Red blood cell transfusion after a global strategy for early detection and treatment of iron deficiency anemia: three-year results of a prospective observational study

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BACKGROUND: Anemia is the main indication for red blood cell (RBC) transfusion and iron deficiency is the most prevalent, preventable, and treatable cause of anemia worldwide. We aimed to assess the impact of iron deficiency anemia (IDA) on RBC transfusion by means of a program for prevention, early detection, and treatment.

STUDY DESIGN AND METHODS: A prospective observational study was conducted starting in 2014 after an intervention in clinical practice in Melilla, a peripheral city isolated by 207 km sea distance to nearest continental Spain. Recommendations were proposed for first-step diagnosis of iron deficiency in the laboratory, oral iron prevention and treatment in primary care, and intravenous iron complexes and RBC transfusion for hospital management. Reduction in RBC use for years 2014 to 2016 was the primary outcome, with the period 2010 to 2013 considered as baseline performance for statistical analysis.

RESULTS: Compared to baseline, there was a significant (p < 0.05) increase in mean (±SD) yearly reference population (79,748 ± 3265 vs. 85,376 ± 781), ferritin assays (6980 ± 997 vs. 11,794 ± 1567), admissions (6768 ± 239 vs. 7629 ± 191), and subjects exposed to iron therapy (3975 ± 60 vs. 4667 ± 21 for oral, 54 ± 7 vs. 257 ± 109 for sucrose, and 128 ± 9 vs. 176 ± 15 for carboxymaltose iron). Mean yearly number of RBC units transfused decreased (1622 ± 112 vs. 1434 ± 44; p = 0.043), with a mean reduction of 11.6% from baseline, or 21.4% when estimated by units transfused per 1000 admissions.

CONCLUSIONS: Management of IDA is a target to avoid RBC transfusion, and awareness of this health problem should be among the first pillars for any patient blood management program.

P

atient blood management (PBM) is an evidence-based, multidisciplinary approach to optimizing transfusion practice.1 The first pillar of PBM is the appropriate identification and management of anemia, and iron deficiency is the most prevalent, preventable, and treatable cause of anemia worldwide,2,3 at times severe enough to require red blood cell (RBC) transfusion or increase the risk for it.

Iron deficiency anemia (IDA) therefore deserves attention across health care, including clinical laboratory, primary care, emergency, and blood transfusion services, as well as departments involved in occult or overt bleeding investigation and control, such as gastrointestinal and gynecology. Here we show the results of a program to prevent and treat IDA by means of early diagnosis in the laboratory, use of oral iron salts in primary care, intravenous (IV) iron complexes and RBC transfusion within the hospital, and establishing a network for the continuum of care for timely treatment and investigation of its cause.

ABBREVIATIONS: CBC(s) = cell blood count(s); CI = carboxymaltose iron; IDA = iron deficiency anemia; PBM = patient blood management; PU = pharmacy units; SI = sucrose iron.

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Our primary outcome measure was the impact of IDA on RBC transfusion. The study stands on a setting of geographical isolation; limited population; and integrated management of core laboratory, transfusion service, and blood establishment. According to population described, blood supply would easily be provided by larger regional transfusion centers; however, self-sufficiency for availability of safe standard blood components is justified by 207 km sea distance to continental Spain, occasional interruptions of air and sea communications, and bordering land neighborhood.

**MATERIALS AND METHODS**

The program design started in 2013 by means of literature review and assessment of performance, but was formally settled in 2014 with the aim to improve care for IDA patients. Recommendations were released for approval by our physician ethical board and executive management and then spread to primary care and hospital physicians by an educational lecture program and guideline implementation during 2014.

**Setting**

Melilla is a peripheral city of Spain located in North Africa bordering Morocco, with a population of 86,026 citizens in January 2016 resulting of yearly sustained increase from 76,034 citizens in January 2010. Nearly 50% of the population is of Berber origin sharing diet and customs like Morocco, a country with high rates of IDA in childhood and women in childbearing age, related to low bioavailability of iron from dietary sources.4

Health care is mainly provided by public funds, with 16% ± 1% of the population having an independent private coverage for outpatient medical, laboratory, and surgical care and agreements with a public health care organization dependent of Spanish Ministry of Health (INGESA) for inpatient- and transfusion-related care. The public system manages a 172-bed secondary care hospital, a blood establishment, and a hospital transfusion service, as well as a core clinical laboratory for samples within the hospital (outpatient and inpatient), four public primary care centers, and other government facilities.

**Network design and IDA workup**

A representation of gastrointestinal, internal medicine, pharmacy, gynecology, primary care, emergency, executive management, and laboratory and transfusion departments took part in the design of recommendations for system improvement in IDA patient care (Fig. 1). Nonsevere IDA patients should be managed in primary care with oral iron therapy and referred for etiology studies according to age and sex.5-7 We offered a hospital flow of care for severe IDA when hemoglobin (Hb) was less than 8.5 g/dL or less than 7.5 g/dL in children and pregnant women, so that children or adult patients could be assessed in the emergency department (ED) to exclude objective bleeding, consider transfusion therapy, and receive IV iron in the case of adult patients. Patients unstable with heart morbidity or actively bleeding should remain in hospital, and all others were scheduled for IV iron delivery weekly in our day care unit to pursue a safe Hb threshold (>9 g/dL) for gastrointestinal endoscopy studies, particularly colonoscopy, or referred to gynecology or primary care for further follow-up.

**Laboratory diagnosis**

Review of cell blood count (CBC) should detect anemia according to the World Health Organization8 and, using Modulab laboratory information system and delta check assessment, a ferritin assay was requested irrespective of other tests when considered necessary, except for known pregnancy, which was presumed IDA in the first place. A ferritin cutoff of less than 30 ng/mL was considered diagnostic of IDA,9 as well as less than 100 ng/mL in cases of kidney or heart failure or other reasons for functional iron deficiency or inflammation.10,11 A diagnostic comment was added to abnormal CBC results, with a therapeutic advice of oral iron in pregnancy or IV iron for inpatient or ED patients.

**IDA prevention**

Pregnancy was considered a target for primary prevention in the third trimester or earlier when Hb was not more than 12 g/dL at the beginning of pregnancy or not more than 11 g/dL any time during pregnancy.12,13 Secondary prevention with intermittent oral iron supplementation14 was considered for any woman of childbearing age and a history of menorrhagia, after a full cycle of iron therapy to restore Hb level (>12 g/dL) and storage iron (ferritin >30 ng/mL). Secondary prevention with oral or IV iron was also offered to any subject with relapsing IDA after full body iron replenishment and etiology evaluation.

**Oral iron**

Available oral iron salts (ATC code WHO B03A) in Spain include bivalent or ferrous salts (ferrous sulfate, ferrous glycine sulfate, ferrous gluconate, ferrous lactate, and ferrous choline citrate), trivalent or ferric salts (mannitol iron and ferric protein succinylate), and some combinations with folic acid. There are at least 15 commercial names within all active ingredients (seven for ferric salts), with pharmacy costs ranging from 0.11 € × 100 mg elemental iron delivered to the intestinal lumen (ferrous sulfate) to 1.5 € × 100 mg elemental iron delivered (ferric protein succinylate). As our intention was to spread iron therapy to target population, as well as being effective in iron bioavailability and content prescription costs, we established an algorithm where 80 to 100 mg of elemental iron in the
Fig. 1. Flow chart for suggested system performance in IDA management. DCU = day care unit; Emergency D. = emergency department; OI = oral iron; Primary C. = primary care; PE = physical examination. [Color figure can be viewed at wileyonlinelibrary.com]
form of ferrous sulfate daily was the first choice, followed by 100 mg of ferrous glycine sulfate, liquid ferrous gluconate, and ferric salts at last. Liquid formulations were advised for childhood.

**IV iron**
Sucrose iron (SI) was in use before carboxymaltose iron (CI) was approved in our hospital in January 2010, with a restricted use for outpatients requiring large doses of iron. We kept both complexes in our framework, so that SI was mainly used for its rapid delivery of iron to transferrin\textsuperscript{15} and initially treat inpatients or outpatients with severe IDA in the ED and CI for outpatients in our day care unit.

**Transfusion**
RBC transfusion triggers should be based on Hb levels with a threshold value of 7 to 8 g/dL\textsuperscript{16} but considering the nature and chronicity of anemia\textsuperscript{17,18} to drive decisions. Uncertainty in lowering transfusion triggers in recognized IDA was a threat, and we relied on Dutch blood transfusion guidelines\textsuperscript{19} to transfuse chronic stable ambulatory anemia only when there was an absolute indication (Hb < 3 mmol/L or 4.83 g/dL), deciding this threshold to be 5.5 g/dL as far as patients were informed and committed for close follow-up. Our proposal was reinforced during 2014 by recommendations from the AABB\textsuperscript{20} and the Spanish Society of Hematology,\textsuperscript{21} both similarly stating not to transfuse IDA patients without hemodynamic instability.

**Statistical analysis**
We recorded data on yearly population changes, number of RBC units transfused and recipients, admissions, patients treated with oral or IV iron, and number of pharmacy units (PUs) served, where a unit was considered any package containing 800 to 5000 mg of elemental iron in different formulations for oral use or ampoules for IV use of 100 mg SI and 500 mg CI complexes. Most records were available since 2010, and thus comparisons are referred to years 2010 to 2013 as baseline performance and years 2014 to 2016 for study results, except for laboratory data and patients prescribed any oral iron where data are available since 2012 and 2013, respectively, because of limitations on information systems.

The target population was those with a public health care plan as opposed to reference population, which represents official data for census population in January of each year. The impact on RBC use of regular recipients, foreign patients requiring transfusion, and pediatric patients requiring RBC aliquots was not assessed despite increased population. Thus, RBC use refers to total RBC of whole blood units that were expedited yearly by the transfusion service.

Results of means (±SD) for baseline and study period, analysis of variance, analysis of covariance, and linear regression were obtained with computer software (SPSS V22, IBM Corp.). Analysis of covariance, performed by estimated differences in adjusted means through the GLM univariate analysis in SPSS, was used for adjustment of results to population changes as covariate. To avoid confounding factors, we performed a double adjustment: the target population was introduced as covariate for those variables that were predominant or exclusive to this group, such as laboratory activity and prescription of oral iron or CI, respectively, and the reference population as covariate for those that were available to anyone in need, such as admission, inpatient IV SI, RBC transfusion, emergency, delivery, and dialysis. To estimate the projection of RBC use for the study period if no intervention had been in place, we also used regression analysis for monthly RBC transfusion and discharges as independent variable for years 2010 to 2013.

**RESULTS**

**Overall**
There was an increase in both target population (64,683 ± 2416 vs. 71,859 ± 1420; \( p = 0.007 \)) and reference population (79,748 ± 3265 vs. 85,376 ± 781; \( p = 0.035 \)) for study period, with mean increases of 10.8 and 7%, respectively. General laboratory requests, ferritin assays, CBCs, and diagnostic comments significantly (\( p < 0.05 \)) increased and so did subjects exposed to any oral or IV iron therapy, total PUs delivered, and admissions (Table 1). However, there was a stable decline in RBC use per thousand admissions or citizens (Fig. 2).

When these variables were adjusted for changes in target population or reference population, only diagnostic comments (\( p = 0.006 \)), increased number of subjects receiving oral iron (\( p = 0.03 \)), PU delivery of oral iron (\( p = 0.025 \)), and subjects exposed to SI (\( p = 0.021 \)) remained significant. The number of patients receiving CI approached but did not reach significance (\( p = 0.058 \)), and the decline in RBC units use (\( p = 0.001 \)) was more evident after adjustment.

**Oral iron**
We observed an increase of 19.5% in oral PUs delivered for study period (Fig. 3). The mean yearly number of persons being prescribed oral iron for period 2014 to 2016 was 4667 ± 21 for a target population of 71,859 ± 1420 persons (mean, 6.5% of insured population at risk who had a blood test done). Most subjects prescribed oral iron were women of any age range, including 40% for group 15 to 44 years, 14.7% for 45 to 54 years, and 15.4% for older than 75 years old. Beyond menopause (older than 55 years), women more than doubled iron prescription compared to men in
any age range, with mean yearly PUs for years 2014 to 2016: 791 versus 279 for age range 55 to 64, 906 versus 351 for range 65 to 75 and 2278 versus 902 for older than 75 years old. Despite the increased number of oral iron PUs delivered, costs were contained ($90,518/yearly for baseline performance vs. $89,328/yearly for study period).

Fig. 2. Changes in yearly RBC use. (A) Per 1000 nonobstetric admissions (×) and total admissions (○). (B) Per 1000 target citizens (+) and reference citizens (△).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Period*</th>
<th>p value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010-2013</td>
<td>2014-2016</td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Target population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory requests</td>
<td>92,195 (3,572)</td>
<td>107,169 (2,683)</td>
<td>0.012</td>
</tr>
<tr>
<td>Ferritin assays</td>
<td>6,980 (997)</td>
<td>11,794 (1,567)</td>
<td>0.033</td>
</tr>
<tr>
<td>CBCs</td>
<td>49,505 (2,584)</td>
<td>57,193 (1,820)</td>
<td>0.028</td>
</tr>
<tr>
<td>Diagnostic comment</td>
<td>624 (328)</td>
<td>5,142 (491)</td>
<td>0.002</td>
</tr>
<tr>
<td>Subjects† OI</td>
<td>3,975 (NA)</td>
<td>4,867 (21)</td>
<td>0.001</td>
</tr>
<tr>
<td>Subjects† CI</td>
<td>128 (9)</td>
<td>176 (15)</td>
<td>0.003</td>
</tr>
<tr>
<td>PUs OI</td>
<td>12,453 (1,008)</td>
<td>15,297 (408)</td>
<td>0.006</td>
</tr>
<tr>
<td>Reference population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admissions</td>
<td>6,768 (239)</td>
<td>7,629 (191)</td>
<td>0.004</td>
</tr>
<tr>
<td>Subjects SI</td>
<td>54 (7)</td>
<td>257 (7)</td>
<td>0.012</td>
</tr>
<tr>
<td>PUs SI</td>
<td>342 (219)</td>
<td>902 (470)</td>
<td>0.085</td>
</tr>
<tr>
<td>RBC recipients</td>
<td>438 (35)</td>
<td>418 (40)</td>
<td>0.47</td>
</tr>
<tr>
<td>Total RBC use</td>
<td>1,622 (112)</td>
<td>1,434 (44)</td>
<td>0.043</td>
</tr>
</tbody>
</table>

* Data are reported as yearly mean (±SD). Decimals for mean (±SD) have been rounded to units.
† Subjects: exposed to therapy.
‡ Available only year 2013 as reference.
NA = not available; OI = oral iron.
There was a progressive decline in SI use through 2010 to 2013 as CI was introduced. However, it increased since 2014 with the introduction of this iron complex for inpatients, showing a steep and sustained increase for 2015 to 2016 (Fig. 3), with 3.3% admissions receiving SI in 2015 and 4.7% admissions in 2016.

Mean yearly number of patients receiving CI in our day care unit significantly increased for the study period in parallel to a nonsignificant increase in yearly use of 500-mg ampoules (Table 1), with a dose distribution of 40.7% of patients receiving 500 mg, 26.8% 1000 mg, 16.7% 1500 mg, and 16.5% at least 2000 mg. A few patients with chronic obscure gastrointestinal bleeding required double replacement of body iron yearly (>7 g iron) and some RBC transfusion, particularly those receiving anticoagulant or antiplatelet agents for heart conditions. No major adverse events were observed with either complex, although some patients had to switch from CI to SI for intolerance or minor allergic reactions and one patient presented with a severe reversible systemic inflammatory reaction after CI, finally attributed to intramuscular administration.

**RBC transfusion**

Compared to baseline, there was a mean reduction of 11.6% in RBC use in the period 2014 to 2016. This reduction upgraded to 21.4% when RBC units transfused per 1000 discharges were considered (95% confidence interval, 16.1-26.3, by regression analysis of monthly activity for years 2010-2013).

**ED and obstetrics**

Transfusion requests from the ED increased for the study period, although there was a trend toward lower numbers of patients and RBC units transfused (Table 2). When we analyzed RBC use with transfusion requests as covariate (patients with a diagnosis that could potentially need transfusion) the reduction in RBC units transfused became significant (p = 0.009), although not the number of recipients (p = 0.17), suggesting that 1-unit RBC transfusion was a common event.

Assessment of transfusion practice in obstetrics excluded those requests coming from the theater or the intensive care unit because of main obstetric complications; thus, analysis is restricted to transfusion received in the ward for postpartum or postsurgical anemia. There were fewer recipients and RBC units transfused, but the low proportion of subjects transfused in any period (1.5% vs. 0.97%) precluded detection of any significant change (Table 2).

**Dialysis and all other departments**

RBC use showed a reduction for both destinations during the study period. This reduction was only significant when adjusted for reference population in the case of dialysis patients (p = 0.046) and significant whether unadjusted or adjusted in all other departments (Table 2), mainly concerned with medical and surgical admissions.

**DISCUSSION**

Results show that improving IDA management with prevention and early diagnosis, increasing iron delivery to outpatients and inpatients, and keeping our transfusion practice according to guidelines and recommendations may result in a significant decrease in RBC transfusion. In March 2017, the European Commission released guidelines for health authorities and hospitals with the goal to support PBM as a sustainable standard of care across the
European Union. Nonetheless, PBM has been traditionally linked to hospital practices and perioperative anemia and reduces complications in surgical patients, when in fact transfusion is the result of ongoing and chronic processes developing over a long period of time in the vast majority of recipients.

Our early analytical detection with ferritin testing and diagnostic comments have shown to be a valuable tool to start iron therapy without delay, so helping to avoid severe or chronic IDA. Anemia is a first-world health impairment leading to years lost with disability in 2015 with 2.36 billion affected, and IDA is the cause in more than half of all cases, ranking Position 16 among causes of global disability-adjusted life-years. Nevertheless, nutritional iron deficiency in the western world is rare and mostly affects individuals with large physiologic requirements or abnormal pathologic bleeding.

Oral iron therapy is an important pillar for public health to prevent disability caused by IDA and RBC transfusion as a last step. Our strategy has allowed to prevent and identify IDA cases, increasing the number of patients receiving oral iron and number of PUs delivered, and we assume that this is a convenient health outcome for any age group, particularly women in reproductive age and their offspring. This is in contrast to other larger primary care districts in Spain, where a continuous decline in oral iron prescription is observed throughout years 2010 to 2016 (E. Contreras and L. Baró, DS Costa del Sol, personal communication, June 2017). The differential sex prescription pattern observed beyond menopause age must reflect the long-term result of weaker iron stores in women when facing common events in life such as blood donation, surgery, or transient unnoticeable or known gastrointestinal bleeding, which otherwise would not result in IDA in men.

A large part of our population is of Berber origin with fragile dietary iron acquisition, and this could have an extra effect on our results. The prevalence of IDA in our health care system for years 2014 to 2016 may be estimated by our systematic approach to IDA diagnosis in the laboratory and number of patients being prescribed oral iron on target population, resulting in 6.5% of our insured outpatient population. This estimate, with limitations as it is not the result of a field study, compare similarly to age-adjusted prevalence of anemia estimates in Europe (14% ± 2% in men and 20% ± 5% in women), suggesting that similar results may be obtained elsewhere.

Ferrous iron salts such as iron sulfate should be the first choice for IDA treatment, as they are inexpensive and generally effective in restoring iron balance but gastro-intestinal side effects and iron bioavailability is an issue for prescribers, which sometimes tend toward ferric compounds. However, bioavailability of iron should be better with ferrous salts, which do not need reduction to be transported into the enterocyte, and constipation, nausea, and diarrhea, as the most reported gastrointestinal toxicities, are estimated in 12, 11, and 8% of patients receiving iron sulfate, respectively. Thus, nearly 80% of patients will do well with this compound, and this figure may even be higher if an alternate day therapy is used.

There were an increased number of transfusion requests in the ED, with a similar number of recipients and fewer RBC units transfused for the study period. To avoid transfusion in severe IDA, ED physicians must realize that there is a network for close follow-up. Our adult patients received 200 mg of SI, and those with a public health plan were referred to our day care unit as we identify IDA cases, increasing the number of patients receiving iron sulfate, respectively. Thus, nearly 80% of patients will do well with this compound, and this figure may even be higher if an alternate day therapy is used.

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<p>| TABLE 2. Period comparison for transfusion activity in emergency and obstetric departments, as well as RBC use in dialysis and all other departments and p values before and after adjustment for reference population |</p>
<table>
<thead>
<tr>
<th>Variable</th>
<th>Period*</th>
<th>2010-2013</th>
<th>2014-2016</th>
<th>Unadjusted</th>
<th>Adjusted</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total visits</td>
<td>60,178 (2,315)</td>
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<td>62,578 (1,064)</td>
<td>0.16</td>
<td>0.7</td>
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<tr>
<td>Transfusion requests</td>
<td>239 (40)</td>
<td></td>
<td>282 (36)</td>
<td>0.20</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>RBC recipients</td>
<td>159 (25)</td>
<td></td>
<td>160 (13)</td>
<td>0.95</td>
<td>0.074</td>
<td></td>
</tr>
<tr>
<td>RBC use</td>
<td>318 (39)</td>
<td></td>
<td>305 (49)</td>
<td>0.70</td>
<td>0.084</td>
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<tr>
<td>Obstetrics</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Deliveries</td>
<td>2,371 (86)</td>
<td></td>
<td>2,901 (128)</td>
<td>0.001</td>
<td>0.027</td>
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<tr>
<td>Transfusion requests</td>
<td>102 (15)</td>
<td></td>
<td>97 (4)</td>
<td>0.62</td>
<td>0.53</td>
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<tr>
<td>RBC recipients</td>
<td>35 (8)</td>
<td></td>
<td>28 (2)</td>
<td>0.19</td>
<td>0.57</td>
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<tr>
<td>RBC use</td>
<td>71 (15)</td>
<td></td>
<td>52 (4)</td>
<td>0.1</td>
<td>0.5</td>
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<tr>
<td>Dialysis</td>
<td></td>
<td></td>
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<tr>
<td>RBC recipients</td>
<td>76 (24)</td>
<td></td>
<td>69 (13)</td>
<td>0.7</td>
<td>0.046</td>
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<tr>
<td>RBC use</td>
<td>1,156 (76)</td>
<td></td>
<td>1,011 (22)</td>
<td>0.026</td>
<td>0.032</td>
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</table>

* Data are reported as yearly mean (±SD). Decimals for mean (±SD) have been rounded to units.
we were treating 176 patients yearly with CI for a target population of 71,860 for years 2014 to 2016. We used limited CI exposure for otherwise healthy patients with severe IDA to guarantee iron delivery for severity reversal and full iron replenishment for those scheduled for imminent surgery, a diagnosis of gastrointestinal cancer or chronic or obscure bleeding, patients with bowel inflammatory disease or bariatric surgery, and those intolerant or refractory to oral iron.40

The main reduction in RBC use was observed in medical or surgical inpatients, despite similar transfusion triggers for both periods except when IDA was detected. Again, the early detection of IDA before or during admission, and subjects exposed to SI as a surrogate marker, may determine these findings. First, many patients could have started iron therapy and improve their RBC mass before admission, and second, once an alternative treatment to RBC use is identified and applied, transfusion triggers and RBC units transfused tend to lower on hold of response to treatment. Our goal for inpatients with IDA was to treat anemia during admission for a diversity of conditions, including medical, surgical, or obstetric patients and not fully replenish body iron. SI was chosen for this purpose, delivered as 100 mg daily for 2 days in a 72-hour schedule, for a maximum of 600 mg. We pursued that labile iron in the complex could immediately increase transferrin saturation, bypass oral route in gastrointestinal bleeding or surgery, avoid alarm with “black stools” for nursery, and assure iron availability for increasing Hb level to ±1 to 3 g/dL during or after admission.41 This iron complex has been in use for years with proven efficacy and safety in a diversity of conditions, and it may be convenient for inpatients with an IV line or frequent hospital visitors as dialysis patients.42

Obstetric transfusion was also reduced during the study period and compares favorably to data of other registries,43 particularly if we have in mind that more than half of women admitted for delivery during the study period (1685 ± 198 vs. 1089 ± 35) were Moroccan women not following our recommendations for assessment, prevention, and treatment in pregnancy.

We have shown that it is possible to increase oral iron delivery to population without increased costs. For IV iron preparations this is relevant, since pharmacy cost of SI is 16 times cheaper than CI for every 100 mg of iron delivered in our setting. Accordingly, SI should still be considered for short-term IDA treatment in those patients that can replenish body iron after discharge with diet or oral supplements.

Our results add to the evidence that improving RBC mass in the population by means of early detection and treatment of IDA may reduce up to 21% RBC utilization. This may not be an issue for hospitals where the blood supply comes without shortage from an independent responsibility, but it should be an essential pillar for any national or wide-based PBM program where every level of health care must be involved.

An important limitation of our study is the observational character on daily clinical practice, where recommendations implementation is highly dependent on physician’s attitude, commitment, and turnover. We have not measured the result of our intervention on disability, admissions, readmissions, cancer detection, or mortality. However, previous experience and larger studies suggest that reducing the need of blood product utilization may just be a way to improve health outcomes.44 In conclusion, we have shown in clinical practice that our strategy for educational awareness, health promotion, screening for early detection, and timely treatment focused on IDA is an essential part of PBM and may result in a significant decrease in RBC use.

CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

REFERENCES