

An echo to Choosing Wisely® in Switzerland

Lionel Chok
Johann Debrunner
Sandra Jaeggli
Karmen Kusic
Esther B Bachli

Department of Internal Medicine,
Medical Clinic, Hospital Uster, Uster,
Switzerland

Background: Inspired by the US Choosing Wisely®, in 2016 the Swiss Society of General Internal Medicine released a list of five treatments or diagnostic tests used in the hospital and considered unnecessary based on not improving patient care and adding to health care costs. These “Smarter Medicine” recommendations were implemented in the Department of Internal Medicine, Uster Hospital, in August 2016. They were supported by lectures and weekly email communications. We analyzed the number of blood draws before and after implementation of the recommendation aimed at reducing blood tests.

Methods: This retrospective analysis was conducted in the Department of Internal Medicine, Uster Hospital, Canton of Zurich, Switzerland. Patients hospitalized in the 3 months before and after implementation were analyzed.

Results: A total of 2023 hospitalizations were analyzed. There was a significant decrease in the number of blood draws after introduction of the recommendation: before implementation, the median number of blood draws per patient was 4 (interquartile range [IQR], 2–7); after implementation, the median was 4 (IQR, 2–6; $P = 0.002$). Indeed, since 46% of the patients in the first group had more than four blood tests, this ratio decreased to 39% after implementation.

Discussion: Inappropriate blood draws may lead to anemia, patient discomfort and false-positive results. The simple and low-cost interventions used to implement “Smarter Medicine” have changed physician behavior by reducing the number of blood orders. These results are promising. Whether such recommendations will impact patient and clinical outcomes remains unknown; hence, further studies are needed to clarify this issue.

Keywords: health care costs, medical societies, medicine, phlebotomy, primary health care, Switzerland

Introduction

The US Choosing Wisely® campaign was launched in 2012 by the American Board of Internal Medicine Foundation to reduce the overuse of medical resources. Up to 70 specialty societies released about 400 recommendations to reduce unnecessary diagnostic tests and therapeutic measures.^{1,2} They were made public to physicians, patient organizations and media, allowing medical professionals and patients to engage in open discussions about the need for wise and effective diagnostic or treatment procedures.³ National initiatives were already adopted in Europe, including the United Kingdom (“Choosing Wisely UK”), Germany (“Klug Entscheiden”), Italy (“Slow Medicine”) and Wales (“Choosing Wisely Wales”).^{4–10} In January 2017, the European Federation of Internal Medicine (EFIM) launched an European “Choosing Wisely” project in order to assess the applicability of such recommendations for its member countries.¹¹

Correspondence: Lionel Chok
Department of Internal Medicine, Medical
Clinic, Hospital Uster, Brunnenstrasse 42,
8610 Uster, Switzerland
Tel +41 44 911 1281
Fax +41 44 911 1360
Email lionel.chok@usz.ch

There is also an increasing concern in Switzerland about the waste of resources on unnecessary care, since Swiss health care costs grow by ~3.9% every year and consume about 11% of the Swiss gross national product, compared to 17.8% in the US in 2015, with a yearly growth of ~5%.^{12,13}

In May 2016, inspired by the US Choosing Wisely campaign, the Swiss Society of General Internal Medicine (SSGIM) released a list of five treatments or diagnostic tests relevant to the hospital setting that were considered unnecessary, since they did not improve patient care but did contribute to health costs.^{14–17} A consensus of committee members of the SSGIM together with Swiss specialists in General Internal Medicine was reached, based on an international literature review for low-value recommendations. The Swiss campaign has been called “Smarter Medicine”. These five “Smarter Medicine” recommendations include diagnostic measures (“Don’t order blood tests at regular intervals [such as every day] or routine extensive lab panels including X-rays without specific clinical questions”) and therapeutic measures (“Don’t place, or leave in place, urinary catheters for incontinence, convenience or monitoring of output for non-critically ill patients. Don’t transfuse more than the minimum number of red blood units necessary to relieve symptoms of anemia or to return a patient to a safe hemoglobin range. Don’t let older adults lie in bed during their hospital stay; in addition, individual therapeutic goals should be established considering the patients’ values and preferences. Don’t use benzodiazepines or other sedative-hypnotics in older adults as first choice for insomnia, agitation or delirium and avoid prescription at discharge.”) regularly provided to the inpatients.^{14,15}

In August 2016, we implemented the recommendations in the inpatient sector of our Department of Internal Medicine, Uster Hospital, situated in the Canton of Zurich. The recommendation implementation targeted primary physicians. First, the Medical Director presented in an educational lecture to interns, trainees and consultants the five “Smarter Medicine” recommendations and focused on one: avoiding unnecessary blood draws. Consequences of overuse of blood draws such as patient discomfort, false-positive results and anemia were presented.¹⁸ Second, chief physicians and consultants highlighted the five “Smarter Medicine” recommendations during patient visits, where nurses were also involved in discussions about these recommendations. Finally, recommendation implementation was supported by weekly emails from Medical Director to the medical team of the Department. Emails restated the “Smarter Medicine” message and recommended

that blood tests be conducted only if “results were expected to have therapeutic or diagnostic consequences”.

The effect of such recommendations has been controversial since it is based on expert consensus rather than patient-oriented evidence.¹⁹ A recent analysis of claims data (billing codes) identified a reduction of only two of the seven “low-value service” measures after Choosing Wisely was released in the US.²⁰

The primary aim of our study was to assess whether the number of blood draws decreased after implementation of the “Smarter Medicine” recommendations in our Department. A secondary aim was to analyze whether the “Smarter Medicine” recommendations reduced the volume of blood drawn during hospitalization.

Methods

Study design and setting

This analysis was conducted in the Department of Internal Medicine at Uster Hospital, a secondary care hospital in the Canton of Zurich, Switzerland. The Department of Internal Medicine provides about 100 beds and treats about 4000 hospitalized patients a year. In December 2016, to early determine whether the introduction of “Smarter Medicine” in our Department led to a change in physician behavior, we decided to analyze the patient population with respect to the number and volume of blood draws in the 3 months before (May 9 to August 8, 2016) and after (August 9 to November 8, 2016) implementation. Interns are usually engaged for 2 years, and rotations at the acute bed units may occur many times during engagement and last 1–3 months. Thanks to this high report rhythm, training profile of interns and confidence in decision-making were expected to be similar before and after recommendation implementation.

Study objectives

The primary objective was to analyze the effect of the implementation of one of the “Smarter Medicine” recommendations. We evaluated whether the implementation of the recommendation “Do not order blood tests at regular intervals (such as every day) or routine extensive laboratory panels without specific clinical questions” led to a reduction in the number of blood draws per patient. A secondary aim was to analyze whether this recommendation led to a decrease in the volume of blood drawn.

Data

Data on hospitalizations to the Department of Internal Medicine are anonymously recorded for quality control and quality

improvement by the Department, that is, without personal information such as name, case number or date of birth. For this study, a subset of data containing demographics and clinical information related to blood tests was extracted from the database. It contained 1) age in years, 2) gender, 3) length of hospital stay, 4) number of blood draws and 5) number of blood tubes ordered per hospitalization and analyzed in the hospital laboratory.

One blood order by a physician was defined as one blood draw in the study analysis. In the hospital's informatic ordering system, one blood order (i.e. one blood draw in the analysis) can include the examination of many blood parameters and thus can result in the drawing of many blood tubes. Blood orders to external laboratories (mostly viral serology, immunologic parameters, protein electrophoresis, immunofixation, etc.) appear in the hospital informatic system. However, at the time of data analysis, it was not possible to determine the number of external blood orders, since external blood orders and other external orders (special urine analysis, puncture material, etc.) are grouped together. We thus excluded orders to external laboratories from the analysis. Blood gas analysis was also excluded since practitioners are not required to order blood gas analysis via the informatic system. In this manuscript, a "blood test" is synonymous with a "blood draw".

Blood volume drawn per hospitalization was defined as the number of blood tubes drawn per hospitalization multiplied by the requested blood volume per tube (e.g., serum chemistry, serum immunohematology, ethylenediaminetetraacetic acid, citrate, heparin, blood culture bottle).

In compliance with Swiss legislation governing human research, informed consent was not needed since data used were anonymous. According to the Federal Act on Research Involving Human Beings (Human Research Act [HRA] of September 30, 2011, Status as of January 1, 2014, Art. 2 Abs. 2 lit. c) and the Canton ethics committee, study approval by the ethics committee was not mandatory since data were anonymous and analysis was retrospective.^{21,22} This retrospective single-center observational analysis complies with the current version of the Declaration of Helsinki and the national legal and regulatory requirements.

Statistics

Datasets were analyzed using the SPSS 23 software package (SPSS Inc., Chicago, IL, USA). Microsoft Office 2010 (Microsoft Corporation, Redmond, WA, USA) was used for data editing and presentation. There were no missing data. Patient characteristics were presented by descriptive statistics.

The heterogeneity between the two groups was assessed using Chi-square and Mann–Whitney *U* tests. The distribution of the number of blood tests was analyzed using a Kolmogorov–Smirnov test. Differences in the number of blood draws and the blood volume before and after the "Smarter Medicine" recommendation was implemented were analyzed using a Mann–Whitney *U* test.

Results

Baseline characteristics

Between May 9 and November 8, 2016, a total of 2023 patients were admitted to the Department of Internal Medicine at the Uster Hospital (Table 1). Of these, 997 patients were hospitalized within the 3 months before (May 9 and August 8, 2016) and 1026 after (August 9 to November 8, 2016) the recommendation was implemented. There was no statistical difference in age ($P = 0.54$) and gender ($P = 0.29$) distribution. We observed a slightly longer, but not significant, length of hospital stay in the first group (median 6 days; IQR, 4–11) than in the second group (median 6 days; IQR, 3–10; $P = 0.06$).

Number of blood draws per hospitalization

A Kolmogorov–Smirnov test demonstrated that the distribution of blood tests was right skewed and was not normal ($P < 0.001$). Skewness was measured as 4.9. Thus, to test whether implementation of the "Smarter Medicine" recommendation impacted the number of blood tests per patient, we used the nonparametric Mann–Whitney *U* test (Figure 1). We demonstrate that there was a significant decrease in the number of blood draws after recommendation implementation on August 9, 2016 (median number of blood tests per patient in the first group, 4 [IQR, 2–7]; median number per patient in the second group, 4 [IQR, 2–6]; $P = 0.002$) (Table 2 and Figure 1). At this point, it is relevant to recall that the Mann–Whitney *U* test does not only compare medians but also, and especially, compare variations in spread.²³ Although 4 is the central value of dispersion in the two groups, 46% of the population (457 patients) had more than four blood tests before "Smarter Medicine" implementation, and this was reduced to 39% (401 patients) in the second group, after "Smarter Medicine" implementation (Table 2). Alternatively, analysis of the quartiles shows that seven or less blood draws were made in 75% of the hospitalizations before August 8, 2016, and six or less were made for the same proportion of the population after implementation of the recommendation.

Table 1 Population characteristics

Characteristics	All patients (n = 2023)	Patients before implementation (n = 997, 49.3%)	Patients after implementation (n = 1026, 50.7%)	P
Demographics				
Age, median (IQR)	71 (55–82)	72 (54–82)	71 (55–82)	0.54 ^a
Gender (female), n (%)	1007 (49.8)	484 (48.5)	523 (51)	0.29 ^b
Clinical features				
Hospitalization days, median (IQR)	6 (3–10)	6 (4–11)	6 (3–10)	0.06 ^a

Notes: ^aP-value calculated using Mann–Whitney *U* test. ^bP-value calculated using Wald Chi-square test.

Abbreviation: IQR, interquartile range.

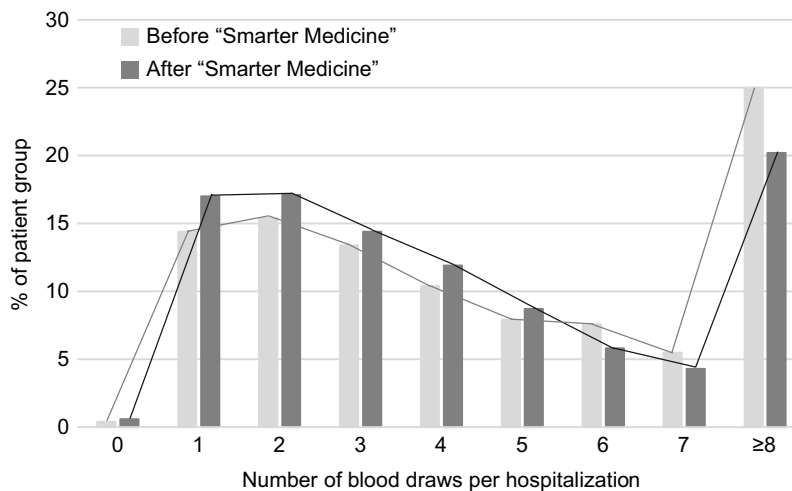


Figure 1 Number of blood draws per hospitalization.

Notes: The histogram shows how the blood draws per hospitalization were distributed across the two patient groups, before (light gray) and after (dark gray) implementation of the “Smarter Medicine” recommendation. There is a significant decrease in the number of blood draws after recommendation implementation; $P = 0.002$ (Mann–Whitney *U* test).

Volume of blood drawn per hospitalization

Blood volume drawn during each hospitalization was also tested by the Mann–Whitney *U* test, since distribution of blood volume toward population was not normal based on skewness (5.4) and Kolmogorov–Smirnov test ($P < 0.001$). The volume of blood drawn during hospitalization was significantly lower after the recommendation was implemented (median blood volume, 56 mL per patient; IQR, 27–99) compared with the 3 months before (median, 65 mL; IQR, 28–108; $P = 0.01$) (Table 2 and Figure 2).

Detailed number of blood tubes drawn and volume of blood drawn according to the type of blood tubes are shown in Table S1.

Discussion

The aim of this study was to analyze whether implementation of the “Smarter Medicine” recommendations had in fact reduced blood tests without specific question in patients hospitalized in

acute care at a Swiss secondary hospital. We found a significant reduction in the number of blood draws during hospitalizations after the recommendation was implemented. Similarly, the volume of blood drawn was also reduced.

“Smarter Medicine” recommendations were recently released, and the impact of the campaign in Switzerland has not yet been studied. Although the US Choosing Wisely campaign was released in 2012 and widely covered in consumer publications and medical journals reaching millions of patients and physicians, the effect of the recommendations on patient care and resource consumption remains unclear.² Choosing Wisely campaign initiators recognized that emphasis was made on the recommendations rather than on measurements of changes after implementation of the recommendations.²⁴ After the campaign was launched, specialty societies and health care providers were encouraged to report on the campaign’s impact on behaviors. We conducted our analysis of the impact of “Smarter Medicine” in our hospital at an early stage of implementation.

Table 2 Outcomes of "Smarter Medicine" recommendation implementation

	Patients before implementation (n = 997, 49.3%)	Patients after implementation (n = 1026, 50.7%)	P
Blood draws			
Median per patient (IQR)	4 (2–7)	4 (2–6)	0.002 ^a
Patients with four or less blood withdrawals, n (%)	540 (54)	625 (61)	
Patients with more than four blood withdrawals, n (%)	457 (46)	401 (39)	
Blood volume (mL)			
Median per patient (IQR)	65 (28–108)	56 (27–99)	0.01 ^a

Note: ^aP-value calculated using Mann-Whitney U Test.

Abbreviation: IQR, interquartile range.

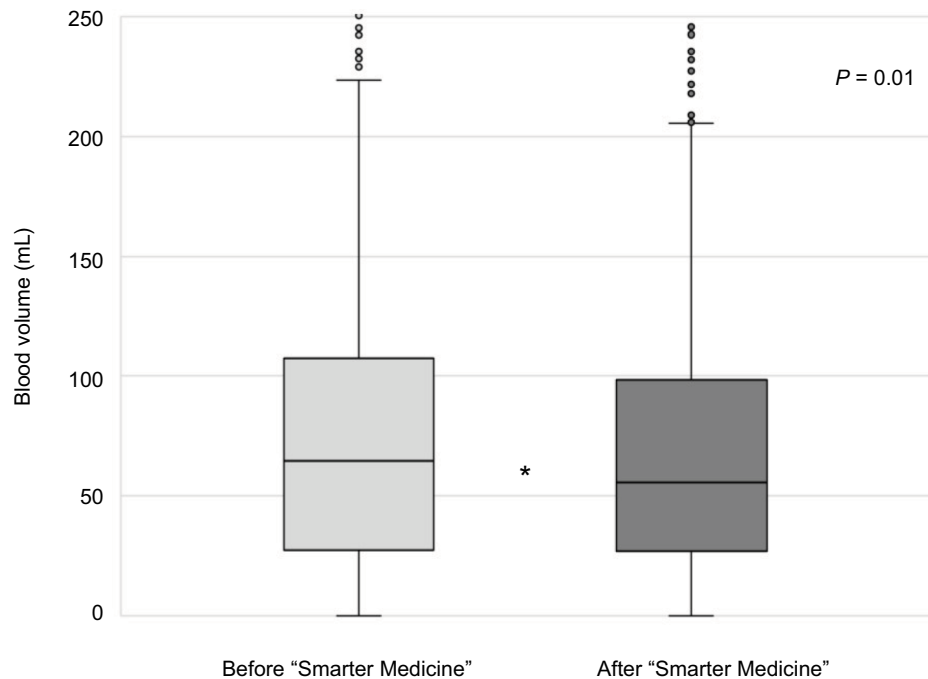


Figure 2 Distribution of blood volume drawn per hospitalizations.

Notes: The box plot represents the volume of blood drawn per hospitalization before (light gray) and after (dark gray) implementation of the "Smarter Medicine" recommendation. *Significant difference before and after implementation; $P = 0.01$ (Mann-Whitney U test). Values above 250 mL are not shown.

Although we could show that physician behavior can be changed by simple interventions, the impact of the recommendation on health care remains to be clarified. We found a significant reduction in the number of blood draws in the 3 months after implementation began. Since 46% of the patients had more than four blood draws in the 3 months before commencement of the campaign on August 9, 2016, only 39% of the population had more than four blood tests after intervention. Since inappropriate blood draws may lead to patient discomfort and false-positive results with referral for unnecessary further investigations, the observed reduction may have a clinical relevance.^{18,25} In addition to the reduction in the number of blood draws, there was a reduction in the volume of blood drawn. The absolute difference of blood

volume drawn before (65 mL) and after (56 mL) recommendation implementation was relatively small and may not impact on clinical outcome. Indeed, our analysis was not designed to report on patient-related outcomes.

This limitation highlights the relevance of the "Smarter Medicine" recommendations. In the US, the strength of the Choosing Wisely recommendations has been controversial. Lin and Yancey¹⁹ applied the Strength of Recommendation Taxonomy (SORT) system to 229 Choosing Wisely recommendations likely to be relevant in primary care.²⁶ Of these recommendations, 43 (19%) were rated as SORT level of evidence A, a consistent and good-quality patient-oriented evidence. However, the remaining 181 recommendations (81%) were rated as level B or C, that is, based on inconsis-

tent or limited-quality patient-oriented evidence, consensus, usual practice, opinion, disease-oriented evidence or case series. As a result, the authors concluded that the majority of the recommendations were based on expert consensus and disease-oriented evidence.¹⁹ As described before, Swiss recommendations are also based on an expert consensus.

The reduction in unnecessary blood tests supported by “Smarter Medicine” also aims at removing resource wasting without harming the patients. Similar interventions reducing the number of blood draws at the Johns Hopkins University led to a cost reduction of \$6.33 per patient day.²⁷ Reduction of blood draws in Swiss hospitals may also decrease resource waste. This, however, will depend on the extent of the implementation of the recommendations. A recent US study identified only modest decline of “low-value” services after Choosing Wisely Implementation.²⁰ Furthermore, unexpected effects of “Smarter Medicine” cannot be excluded. Establishment of study protocols aimed at analyzing the impact of the “Smarter Medicine” recommendations on health care costs and patient outcomes would probably need substantial data and resources.

Our analysis has some limitations. First, this study was an observational retrospective analysis and does not assess clinical outcomes such as patient satisfaction, blood transfusions, comorbidity or mortality. Second, the analysis was based on an anonymous database without clinical information. Thus, analysis did not consider clinical severity, diagnoses or comorbidities, which have an influence on the number and type of blood tests needed during hospital stay. Further biases such as seasonal effects, workload of the interns and variations in individual experience and in decision-making ability are not excluded. Although confidence in decision-making improves during training, we expected the two groups of interns to be comparable, due to the high-rotation rhythm on the acute care units. Finally, strategies based on educational intervention alone may not be sustainable.²⁸ We decided to analyze the number of blood tests 3 months after the implementation began to assess early on whether the “Smarter Medicine” recommendations has had an impact. This led to a relative short period of observation; further analyses are needed to confirm long-term changes in practice.

In a world of rising concern about health care costs and waste, the “Smarter Medicine” recommendations highlight the overuse of tests and treatments in General Internal Medicine and aim to engage patients and practitioners in discussion about provision of care. To our knowledge, this is the first study to assess the impact of a “Smarter Medicine”

recommendation in a Swiss hospital. Using simple, didactic and low-cost interventions, we selected one recommendation and found a significant reduction in the number of blood draws after its implementation.

Acknowledgment

The authors thank Cheryl Pech, PhD, for editing the manuscript.

Disclosure

The authors report no conflicts of interest in this work.

References

1. American Board of Internal Medicine Foundation. Choosing Wisely®. Philadelphia: American Board of Internal Medicine Foundation; 2017. Available from: <http://www.choosingwisely.org>. Accessed December 13, 2016.
2. Wolfson D, Suchman A. Choosing Wisely®: a case study of constructive engagement in health policy. *Healthc (Amst)*. 2016;4(3):240–243.
3. Born KB, Coulter A, Han A, et al. Engaging patients and the public in Choosing Wisely. *BMJ Qual Saf*. 2017;26(8):687–691.
4. Malhotra A, Maughan D, Ansell J, et al. Choosing Wisely in the UK: reducing the harms of too much medicine. *Br J Sports Med*. 2016;50(13):826–828.
5. Academy of Medical Royal Colleges. Choosing Wisely UK. London: Academy of Medical Royal Colleges; 2017. Available from: <http://www.choosingwisely.co.uk/>. Accessed July 7, 2017.
6. Hasenfuß G, Märker-Hermann E, Hallek M, Sieber CC, Fölsch UR. Klug entscheiden - evidenzbasiert. [Choosing Wisely-evidence-based]. *Internist (Berl)*. 2017;58(6):525–526. German [with English abstract].
7. Deutsche Gesellschaft für Innere Medizin e.V. Klug entscheiden [Decide wisely]. Wiesbaden: Deutsche Gesellschaft für Innere Medizin e.V.; 2017. Available from: https://www.dgim.de/fileadmin/user_upload/PDF/Publikationen/Klug_entscheiden/Sammelband_Klug_Entscheiden.pdf. Accessed July 24, 2017. German.
8. Slow Medicine. Measured. Respectful. Equitable. Torino: Slow Medicine; 2017. Available from: https://www.slowmedicine.it/pdf/MANIFESTO/Manifesto_ENG.pdf. Accessed July 7, 2017.
9. Academy of Medical Royal Colleges in Wales, Board of Community Health Councils in Wales, Public Health Wales. Making choices together. Wales: Choosing Wisely Wales Partnership; 2017. Available from: <http://www.choosingwisely.wales.nhs.uk/home>. Accessed July 7, 2017.
10. Malhotra A, Maughan D, Ansell J, et al. Choosing Wisely in the UK: the Academy of Medical Royal Colleges’ initiative to reduce the harms of too much medicine. *BMJ*. 2015;350:h2308.
11. European Federation of Internal Medicine. EFIM Choosing Wisely. Brussels: European Federation of Internal Medicine; 2017. Available from: <https://www.efim.org/about/efim-choosing-wisely>. Accessed July 17, 2017.
12. Eidgenössisches Departement des Innern (EDI) – Bundesamt für Statistik (BFS) – Schweizerische Eidgenossenschaft. Gesundheitsstatistik 2014 [Health statistics 2014]. Neuchâtel: Bundesamt für Statistik (BFS); 2014. German.
13. Martin AB, Hartman M, Washington B, Catlin A; National Health Expenditure Accounts Team. National Health Spending: faster growth in 2015 as coverage expands and utilization increases. *Health Aff (Millwood)*. 2017;36(1):166–176.
14. Swiss Society of General Internal Medicine. Smarter medicine. Bern: Swiss Society of General Internal Medicine; 2017. Available from: <http://www.smartermedicine.ch>. Accessed December 13, 2016.

15. Swiss Society of General Internal Medicine. Smarter medicine recommendations. Bern: Swiss Society of General Internal Medicine; 2017. Available from: http://www.smartermedicine.ch/fileadmin/user_upload/Adaptionen/smartermedicine/Dokumente/Listen_Flyer_neu/Smarter-Medicine_Flyer_ENG_web300.pdf. Accessed March 25, 2018.
16. Selby K, Gaspoz JM, Rodondi N, et al. Creating a list of low-value health care activities in Swiss primary care. *JAMA Intern Med.* 2015;175(4):640–642.
17. Gaspoz JM. Smarter medicine: do physicians need political pressure to eliminate useless interventions? *Swiss Med Wkly.* 2015;145:w14125.
18. Alonso-Cerezo MC, Martin JS, Garcia Montes MA, de la Iglesia VM. Appropriate utilization of clinical laboratory tests. *Clin Chem Lab Med.* 2009;47(12):1461–1465.
19. Lin KW, Yancey JR. Evaluating the Evidence for Choosing Wisely™ in primary care using the strength of recommendation taxonomy (SORT). *J Am Board Fam Med.* 2016;29(4):512–515.
20. Rosenberg A, Agiro A, Gottlieb M, et al. Early trends among seven recommendations from the Choosing Wisely Campaign. *JAMA Intern Med.* 2015;175(12):1913–1920.
21. Federal Act on Research Involving Human Beings (Human Research Act, HRA) of 30 September 2011 (Status as of 1 January 2014). The Federal Assembly of the Swiss Confederation.
22. Department of Health of the Canton of Zurich, Zurich Ethics Committee. FAQ. Zurich: Canton of Zurich; 2017. Available from: https://kek.zh.ch/internet/gesundheitsdirektion/kek/de/fragen_antworten.html#title-content-internet-gesundheitsdirektion-kek-de-fragen_antworten-jcr-content-contentPar-textimage_7. Accessed December 21, 2017.
23. Hart A. Mann-Whitney test is not just a test of medians: differences in spread can be important. *BMJ.* 2001;323(7309):391–393.
24. Wolfson D, Santa J, Slass L. Engaging physicians and consumers in conversations about treatment overuse and waste: a short history of the choosing wisely campaign. *Acad Med.* 2014;89(7):990–995.
25. Verstappen WH, van der Weijden T, Sijbrandij J, et al. Effect of a practice-based strategy on test ordering performance of primary care physicians: a randomized trial. *JAMA.* 2003;289(18):2407–2412.
26. Ebell MH, Siwek J, Weiss BD, et al. Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. *Am Fam Physician.* 2004;69(3):548–556.
27. Thakkar RN, Kim D, Knight AM, Riedel S, Vaidya D, Wright SM. Impact of an educational intervention on the frequency of daily blood test orders for hospitalized patients. *Am J Clin Pathol.* 2015;143(3):393–397.
28. Eaton KP, Levy K, Soong C, et al. Evidence-based guidelines to eliminate repetitive laboratory testing. *JAMA Intern Med.* 2017;177(12):1833–1839.

Supplementary material

Table S1 Number of blood tubes drawn and volume of blood drawn according to the type of blood tubes

	All patients (n = 2023)	Patients before implementation (n = 997, 49.3%)	Patients after implementation (n = 1026, 50.7%)
Number of blood tubes drawn (median, mean per patient)			
Total	36,449 (12, 18)	18,685 (14, 19)	17,764 (12, 17)
Serum chemistry	10,430 (4, 5)	5344 (4, 5)	5086 (3, 5)
Ethylenediaminetetraacetic acid	10,404 (3, 5)	5419 (4, 5)	4985 (3, 5)
Citrate	8217 (2, 4)	4283 (2, 4)	3934 (2, 4)
Heparin	2164 (1, 1)	1051 (1, 1)	1113 (1, 1)
Blood culture	4344 (0, 2)	2154 (0, 2)	2190 (0, 2)
Immunohematology	801 (0, 0)	380 (0, 0)	421 (0, 0)
Serology	17 (0, 0)	11 (0, 0)	6 (0, 0)
Erythrocyte sedimentation rate	72 (0, 0)	43 (0, 0)	29 (0, 0)
Volume of blood drawn according to blood tubes (mL) (median, mean)			
Total	169368 (60, 84)	85,337 (65, 86)	82,120 (56, 81)
Serum chemistry (5 mL ³)	52,150 (20, 26)	26,720 (20, 27)	25,430 (15, 25)
Ethylenediaminetetraacetic acid (3 mL)	31,212 (9, 15)	16,257 (12, 16)	14,955 (9, 15)
Citrate (3.5 mL)	28,760 (7, 14)	14,991 (7, 15)	13,769 (7, 13)
Heparin (4 mL)	8656 (4, 4)	4204 (4, 4)	4452 (4, 4)
Blood culture (10 mL)	43,440 (0, 21)	21,540 (0, 22)	21,900 (0, 21)
Immunohematology (6 mL)	4806 (0, 2)	2280 (0, 2)	2526 (0, 2)
Serology (5 mL)	85 (0, 0)	55 (0, 0)	30 (0, 0)
Erythrocyte sedimentation rate (3.6 mL)	259 (0, 0)	155 (0, 0)	104 (0, 0)

Note: ³Requested volume of blood per tube.

International Journal of General Medicine

Publish your work in this journal

The International Journal of General Medicine is an international, peer-reviewed open-access journal that focuses on general and internal medicine, pathogenesis, epidemiology, diagnosis, monitoring and treatment protocols. The journal is characterized by the rapid reporting of reviews, original research and clinical studies across all disease areas.

Submit your manuscript here: <https://www.dovepress.com/international-journal-of-general-medicine-journal>

Dovepress

The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.