adolescents); and the many services that are backed by little evidence to help decide which patients, if any, might benefit and by how much (eg, routine blood testing in patients with hypertension) (see figure 1: Grey zone services). Even when robust consensus has established criteria defining the appropriateness of tests and treatments (such as those developed for cardiological services in the USA), appropriateness can remain uncertain in many individual cases.<sup>25</sup>

Chassin and Galvin's simple definition is further complicated by the question of whose values and preferences should determine the balance between potential benefits and acceptable harms. Certainly different patients faced with a choice of potentially beneficial treatments will vary in their views regarding the tradeoffs of each.<sup>26</sup> Thus, individual patient values and preferences are critical for defining appropriate care for many conditions that lie within the grey zone.

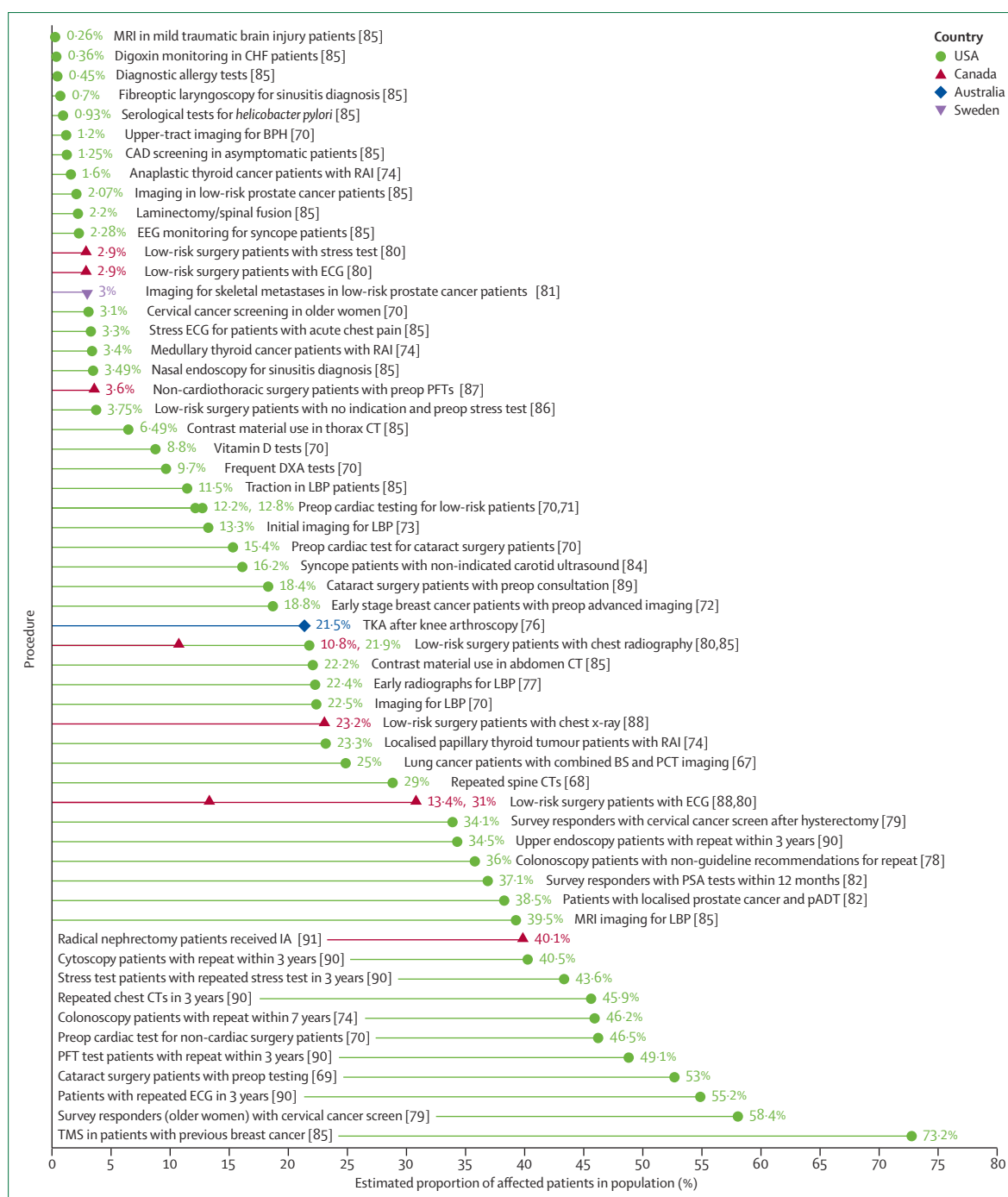
Unfortunately, clinicians often have a poor understanding of patient values, incorrectly assuming in some cases that a patient would prefer to avoid aggressive or invasive intervention, and in other cases that the patient would favour more rather than less care. This so-called preference misdiagnosis contributes to overuse (and underuse) when clinicians deliver a service that is wrong for that individual patient.

### Measurement of overuse

Overuse can be measured in various ways. Overuse of a specific service can be measured directly within a population by use of patient registries or medical records. This approach requires a reliable definition of appropriateness for a given service, generally using an evidence-based or consensus-based guideline, or a multidisciplinary iterative panel process (eg, the RAND Appropriateness Method<sup>27</sup>) to define necessary and unnecessary use. Rates of overuse are then calculated as either the proportion of delivered services that are inappropriate or as the proportion of patients who receive the service inappropriately. This direct measure, which is the most reliable indicator of overuse, has been used in a growing body of literature, including several systematic reviews (see figure 2: Overuse of selected services in four countries).<sup>10-12</sup> However, several challenges inherent in this approach exist when applied to many health-care interventions.<sup>4</sup> First, as discussed above, evidence for defining appropriate care is scarce in many clinical situations, precluding the direct measurement of overuse for those services. Second, even if evidence is available, necessary details for defining the appropriateness of care in individual patients are often absent from guidelines, while iterative panel processes, which incorporate more nuance, are costly and time consuming. Third, few measures have been developed to assess the prevalence of overuse that occurs because patient preferences are not elicited. Electronic health records (EHR) and the development of large datasets, informed by clinical information from EHRs, have facilitated the measurement of overuse in some contexts (eg, the USA Veteran's Affairs system<sup>28,29</sup>) and could have broader applicability in the future. However, EHRs alone are not likely to enable widespread measurement of overuse directly.

A growing literature seeks to expand knowledge of overuse through an indirect measure: identifying unexpected variations in health-care implementation. Variations in utilisation that are not attributable to differences in patient or population characteristics have been documented both within and among countries and health-care systems.<sup>1-3,5,6,30,31</sup> Although these variations are often not related to overuse (or underuse) per se, but rather to different rates of discretionary care (or services for which the evidence does not point clearly to a right answer,<sup>23</sup> such as revisit interval for patients with diabetes), unexpectedly high

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**Figure 2: Overuse of selected services in four countries**

Estimates from the literature of the proportion of patients that received various low-value services, out of the relevant patient population. The populations are based in four locations. preop=preoperative. TKA=total knee arthroplasty. LBP=lower back pain. BPH=benign prostate hyperplasia. pADT=primary androgen deprivation therapy. BS=bone scintigraphy. PET=positron emission tomography. TMS=tumour marking studies. DXA=dual-energy x-ray absorptiometry. EEG=electroencephalogram. ECG=echocardiography. PSA=prostate specific antigen. PFT=pulmonary function test. IA=ipsilateral adrenalectomy. RAI=radioactive iodine treatment. CAD=carotid artery disease. CHF=congestive heart failure. Adapted and updated from Chalmers, Pearson and Elshaug (unpublished data).

rates of use of a particular service can reflect overuse.<sup>8,9</sup> In more recent years, investigators have used large databases to explore variations in the use of specific services as a method of identifying probable overuse.<sup>32,33</sup>

Examples of both direct and indirect evidence documenting overuse of specific services around the world have been noted (table). Some investigators have moved beyond individual services to evaluate rates of

|                                | Direct evidence of inappropriate care  | Indirect evidence of inappropriate care  |
|--------------------------------|--|--|
| Musculoskeletal procedures     | Spain: Rates of inappropriate total knee replacement 26% and total hip replacement 25%; <sup>34</sup><br>USA: Rate of inappropriate total knee replacement 34% <sup>35</sup>   | International: 4-fold variation across countries and 2–3 fold variation within countries in rates of knee replacement; <sup>36</sup><br>England: 13-fold regional variation in rates of arthroscopic knee lavage; <sup>37</sup><br>USA: 5-fold regional variation in adjusted rates of total hip and knee replacement <sup>38</sup>  |
| Cardiovascular procedures      | Italy: Rate of inappropriate PCI 22% and inappropriate coronary angiography 30%; <sup>39</sup><br>USA: Rate of inappropriate PCI 1.1% for acute indications and 11.6% for non-acute indications with variation across hospitals (6.0–16.7%); <sup>40</sup><br>Brazil: Rate of inappropriate coronary angiography 20% <sup>41</sup>   | International: 9-fold variation in use of PCI and 5-fold variation in use of coronary artery bypass grafting across OECD countries; <sup>30</sup><br>USA: Rates of elective PCIs vary 10-fold within the state of California; <sup>42</sup><br>India: A second opinion centre reported recommending against cardiac interventions in 55% of patients in whom intervention was initially recommended <sup>43</sup>  |
| Hysterectomy                   | Taiwan: 20% of hysterectomies inappropriate; <sup>44</sup><br>Switzerland: 13% of hysterectomies inappropriate; <sup>45</sup><br>USA: Rates of inappropriate hysterectomies between 16 and 70% across studies <sup>46</sup>  | Canada: 2.7-fold variation in rates of hysterectomy across regions within Ontario; <sup>47</sup><br>Netherlands: 2.2-fold regional variation in rates of hysterectomy for bleeding disorders; 2.3-fold regional variation in rates for pelvic organ prolapse; <sup>48</sup><br>India: Prevalence of up to 9.8% overall, with one third of hysterectomies performed in women under the age of 35 (probably inappropriate in this age group) <sup>49</sup> |
| Antibiotics for acute diarrhea | Italy: Among children hospitalised for acute diarrhea, 9% received antibiotics inappropriately; <sup>50</sup><br>China: 57% of patients received antibiotics inappropriately; among those with an indication for antibiotics, 21% were not treated (adults); <sup>51</sup><br>Thailand: 55% of children with acute diarrhea received antibiotics inappropriately <sup>52</sup> | USA: 10.4% of patients with diarrhea received antibiotics (often likely inappropriate); <sup>53</sup><br>India: 71% of children with acute diarrhea received antibiotics (despite recommendations against routine use); <sup>54</sup><br>India: Rates of antibiotic use for acute diarrhea 43% in public facilities and 69% in private facilities (despite recommendations against routine use) <sup>55</sup>  |

PCI=percutaneous coronary intervention. OECD=Organisation for Economic Co-operation and Development.

**Table: Direct and indirect evidence of global overuse in different clinical categories**

general overuse in health-care systems by evaluating variations in groups of possibly overused services,<sup>5,56–58</sup> but these methods are not yet well established.

### Related concepts

We use the term “overuse” to refer to any services that are unnecessary in any way. The related terms, overtreatment and overtesting, indicate the inappropriate delivery of particular types of services.

Another related term, overdiagnosis, is commonly defined as the diagnostic labelling of abnormalities or symptoms that are indolent, non-progressive or regressive, and that if left untreated will not cause considerable distress or shorten the person’s life.<sup>59</sup> This definition can be complicated by the varying natural history of specific diseases, and does not entirely encompass the various settings in which overdiagnosis occurs or the role that it has in overuse.<sup>60</sup> Overdiagnosis can occur as a consequence of screening (including recommended screening). For some screening tests, such as cervical cancer screening,<sup>61</sup> the small risk of overdiagnosis and subsequent overtreatment are outweighed by the reduction in risk of death. For other screening tests, however, the balance is less clear<sup>62</sup> and overdiagnosis may be an important driver of overuse in the form of aggressive overtreatment of clinically insignificant findings.<sup>5,63</sup> (The third paper in this Series<sup>4</sup> discusses overdiagnosis in greater detail and other drivers of overuse, including defensive medicine, which

has been associated with aggressive diagnostic testing in the USA<sup>64</sup> and has been identified by physicians in several countries<sup>65–67</sup> as an important reason for overusing tests and treatments.)

Overdiagnosis can also occur when the definition of disease or abnormality is broadened, leading to populations that were previously considered “normal” or healthy being labelled as diseased. This phenomenon is referred to as overmedicalisation and can result in the treatment of essentially healthy patients in whom potential benefit is small and likely to be outweighed by harms. A review of recent USA guidelines showed that for ten of the 16 guidelines studied, disease definition had been widened, potentially leading to overuse.<sup>68</sup> For example, lowering risk thresholds for treating cholesterol has led to a growing proportion of populations in many countries being prescribed lipid-lowering drugs with unclear benefits.<sup>69,70</sup> Furthermore, a broadened definition of chronic kidney disease that is used in many countries, although potentially beneficial for ensuring safe drug dosing, has led to large numbers of asymptomatic older people being labelled as ill; as many as 30% of older adults diagnosed with moderately advanced kidney disease (stage 3A) have no urine markers of kidney damage.<sup>71</sup> In children, overdiagnosis can occur in frequently diagnosed conditions, such as Attention Deficit Hyperactivity Disorder (ADHD), food allergies, gastroesophageal reflux, obstructive sleep apnea, and urinary tract infections.<sup>72</sup>

## Worldwide prevalence of overuse

Overuse is gaining increasing recognition as a worldwide problem; however, the significance of it has not yet been defined. A 2012 systematic review of the prevalence of service overuse in the USA noted that the majority of studies that directly measured overuse were focused on a relatively small number of services.<sup>4</sup> However, indirect evidence, such as studies of geographical variation, suggests that overuse is not limited to these services in the USA.<sup>73</sup> A more recent systematic review (unpublished) of global overuse categorised 83 overused or low-value services from studies including large sample sizes (more than 800 patients).<sup>30,74–97</sup> These authors identified studies from four countries (with USA studies predominating) and found that the rates of overuse of various services ranged from about 1% to 80% (see figure 2). For LMICs and many HICs, the evidence of overuse is more scarce and largely indirect, although it appears to be increasing (see for example, a 2014 report<sup>36</sup> on geographical variation in health care in 13 countries). In this section, we describe worldwide rates of overuse for a selection of clinical services. We focused our attention on the services most commonly described in systematic reviews and other literature, and services in which overuse has the potential to substantially affect patients or health-care systems.

### Overuse of medication

One of the best-documented examples of medication overuse in both HICs and LMICs is the inappropriate use of antibiotics, which represents a worldwide problem that has important consequences for antimicrobial resistance. Many studies have addressed inappropriate antibiotic use in patients with upper respiratory viral infections. A 2012 systematic review of overuse in the US health-care system found 59 studies documenting widely variable rates of overuse of antibiotics for upper respiratory infections.<sup>4</sup> In Europe, rates of antibiotic prescribing for viral upper respiratory infections are high in Poland, Sweden, and the UK, with half of patients receiving unnecessary antibiotics.<sup>98–100</sup> Additionally, across the continent, studies have documented variable rates of antibiotic prescribing for patients with acute cough, with no associated differences in rates of recovery,<sup>101</sup> suggesting overuse.

Evidence of antibiotic overuse in LMICs is largely indirect. Global consumption of antibiotic drugs has risen by 36% between 2000 and 2010, with growing economies such as Brazil, China, India, Russia, and South Africa accounting for 76% of this increase.<sup>102</sup> The extent to which this increase represents overuse is not known, however, a 2015 systematic review<sup>12</sup> of medication use in China and Vietnam found evidence for antibiotic overuse in both countries. Furthermore, a 2005 systematic review<sup>11</sup> of patterns of antibiotic use, which included studies from around the globe, found high rates

of inappropriate administration, including substantial patient consumption of so-called leftover antibiotics. Similarly, a 2013 Cochrane review<sup>103</sup> of the effect of interventions to improve antibiotic prescribing in patients admitted to hospital included studies from both HICs and LMICs, suggesting wide recognition of the problem of inappropriate antibiotic use, however, the review did not directly quantify prescribing rates.

In other clinical specialties, unexpectedly high prescribing rates for specific drugs in individual health systems suggests overuse. Bevacizumab, an expensive and generally ineffective treatment for breast cancer, is not recommended by the National Institute for Health and Care Excellence (NICE) in the UK, and its US Food and Drug Administration marketing authorisation for breast cancer was withdrawn. However, the drug is reimbursed by health insurers in Colombia for all (licensed and unlicensed) cancer indications at great expense to the country's health-care system.<sup>104</sup> Similarly, erythropoiesis stimulating drugs, epoetin alfa and beta and darbapoetin alfa, have been widely and inappropriately used in Romania to treat ribavirin-induced anaemia in patients with Hepatitis C and organ transplantations, in the absence of supporting evidence.<sup>105</sup>

### Overuse of screening tests

High rates of inappropriate use of screening tests have been documented, often in the context of concurrent underuse in appropriate populations. In the USA, where there is widespread public support for cancer screening,<sup>106</sup> overuse of screening for cervical cancer<sup>107,108</sup> in women at very low-risk, and overuse of mammography in women with short life expectancy, who are unlikely to benefit from diagnosis and treatment,<sup>109</sup> has been documented. Furthermore, inappropriate use of colonoscopy screening has been found in both the USA and Canada.<sup>110–12</sup>

Few studies have evaluated rates of inappropriate cancer screening outside of North America. A notable exception is South Korea's aggressive use of ultrasound screening, which has led to a 15-fold increase in incidence of papillary thyroid cancer. The death rate from this cancer has remained unchanged throughout the period of increased screening, and it is estimated that 99.7–99.9% of screen-detected thyroid cancers in Korea represent overdiagnosis.<sup>113</sup> Patients subjected to unnecessary thyroidectomy face an 11% risk of hypoparathyroidism and a 2% risk of vocal cord paralysis, demonstrating clear downstream harms of inappropriate screening. Despite low levels of appropriate mammography screening and widespread doubts regarding the cost-effectiveness of mammograms,<sup>114</sup> there are reports of touring mammography vans in India that provide indiscriminate breast cancer screening in women as young as 18 years old,<sup>115</sup> much of which represents clear overuse.



### Overuse of diagnostic tests

Overuse of testing appears to be common, driven by availability, apparent objectiveness, and the increasing sensitivity of tests to detect disease. Although few systematic analyses of inappropriate use of diagnostic tests have been performed in general, some specific diagnostic services have been evaluated around the world. For example, overuse of endoscopy seems to be common globally. In primary care practices in Switzerland, 14% of colonoscopy referrals and 49% of referrals for upper endoscopy represented overuse.<sup>116,117</sup> Elsewhere in Europe, appropriateness rates for endoscopy have been reported in Portugal, Spain, Italy, and Norway; overuse accounted for between 13% and 33% of tests,<sup>118–21</sup> and at an Israeli centre 16% of endoscopies were unnecessary.<sup>122</sup> Studies in the USA have reported overuse rates as high as 60%.<sup>123</sup> In Saudi Arabia, which has open access to endoscopy, nearly half of procedures were deemed inappropriate.<sup>124</sup> A Dutch study<sup>125</sup> found that approximately a quarter of patients received appropriate colonoscopy after removal of colorectal adenomas, with both overuse and underuse of surveillance observed.

### Overuse of therapeutic procedures

Surgery and other invasive procedures are likely to be commonly overused in high-income countries. Although prevalence of directly-measured overuse were not reported, Elshaug and colleagues<sup>5</sup> identified more than 150 low-value services in use in Australia, and in the USA, up to 42% of Medicare beneficiaries had received at least one of 26 low-value treatments, with these interventions accounting for as much as 2.7% of overall Medicare spending.<sup>56</sup> Such findings are suggestive of widespread overuse of these services.

There are ample global data regarding the overuse of several cardiovascular procedures, despite clear and broadly accepted appropriateness criteria.<sup>126</sup> Inappropriate percutaneous coronary intervention has been documented in many countries, with a prevalence of 4–12% in the USA;<sup>40,127</sup> 10–14% in Germany,<sup>128,129</sup> 16% in Italy,<sup>130</sup> 22% in Israel;<sup>8</sup> 20% in Spain;<sup>9</sup> and 4% in Korea.<sup>131</sup> In one second-opinion centre in India, 55% of recommended cardiac stents or surgery were deemed inappropriate.<sup>43</sup>

### Site of care delivery

The site of care delivery and the intensity of care provided are relevant to overuse since more intense care carries a greater risk of complications, and is more costly. If more intense care does not improve outcomes for a condition when compared with less invasive or intensive care, it represents overuse. Hospital care overuse has been documented in both HICs and LMICs. A 2000 systematic review<sup>10</sup> found widely varying rates of inappropriate hospital admissions around the world, ranging from 1% to 54% of hospital admissions. Rates of hospital care

overuse in specific countries measured using established criteria to determine appropriateness, were 18–25% in France,<sup>132</sup> 33% in Germany,<sup>133</sup> 19% among internal medicine admissions in Portugal,<sup>134</sup> 7% at a referral centre in Spain,<sup>135</sup> 27% in rural hospitals in China,<sup>136</sup> and widely variable across three Egyptian hospitals, with rates ranging between 0% and 79%.<sup>137</sup> Additionally, studies have shown broad variations in rates of hospital use both within and among countries,<sup>138,139</sup> suggesting possible overuse, as well as underuse, of hospital care in different locations. Many of these variations are particularly striking with regard to “ambulatory care-sensitive” conditions, or conditions for which high-quality primary care is likely to prevent the need for hospital admission.<sup>140</sup> Overuse of hospital care for ambulatory care-sensitive conditions demonstrates that overuse of one (usually more aggressive) service can result from underuse of another, often less aggressive service.

### End-of-life care

In many countries, evidence exists for the overuse of aggressive care for dying patients and simultaneous underuse of appropriate palliative care. Despite evidence that the majority of people around the world would prefer to die at home,<sup>141–46</sup> about half die in hospital worldwide, with considerable variation among countries.<sup>147</sup> Inappropriately aggressive cancer care near the end of life has been identified as a common problem in Canada,<sup>148</sup> the USA,<sup>149</sup> and the UK,<sup>150</sup> with regional variations observed.<sup>151</sup> Overuse of aggressive end-of-life care in the UK, for example, includes futile insertion of percutaneous endoscopic gastrostomy tubes<sup>151</sup> and administration of chemotherapy that hastens death.<sup>152</sup> Furthermore, ineffective intensive care unit treatment at the end of life has been reported in Canada,<sup>153</sup> the USA,<sup>154</sup> and Brazil.<sup>155</sup> A study from Korea found that the majority of terminal cancer patients received futile intravenous nutrition during the last week of life, with discussions of palliation in only 7% of cases.<sup>156</sup>

Although few systematic assessments of end-of-life care have been performed in LMICs, it is likely that futile care at the end of life is not limited to HICs. In one study in India, nearly half of patients with cancer were diagnosed late and received ineffective radiotherapy.<sup>157</sup> In Brazil, one in five patients with cancer were administered useless medication, most often a statin.<sup>158</sup> Overall, it is likely that overuse of aggressive care and underuse of palliative care at the end of life is commonplace in both HICs and LMICs.

### Harms to patients and health-care systems

Overuse is likely to harm patients physically, psychologically, and financially, and could threaten the viability of health-care systems by increasing costs and diverting resources. However, our ability to collect strong evidence that describes the direct consequences of overuse on patients and health systems has been impeded by the same factors that challenge our ability to document

overuse itself, including an incomplete evidence base for effectiveness and limited reporting of treatment harms.<sup>159</sup> Much of what we know regarding the harms of overuse is derived from estimates and extrapolations.

### Harms to patients

Few studies have directly documented patient harms from overuse, however, estimates of physical harm to patients from overuse can be inferred from data on adverse events and studies regarding overuse of specific treatments. For example, Cushner and colleagues<sup>160</sup> used outcomes from a global orthopaedic registry for total knee and hip arthroplasty to estimate a rate of 7–8% for serious adverse events, which included severe infection, revision, cardiovascular events, and death. Other researchers estimate that more than 20% of total knee replacements in Spain and 30% in the USA are inappropriate.<sup>35,161</sup> Thus we can estimate that 2–3% of patients undergoing arthroplasty in those two countries are unnecessarily harmed by an inappropriate procedure, with approximately 14000 patients suffering harm from unnecessary knee and hip arthroplasty per year in the USA alone. Other examples of documented harm from overuse include high rates of overuse of implantable vena cava filters and low rates of appropriate removal,<sup>162</sup> with known excess venous thrombotic complications in 10% of patients who receive them,<sup>163</sup> and continued overuse of tight glycaemic control in intensive care units, despite evidence of higher rates of hypoglycaemic complications without reductions in mortality.<sup>164</sup>

Psychological harms from overuse have only been documented for few clinical situations but may be common. Several authors have noted that treatment in hospital may lead to unnecessary physical isolation of patients,<sup>165</sup> with negative consequences including loneliness, feelings of stigmatisation, and depression.<sup>166</sup> Furthermore, screening for breast cancer is known to lead to the diagnosis of precancerous lesions, such as ductal carcinoma in situ,<sup>167</sup> which has been associated with anxiety for several years after diagnosis and patient overestimation of future cancer risk.<sup>168–70</sup>

Patients can also suffer from being inappropriately labelled as “ill” as a result of unnecessary testing. As early as 1967, Bergman and Stamm found that among adolescents with heart murmurs, which had been previously (and possibly unnecessarily) evaluated and deemed ‘innocent’, 40% continued to experience restricted activity and 63% had parents who continued to believe their child was unhealthy.<sup>171</sup> Harm from labelling can also occur in the context of mental illness. For example, it is widely acknowledged that ADHD is overdiagnosed and overtreated in the USA and other HICs. ADHD is also overtreated in some LMICs,<sup>172</sup> although some children with ADHD fail to receive appropriate treatment. There is scant research on the effect of an ADHD diagnosis on a child’s sense of self-esteem and ability to modulate their own behaviour,

but the label has been shown to affect teacher’s expectations and peer interactions, which can substantially influence a child’s self-perceptions.<sup>173–75</sup>

Financial costs represent a potentially important but poorly documented source of harm from overuse to patients. In the USA, cost has been identified as a known consequence of all medical care<sup>176</sup> and of cancer treatment in particular,<sup>177</sup> with medical bills contributing to over half of personal bankruptcies,<sup>178</sup> although the contribution of overuse is not known. Similarly, in Australia, parents of children with cancer reported high out-of-pocket expenses,<sup>179</sup> and WHO has documented medical indebtedness across the globe. Health care is a major source of impoverishment and indebtedness among the poor of India,<sup>180,181</sup> and 15% of rural Vietnamese families with one member with a chronic illness experience financial catastrophe.<sup>182</sup> Determining the financial burden of overuse on patients requires active investigation in the future.

### Harms to health-care systems

Although there are few direct measurements of the proportion of health-care spending attributable to overuse, evidence is emerging that suggests the cost might be considerable. A study<sup>183</sup> regarding the inappropriate use of bone scans for US Medicare beneficiaries with prostate cancer found that 21% of patients at low risk and 48% of patients at moderate risk of bone metastases underwent at least one scan, despite recommendations against scanning in these groups, at an annual cost of US\$11300000. Experts estimate that prevalence of overuse contributes substantially to health-care spending in the USA.<sup>184</sup> Based on a conservative estimate,<sup>2</sup> the USA spent at least \$270 billion on care that could be defined as overuse in 2013, despite the fact that millions of Americans do not have adequate access to basic health care. Overuse might also strain health-care budgets in other countries.<sup>185</sup> In Australia, where many common services are believed to be overused,<sup>5</sup> the growth in health care expenditure from the rising volume of medical services has been identified as the greatest threat to the financial position of the government, and a bigger cause of health-care cost increases than population growth or ageing.<sup>186</sup>

Of particular concern is the potential financial effect of overuse on LMICs. The use of expensive advanced technology in HICs, such as new cancer biologics, imaging devices, and multi-focal cataract replacement lenses, spreads through globalised markets to LMICs, potentially crowding out less technological (and potentially higher value) means of promoting population health.<sup>187</sup> In India, private health insurance and formal sector employees’ insurance programmes cover expensive cancer drugs for a tenth of the country’s population, although the general population does not have access to many basic health-care interventions.<sup>180</sup> Although the extent to which the use of expensive

services represents true overuse as opposed to lower-value care from a public health perspective is not clear, overuse is a potential threat to both the viability of public budgets and to population health in LMICs.

### Worldwide trends in overuse

Is overuse getting better or worse? This is a difficult question to answer for several reasons. First, we are only beginning to conceptualise overuse as a general system problem and to develop system-level metrics.<sup>188</sup> Second, there are no measures in general use and providers in most countries have few incentives to report overuse. Third, health-care systems are complex and dynamic;<sup>189</sup> reducing or eliminating overuse of one service or in one site of care could encourage overuse in another, particularly in systems whereby providers are paid a fee-for-service and expect to maintain revenue.

We do know that there has been increased attention among health ministers, clinicians, policy makers and the public, with respect to overuse during the past 5–10 years, particularly in HICs but also in some LMICs. However, awareness of the problem has not automatically led to clinicians delivering the right care. In the USA, for example, concerns about excessive caesarean delivery have existed for decades, however, incidence has continued to rise (from 21% in 1996 to 31% in 2006).<sup>190</sup> Furthermore, despite longstanding concerns regarding the overuse of imaging with CT and MRI, their use increased between 8% and 10% annually from 1996 to 2010.<sup>191</sup>

In LMICs, overuse appears to be increasing, at least for certain services. In Tanzania, rates of caesarean delivery rose from 19% in 2000 to 49% in 2011 among low-risk deliveries,<sup>192</sup> with similar increases over time in India, Nepal, and Bangladesh.<sup>193</sup> Financial incentives and government policies can contribute to increased overuse. In China, government cuts in subsidies led hospitals to charge patients for care,<sup>194,195</sup> potentially contributing to notably high rates of caesarean delivery (46% in one study in a rural area).<sup>196</sup> Amid allegations of physician corruption and kickbacks from the pharmaceutical industry and diagnostic centres, there are reports from India of inappropriate use of drugs, diagnostic tests, and procedures,<sup>197</sup> including strikingly high rates of hysterectomies.<sup>198</sup> These trends appear to be novel and probably reflect increases in overuse over the past decade, but there are few data documenting longitudinal changes.

HICs are experimenting with specific initiatives to address overuse, such as NICE's "do not do" list,<sup>199</sup> attention to low-value practices in Australia,<sup>5</sup> and the Choosing Wisely campaign (<http://www.choosingwisely.org/>).<sup>200</sup> However, there are few studies in either HICs or LMICs addressing the impact of such initiatives. Additionally, EHRs, which have been used as a tool to reduce overuse locally,<sup>201</sup> could be used more broadly in the future. The fourth paper in this Series<sup>15</sup> reviews efforts around the world to reduce overuse.

### Conclusion

There is strong evidence for the widespread overuse of several specific medical services in many countries, suggesting that overuse is common around the world and might be increasing. However, this paper highlights a key challenge: measuring overuse and developing robust evidence for its prevalence in health services and patient populations. There is a clear need for a research agenda to develop such evidence.<sup>13</sup> Overuse is likely to cause harm to both patients and health-care systems and thus, physicians, politicians and policy makers in both HICs and LMICs must understand overuse and act to reduce it.

#### Contributors

All authors participated in the development of the report, including conception, provision of data and references, writing of the manuscript, revision of the draft, and approval of the final version. SB and DK wrote drafts, which were improved and revised by all other authors. KeC developed figure 2.

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