



## REVIEW

# Home-based blood transfusion therapy: A systematic review

Jesús Rodríguez Corte<sup>1</sup> | Cristina Candal-Pedreira<sup>1,2</sup>  | Alberto Ruano-Ravina<sup>1,2,3</sup> |  
 Mónica Pérez-Ríos<sup>1,2,3</sup> | Alejandro Rivero-de-Aguilar<sup>1,4</sup> | Marisa López García<sup>5</sup> |  
 Leticia Hermida Porto<sup>6</sup> | Leonor Varela-Lema<sup>1,2,3</sup> 

<sup>1</sup>Department of Preventive Medicine and Public Health, University of Santiago de Compostela, Santiago de Compostela, Spain

<sup>2</sup>Health Research Institute of Santiago de Compostela (Instituto de Investigación Sanitaria de Santiago de Compostela - IDIS), Santiago de Compostela, Spain

<sup>3</sup>Consortium for Biomedical Research in Epidemiology and Public Health (CIBER en Epidemiología y Salud Pública/CIBERESP), Madrid, Spain

<sup>4</sup>Neurology Service, University Hospital of the Canary Islands, Tenerife, Spain

<sup>5</sup>Galician Health Service, The Galician Blood and Organ and Donation Agency (ADO), Santiago de Compostela, Spain

<sup>6</sup>Galician Health Service, Home Hospitalisation Unit (HADO), A Coruña University Hospital Complex, Santiago de Compostela, Spain

## Correspondence

Cristina Candal-Pedreira, Department of Preventive Medicine and Public Health, School of Medicine. C/ San Francisco s/n, University of Santiago de Compostela. Postal Code 15782, Santiago de Compostela, Spain. Email: [cristina.candal.pedreira@rai.usc.es](mailto:cristina.candal.pedreira@rai.usc.es)

## Summary

Home care is a healthcare alternative to hospitalisation. Different types of procedures are performed at home care services, such as home transfusion of blood products. However, home blood transfusion is not fully implemented and there is a great lack of knowledge about it. The aims of this study were thus to assess the safety and effectiveness of home blood transfusions and patient acceptance and satisfaction. A systematic literature review was conducted in the main biomedical databases. We included all studies that covered patients who had received a home blood transfusion, regardless of their baseline diagnosis. The literature search yielded 290 studies, 14 of which were included in this study as they met the predefined criteria. The main patient profile of a home-transfusion recipient was a person with anaemia associated with other diseases. Overall incidence of severe adverse events was 0.05%. No studies evaluated the effectiveness of home versus hospital transfusions. One study showed that 51% of patients would be willing to receive home transfusions. Home blood transfusion appears to be a feasible, safe, and well-accepted procedure. Existing studies are of low quality, however, and this is an important limitation when it comes to drawing definitive benefit–risk conclusions.

## KEY WORDS

blood components, blood transfusion, blood transfusion at home, home care service

## INTRODUCTION

Many patients with haematological diseases, cancer or advanced chronic diseases need intermediate or long-term blood product transfusions.<sup>1</sup> These patients are required to regularly attend a hospital or an ambulatory care centre to undergo this procedure. This can be very burdensome, especially for terminal or frail patients that must rely on caregivers for travelling. Home-based blood transfusion therapy can constitute an alternative to conventional hospitalisation for these patients by reducing the disruption which hospital

admission entails for patients and caregivers. With respect to the health system, home care can enable resources to be used sustainably, by avoiding costs of care and unnecessary patient transfers to health centres, always in the interests of enhanced patient comfort and care.<sup>2–5</sup> Mention should also be made of patients' and caregivers' satisfaction with home care, with greater satisfaction being shown by caregivers.<sup>3</sup>

Home blood transfusion can be used in different contexts, as a stand-alone process or as part of home care services. The concept of home care emerged in New York (USA) in 1947, with the initial aim of relieving the overcrowding of hospital wards and ensuring more humane treatment of patients. In

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1951, the first unit was implemented in Europe, specifically at the Tenon Hospital (Paris, France), where it gradually evolved towards attending chronic and terminal patients.<sup>6</sup> Currently, this healthcare model is present in many countries but its application and scope are very uneven.

The profile of patients who are commonly admitted to home care services are those who require oncological and non-oncological palliative care, frail and pluripathological elderly patients, decompensated complex chronic patients, patients with acute infections, and patients with complete postoperative and transitional care, among others.<sup>3,7</sup> In these cases, home care is targeted at ensuring symptomatic control, administration of drugs, and performance of techniques and procedures, both diagnostic and therapeutic. In addition, it can be useful to instruct and teach caregivers and patients about home care, as well as guide processes and decision-making. To this end, different types of catheters, probes, intravenous, oral or subcutaneous drugs are used, and various techniques and procedures performed, such as paracentesis, mechanical ventilation, parenteral nutrition, and transfusion of blood and blood products.<sup>7</sup>

There has been a trend in recent years towards the treatment and management of patients at home. However, transfusion of blood components at home, such as red blood cells (RBC), platelets (PLTs) or plasma, seems to be scarcely implemented due to safety concerns. During transfusion, complications may arise, such as acute haemolysis due to a mismatch of blood types, allergic reactions, and transmission of infectious diseases. The safety of blood transfusion depends both on the blood products and on the safety of the clinical transfusion process, which consists of a number of interconnected steps that include correct indication, collection, transport, handling of the bags, administration of the components, and patient surveillance.<sup>8</sup> This is thus a process which requires quality and safety protocols to ensure optimal performance and outcomes.

Currently, there is scarce evidence regarding home transfusion of blood and blood products, which makes it difficult to ascertain the procedure's potential and whether its implementation in home care services might be beneficial. The main aim of this systematic review was thus to evaluate the safety and effectiveness of the procedure. Second, it also sought to ascertain the degree of acceptance and satisfaction of patients with blood transfusions. To our knowledge, this is the first systematic review to address the topic.

## METHODS

We conducted a systematic review of the literature in accordance with the PRISMA standards (Preferred Reporting Items for Systematic reviews and Meta-Analyses statement)<sup>9</sup> for methodological design, that is protocol, search process, selection and synthesis of results. The search protocol was registered in the PROSPERO database under code no. CRD42021292315.

A comprehensive bibliographic search was made in the leading biomedical databases on 24 October 2021 to retrieve medical literature on all relevant outcomes. Search strategies were developed for Pubmed (Medline), Embase, Cochrane Plus and Dialnet Plus, using the following key words and MesH terms: “home care delivery”, “home hospitalisation”, “hospital at home”, “home care”, “home care service”, “home health nursing”, “blood transfusion”, “blood component transfusion” and “transfusion”, which were combined using Boolean operators. In addition to these databases, we also searched Google Scholar and Research Gate, and screened references cited by the studies included, in order to conduct a search of additional literature.

The eligibility criteria were defined according to the Patient, Intervention, Comparator, Outcome and Study design (PICOS) framework. Our review included all studies which assessed outcomes of patients receiving blood and blood-product transfusions at home, regardless of their baseline diagnosis. To assess acceptability, defined as willingness to undergo home blood transfusion, we included studies that covered patients who had not received blood transfusions at home. In terms of study design, we included systematic reviews, clinical trials, observational studies (cohort, case-control and case series), and cross-sectional studies. Studies that provided a comparison with patients who had received traditional transfusions as well as studies without a comparison group were both considered. To measure effectiveness, increases in haemoglobin per blood unit and improvement in symptomatology (fatigue, weakness, dizzy spells) were assessed; when it came to safety, all transfusion reactions and adverse events were taken into account.

We excluded studies published in journals without peer review, opinion articles, editorials, and single-case studies, and only considered studies published in English, Spanish or French. With regards to acceptability, we excluded studies that focused exclusively on economic aspects or patient preferences. No restrictions were imposed in terms of date of publication.

Data selection and extraction were performed by two independent researchers. After duplicated studies had been removed, titles and abstracts were screened to identify studies that complied with both the PICOS framework and with the inclusion/exclusion criteria. These studies then underwent a full-text review to exclude any study that failed to fulfil the eligibility criteria. In the event of discrepancies between the two researchers, a third researcher was consulted.

The relevant information was extracted using a pre-designed data-extraction sheet which included basic information about the study (author, year of publication, country, sample size), design, follow-up time, patient characteristics (age, sex, race, main diagnosis, transfusion criteria), characteristics of the intervention (transfusion episodes, transfusion components, etc.), outcome variables, and conclusions.

Quality was evaluated by two independent researchers using the Joanna Briggs Institute<sup>10</sup> checklist for case-series and cross-sectional studies. Due to the impossibility of

carrying out a meta-analysis, a descriptive synthesis of the results was made.

This study, as they fulfilled the pre-established criteria. The search strategy is shown in Table S1.

## RESULTS

### Search results

The search results are shown in Figure 1. Our literature search yielded 290 studies, 23 of which were selected for a reading of the full text; of these, 14 were finally included in

### Study characteristics

This systematic review included 13 case-series studies (4 prospective; 8 retrospective; 1 ambispective) and one cross-sectional study. The studies were published across the period 1987–2021, and came from a great variety of countries, namely, USA (1), Scotland (1), United Kingdom (2), Colombia

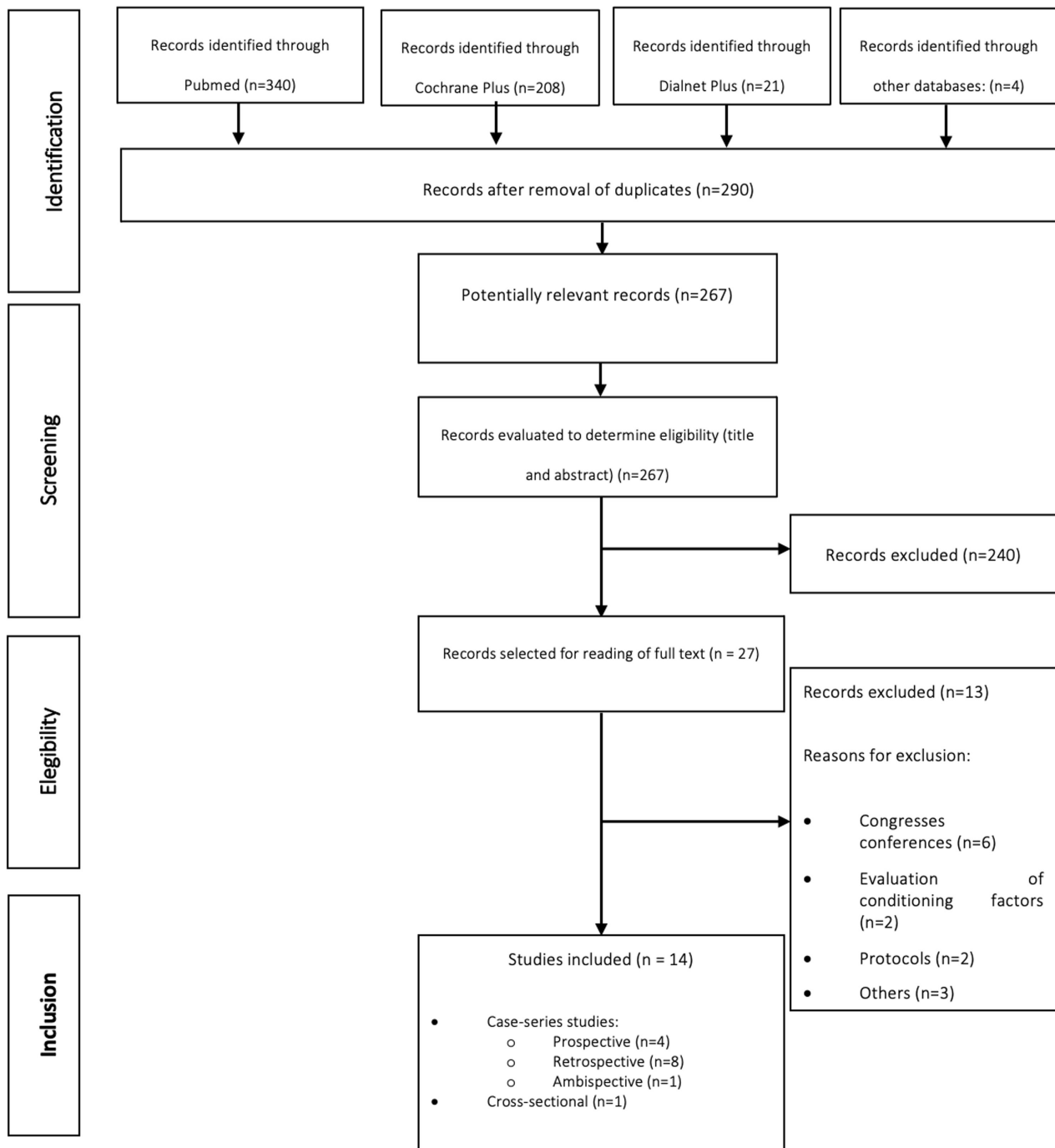


FIGURE 1 Flowchart of study selection

(1), Brazil (1), Sweden (1), Italy (2), France (1), Spain (3) and Australia (1).

Of the studies selected, 12 reported results on the effectiveness and/or safety of blood transfusion recipients with diverse clinical profiles, most notably haematological and oncological diseases. One study assessed patients' concerns about and willingness to undergo a home blood transfusion, while another conducted a survey of haematological patients as regards their desire to receive transfusions at home.

## Study quality

The studies included were of low methodological quality. Among the limitations, mention should be made of the fact that 64% of the case series did not include consecutive patients, and 50% did not provide detailed information about the demographic characteristics of the patients. The cross-sectional study likewise failed to provide detailed information about the study subjects and characteristics of the procedure.

## Description of the population and the transfusion process

The main characteristics of the included studies are shown in Table 1. As can be observed, 12 of the 14 included studies describe individual home blood transfusion experiences. One reports on a nurse-based pilot study implemented in the UK at the national level<sup>11</sup> and another on the results within the palliative research network in Sweden.<sup>12</sup> Overall, studies included a total of 2208 patients who received home blood transfusions, with sample sizes ranging from three to 613 patients. The mean age of the patients ranged from 15.3 years to 85 years. Patients were in all cases selected based on the individual programmes/protocols implemented, which detail patient selection criteria, product pretreatment, staff involvement and adverse event management. Of the included studies, 10 established as a criterion for inclusion having received previous blood transfusions (either at home or in hospital) and/or not having had any serious transfusion reactions. Patients with haematological diseases and tumours were the most common population transfused at home.

The transfusion process was mainly performed by a physician and/or a nurse. In the studies carried out in Italy, Scotland and Colombia the process was overseen by a physician and a trained nurse.<sup>11,13-15</sup> Two of the Spanish studies reported that it was performed by a trained nurse with assistance of a trained family member or caregiver and a physician on call.<sup>16,17</sup> In the French study,<sup>18</sup> the nurse supervised the whole procedure but a physician was also available in case of emergency. Transfusions were nurse-led in studies coming from Sweden,<sup>12</sup> USA,<sup>11</sup> Australia<sup>19</sup> and the UK.<sup>20</sup> One study coming from a hospital in the UK reported on

a programme where family undertook training and transfusion responsibilities.<sup>21</sup> Relatives attended an individually designed resuscitation course and where requested, were taught to insert an intravenous cannula. They also received practical training in setting up the RBC units, monitoring and recording the patient's pulse and temperature and conducting three transfusion episodes in a hospital before attempting the first home blood transfusion. In the Brazilian study, the country legislation requires that a physician is present during the whole transfusion process.<sup>22</sup>

Most of the studies did not indicate what safety measures were taken. Gay et al.<sup>18</sup> stated that the maximum distance between a patient's home to the reference hospital must be 15 km. The same maximum distance was stated by the study conducted by García et al.<sup>17</sup>

RBCs were the most common blood product transfused. The population in eight studies received RBCs and PLTs<sup>11,13,14,16,17,19,22,23</sup>; in five RBC only<sup>12,15,20,21,24</sup> and in one PLTs only.<sup>12</sup> Most of the patients were transfused via peripheral venous catheters or central venous catheters.<sup>11-13,15,16,19,22</sup> Five studies reported transfusing an average of 1–1.6 units of blood products<sup>15-17,22,24</sup> and four  $\geq 2$  units.<sup>11,12,19,21</sup> Eight studies transfused modified blood cell products. Of these, two used leucoreduced blood cells products<sup>13,21</sup>; three leucoreduced and/or irradiated blood cell products<sup>16,17,22</sup>; one leucoreduced and/or washed blood cell products<sup>11</sup>; and two leucoreduced, irradiated and/or washed blood cell products.<sup>15,24</sup>

Regarding the use of pretransfusion medication in the studies, Szterling et al.<sup>22</sup> mentioned that the most frequently used therapeutic agents were acetaminophen, diphenhydramine, hydrocortisone, nifedipine and furosemide. In the study conducted by Craig et al.<sup>13</sup> oral paracetamol was given to patients to reduce the risk of febrile transfusion reactions. García et al.<sup>17</sup> stated that pretransfusion medication was administered in specific cases such as patients with previous transfusions reaction. Tamayo et al.<sup>16</sup> also referred using premedication in 49.3% of the participants, although they did not specify medication type or criteria.

No information exists regarding target post-transfusion haemoglobin. In relation to platelets, only Tamayo et al.<sup>16</sup> refers that the platelet level pretransfusion was between 2000–70 000/ml, and the level post-transfusion was between 2000–320 000/ml.

## Effectiveness of the procedure

No studies were identified which specifically evaluated the effectiveness of home blood transfusions. In the studies retrieved, Martinsson et al.<sup>12</sup> reported that in 68% of patients ( $n = 117$ ) there was an improvement post-transfusion, in 25% ( $n = 44$ ) the improvement was unclear, and in 7% ( $n = 10$ ) it was totally ineffective. However, these values refer both to patients who received blood transfusions at home and to patients who participated in the same study in hospital, thus rendering any assessment impossible.

TABLE 1 Main characteristics and results of the studies included

Author, year, country	Study period	Transfused patients (episodes)	Type of study	Population	Patient characteristics	Main indication	Blood component transfused (units)	Venous access	History of transfusion with no SR	Preparation for transfusion	Management
Crocker KS et al (1990) <sup>11</sup> USA	NR	71 (137 episodes)	P. case series National basis	A. secondary to HIV, cancer, CRD or others.	Mean age: 51 years 72% M	HD (anaemia secondary to other diseases, thrombocytopenia and others). Hb $\leq 100$ g/l and PLT $\leq 20,000/\mu$ l	RBC ( $n = 248$ ); mean units per episode: 1.8) PLTs ( $n = 104$ ); Mean units per episode: 0.8)	PVC ( $n = 17$ ) CVC ( $n = 20$ ) CVP ( $n = 6$ ) Dialysis port ( $n = 28$ )	Yes	Use of leucoreduced and washed blood cell products Premedication of certain patients with previous transfusions	Nurse clinician with learning module on haemotherapy Nursing visit and travel time per transfusion cycle: 8,8 h
Craig et al (1998) <sup>13</sup> SCOTLAND	NR	3 (65 episodes)	Ambi-spective H. case series	MDS	Median age: 71 years 38% M	Patients with regular PLT requirements	PLTs	Venous access or LT CVC	Yes	Platelets depleted (bed-side filtration): paracetamol administered	Nurse under the supervision of a medical officer Time in patient's home: 1 h
Madgwick KV et al (1999) <sup>21</sup> UK	NR	4 (108 episodes)	P.H. case series	$\beta$ -thalassaemia	Mean age: 15.3. Sex: SD	$\beta$ -thalassaemia with weekly transfusion requirements	RBC (278 units) Mean units per episode: 2.6	NR	Yes	Prefiltered red-cell units	Trained family member
Cortés et al (2002) <sup>24</sup> COLOMBIA	1991–1999	51 patients	R. H. case series	IDA, unclassified A., AIF, cancer, H. disease.	Mean age: 48 years Sex: 56% M	Chronic A. (different criteria across 3-year periods)	RBC	NR	Yes	Leucoreduced, irradiated and washed blood cell products in oncologic and immunocompromised patients after 1997	Clinical doctor assisted by a trained nurse Mean time patients' home (2 units): 2–4 h (max 8)
Szerling LN (2005) <sup>22</sup> BRAZIL	July 2001– July 2005	128 (341 episodes)	R. H. case series	A. (56%), malignant disease (30%), MDS (6%), others (8%).	Mean age: 73 years Sex: 43% M	Chronic patients who met home care criteria, with A	RBC and PLTs ( $n = 448$ units; mean units per episode: 1.3)	Venous access	NR	63.6% leucoreduced and irradiated; 35.7% leucoreduced Premedication	Medical assistance by a transfusion physician RBC transfusion time: 1.5–2 h
Martinsson U et al (2008) <sup>12</sup> SWEDEN	Feb 2004	82	P. case series 24 clinics	Malignant disease (87%), non-malignant disease (13%)	Mean age: 68 years Sex: 45% M	Patients admitted to home care services	Erythrocyte and thrombocyte (mean units per patient: 2.9)	52% CVC or SCV; rest PVC	NR	NR	Nurses Mean transfusion time: 1.5 h (0.5–2.5)
Devlin B et al (2008) <sup>20</sup> UK	July 2007	16	R. H. case series	Malignant and non-malignant disease	Age range: 55–89 31% M	Patients with palliative stage of disease who met criteria	RBC	NR	Yes	NR	Trained nurses
Isaia G et al (2010) <sup>14</sup> ITALY	2007	34 patients	R. H. case series	Patients with A. and leukaemia.	Mean age: 80.9 (SD: 9.6). 44.4% M	Symptomatology or haemoglobin $< 8$ /PLTs $< 10,000$	RBC ( $n = 112$ ); mean units per patient: 3.3) PLTs ( $n = 49$ ); mean units per patient: 1.4)	NR	Yes	NR	Physician and nurse specialist in transfusion Mean transfusion time: 1.5–2 h

(Continues)

TABLE 1 (Continued)

Author, year, country	Study period	Transfused patients (episodes)	Type of study	Population	Patient characteristics	Main indication	Blood component transfused (units)	Venous access	History of transfusion with no SR	Preparation for transfusion	Management
Tamayo B et al (2010) <sup>16</sup> SPAIN	1984–2009	458 (2939 episodes)	R. H. case series	HD	6–98 Sex: SD	Symptomatic A. and Hb <80 g/l or PLTs ≤10000/μl	RBC (mean units per episode: 1.7) and PLTs (mean units per episode: 1.5)	RBC: PVC and CVC	Yes	RBC: 969 irradiated; 1057 filtered; PLTs: 267 irradiated, 316 filtered Premedication: 49.3%	Nurses/family or carer trained to identify SR/physician on call
V. Gay et al (2010) <sup>18</sup> FRANCE	2007–2009	3 (3 episodes)	P. H. case series	Prostate cancer, A., heart failure.	Age range: 35–85 67% M	Home care service with palliative care.	NR	NR	NR	NR	Trained nurses
Niscola P et al (2012) <sup>15</sup> ITALY	2006–2010	211 (4980 episodes)	R. H. case series	MDS	Mean age: 85 years 40% M	Hb <8, clinical status and symptoms	RBC ( <i>n</i> = 7766; mean units per episode: 1.6)	PVC and CVC	Yes	Leucoreduced, saline washed or irradiated blood cell products used according to patients needs	Physician assisted by a nurse
García D et al (2018) <sup>17</sup> SPAIN	1985–2015	613 (2126 episodes)	R. H. case series	HD (32%), solid tumours (20%), non-specific A (10%), Infections (9%).	Mean age: 70.55 (SD 19.4) 50.2% M	Patients >14 years, with home care services and transfusion criteria	RBC ( <i>n</i> = 2126; mean units per episode = 1.0) PLTs ( <i>n</i> = 134; mean units per episode: 0.07)	NR	NR	From 2002: RBC leucoreduced and irradiated blood cell products Premedication (38%)	Trained nurse and caregiver, physician is on call Nurse stays during 30 first minutes and comes back once it finishes
Alarcón et al (2018) <sup>23</sup> SPAIN	2016–2017	52 (136 episodes)	Cross-sectional Hospital-based	Palliative and non-palliative oncological and chronic patients	Mean age: 82 Sex: 53% M	Patients who received home blood transfusions	RBC (90.4%), PLTs (1.9%), both (7.7%)	NR	Yes	NR	NR
Sharp R et al (2021) <sup>19</sup> AUSTRALIA	2004–2019	533 (1790 episodes)	R. H. case series	Cancer, A., IB, CKF, iron deficiency	Mean age: 82. 906 W	Patients who received home blood transfusions	RBC ( <i>n</i> = 3067, mean units per episode: 1.7), PLTs ( <i>n</i> = 157; mean units per episode: 0.09)	PICC (193), PVC (1577), TIVD <sup>20</sup>	Yes	Preparation of cells NR Planned medication (1201)	Trained registered nurses

Abbreviations: A, anaemia; AIF, acute intestinal failure; Alb, albumin; CKF, chronic kidney failure; CVC, central venous catheter; CVP, central venous port; H, hospital; Hb, haemoglobin; HD, haematological disease; IB, Intestinal bleeding; IDA, iron deficiency anaemia; LT, long term; M, men; MDS, myelodysplastic syndrome; NR, not reported; P, prospective; PICC, peripherally central catheter; PLTs, platelets PVC, peripheral vein catheter; R, retrospective; RBC, red blood cells; SCV, subcutaneous central venous; SR, severe reaction; TIVD, totally implantable vascular device; W, Wome.

## Safety of the procedure

Of the 12 studies that evaluated the safety of home blood transfusions, six (50%) recorded some type of adverse reaction. These six studies included 1943 patients. The most common safety issues were device-related adverse events and non-haemolytic febrile transfusion reaction (NHFTRs), characterised by a rise in temperature of more than 1°C, along with chills. Other mild reactions recorded were skin rash, hypotension and dyspnoea. All mild reactions were efficiently managed at the individual's home in accordance with existing protocols for management of transfusion complications. These protocols contemplate that if a reaction is suspected, blood transfusion should be discontinued, patient's vital signs monitored and the physician informed. If severe reactions are ruled out, the transfusion can be restarted at a slow rate, with appropriate symptomatic treatment and direct observation. If the contrary, the transfusion

is stopped and the component returned to the blood bank for analysis. Tamayo et al. notified that 12 transfusions were stopped (0.8%) but patients did not require hospital admission. Follow-up information is lacking for these patients.

Of the total of adverse reactions, six severe reactions were reported, accounting for 0.05% of total home blood transfusions. Sharp et al. notified five severe reactions, of which four required hospital care and one was described as an allergic reaction to a platelet concentrate, which could be managed at home. Whilst the diagnosis for these severe reactions was unavailable, the authors reported that most appeared to be mild. Szterling et al.<sup>22</sup> reported on one patient who was admitted to hospital as a consequence of the transfusion procedure. Information is lacking regarding the outcome of the patients transferred to hospital or management with respect to future transfusions. None of the studies reported deaths.

Table 2 shows the results of studies that reported data on the safety of blood transfusions at home.

TABLE 2 Safety results of the studies included

Study	No. of home blood transfusions	No. of mild adverse events	No. of severe adverse reactions
Crocker <sup>11</sup>	352	0	0
Craig et al. <sup>13</sup>	51	0	0
Madgwick et al. <sup>21</sup>	278	0	0
Cortés et al. <sup>24</sup>	51	1 (1.96%) mild allergy	0
Szterling et al. <sup>22</sup>	448	6 (1.34%) 3 hyperthermia 3 urticaria	1 (0.22%) severe allergic reaction
Isaia et al. <sup>14</sup>	161	0	0
Tamayo et al. <sup>16</sup>	1518	56 (3.69%) 26 hyperthermia 10 chills 4 dyspnoea 2 skin rash 1 bacteraemia 1 mild hypotension 7 different clinical profiles 5 No data	0
Gay et al. <sup>18</sup>	4	0	0
García et al. <sup>17</sup>	2260	61 (2.7%) 44 hyperthermia 6 dyspnoea 2 rash 1 haematuria 1 hypotension 7 others	0
Cases Alarcón et al. <sup>23</sup>	52	0	0
Sharp et al. <sup>19</sup>	1773	8 transfusion reactions (0.45%) 153 device related adverse events (8.6%)	5 severe transfusion reactions (0.28%) 5 No data
Nicola et al. <sup>15</sup>	4980	12 (0.24%) 6 Extravasation/vascular access haematoma 2 cardiorespiratory symptoms 1 skin rash 1 nausea and vomiting	0
	TOTAL: 11928	TOTAL: 144 (1.21%)	TOTAL: 6 (0.05%)

## Acceptance of home blood transfusion

The bibliographic search identified one study which addressed the issue of acceptance, evaluating what patients thought about this procedure.

This study by Barki-Harrington et al.<sup>25</sup> conducted a survey of 385 haematological patients and found that 51.2% would be willing to receive home blood transfusions. The persons most willing to receiving this type of treatment were those who had a “university” education (58.6%) whereas the persons most reluctant to receive it were those who had a “basic” education (57.7%). The main reason cited was “apprehension at applying the treatment at home”, distantly followed by “losing contact with the medical team”.

## Patient-caregiver satisfaction

Of all the studies, there was only one<sup>23</sup> that measured patients' and caregivers' satisfaction after the introduction of home blood transfusions. In this instance, a satisfaction survey of the 53 patients who participated in the transfusion episode was used for data-collection purposes: an overall score of 9.7 out of 10 was obtained but no more information than the overall result was otherwise reported.

Although another two studies<sup>18,21</sup> were found which made specific references to patient-caregiver satisfaction, this was mentioned as a secondary matter.

## DISCUSSION

Within the portfolio of the various types of care and procedures susceptible to being provided at the patient's home, blood transfusion has been somewhat erratically applied, with considerable doubts about its safety, acceptability, and implementation.<sup>23,24,26</sup> The most worrying aspect when performing home blood transfusions is what to do in the event of an adverse reaction. This aspect has been a frequent subject of debate, dating back to a time when blood processing techniques were not as refined.

## Safety and effectiveness of home blood transfusion

After reviewing available data, home blood transfusion can be considered a safe technique. Most of the adverse reactions reported in reviewed studies were mild, generally NHFTRs, which could be resolved at home after halting the transfusion and applying existing protocols for management of transfusion complications.<sup>16,27,28</sup> Transfers to hospital due to more severe complications requiring more advanced care were documented on only five occasions.<sup>19</sup> Nevertheless, included studies do not allow for a direct comparison on adverse events at home and in hospital.

The highest rate of NHFTRs were found in older studies which included PLT-transfused patients.<sup>16,17</sup> García

et al.<sup>17</sup> reported that these NHFTRs decreased after the incorporation of leucoreduction and irradiation methods in 2002. Leucocytes are the prime major component causing NHFTRs. Because PLTs are stored at room temperature, the rate of leucocyte-derived pro-inflammatory cytokines increases due to the active synthesis of cytokines by these cells.<sup>24</sup> Prestorage or post-storage leucoreduction can reduce this risk by removing leucocytes as well as human neutrophil peptides, the major antimicrobial peptides of neutrophils.<sup>29</sup> Leucoreduction also contributes to reduce human leucocyte antigen (HLA) alloimmunization, transmission of leucotropic viruses and transfusional associated graft versus host disease (TA-GvHD). TA-GvHD can be prevented by irradiation of blood to inactivate lymphocytes.<sup>30</sup>

Vascular access device adverse events were the most common clinical complication in two of the studies that included ageing populations.<sup>15,19</sup> Although little research has been done on ageing populations, it is reasonable to think that they may be prone to more device related complications due to the anatomical changes in vein structure which make vascular access difficult. Special consideration should be given to the vascular access choice in these patients and other patients with comorbidities to avoid unintended adverse events.

The influence of the underlying diagnosis, number of units transfused, and planned medication on NHFTRs is relatively unknown. A higher number of reactions were reported in studies including patients with haematological disorders<sup>16,17,19</sup> than those which included oncological or chronic diseases.<sup>13,15,18,21,23</sup> This is consistent with the analysis performed by Sharp et al.<sup>19</sup> which showed that participants with a diagnosis of anaemia or lower Hb levels have higher risk of reaction in relation to other conditions. In a similar way, García et al.<sup>17</sup> found higher risk for patients with anaemia or chronic inflammation.

In agreement with the findings of two other analyses,<sup>17,19</sup> we also found that the risk of reaction was higher in studies which transfused >1.5 mean units in comparison to those that transfused ≤1.5 mean units. It is unknown whether these findings are due to an underlying biological mechanism or are associated with other factors. In any case, results should be interpreted with caution given the great heterogeneity among the studies included in this systematic review.

It is noteworthy that none of the studies assessed the effectiveness of home blood transfusion. However, we consider that there are no grounds to believe that effectiveness would differ in the home setting with respect to the hospital.

## Patient preference and convenience

The added benefits on home blood transfusion relate to the improvement in quality of life by dispensing with needless travel (which can sometimes be problematic due to patients' physical

limitations), preventing nosocomial infections, avoiding unnecessary hospital admissions, and enhancing the benefits of remaining in a family setting.<sup>17,22,24,26</sup> The included satisfaction survey<sup>23</sup> reflects a high degree of satisfaction among caregivers and patients alike. The only survey identified addressing acceptance showed that 52% of those surveyed were in favour of home blood transfusion. Patients valued the potential increase in the quality of life because they felt that they spent too much time at hospital due to transfusions. Among those who rejected the idea, the aspect which they tended to find most discouraging was that they “considered themselves too apprehensive” to receive such treatment at home. It was those with a lower level of education who were most against home blood transfusion, while it was those with a higher educational level who were most in favour of it.<sup>25</sup>

## Organisational and economic issues

Health authorities need to bear in mind that incorporating blood transfusion into the home care services portfolio requires multidisciplinary teams. On the one hand, there is the department in charge of the patient, whose physician will be tasked with requesting the blood transfusion, as well as the nursing team, which will be responsible for withdrawing the pretransfusion sample 24–48 h beforehand.<sup>16,31</sup> On the other hand, there is the technical part of the transfusion, which would involve the blood transfusion centre or service, since it is this facility that would have to prepare the RBC-pooled platelet concentrate. Good co-ordination between the different services is essential. The great majority of studies<sup>12,14,16,24,31</sup> stress the fact that nurses should have previous experience in transfusions, so that they are in a position to manage potential adverse effects.

There were differing opinions about who must be present during the transfusion. There are studies which leave this process in the hands of a physician-nurse team,<sup>14,22</sup> or alternatively in the hands of nursing staff, requiring the presence of a nurse during the entire blood transfusion process,<sup>12,16,18,19,24</sup> or for only the first 30 min.<sup>17</sup> As already mentioned, one study carried out in the UK relied on trained family or caregivers.<sup>21</sup> The fact that most of the adverse events frequently occur during the first 15 min or within 4 h of cessation of transfusion,<sup>28</sup> leads one to think that a nurse or physician might not be required to oversee the whole process if there is cooperation of trained caregivers, coupled with telephone support from a clinical team. This would render the process more feasible and sustainable because the mean time could be around 4 h, excluding travelling time. Some studies argue that a nurse-led model might lead to more hospital admissions,<sup>19</sup> since there are no physicians available when advert events arise. Given the few studies identified it is difficult to disentangle the effect of the different factors on the overall outcomes.

Included studies also differed substantially with respect to the requirement on the distance and travel time between patient's home and the referral unit, having each unit its own protocol. The most restrictive case was the study undertaken in France,<sup>18</sup> where patients were required to live within a 15-km radius of their referral hospital. This would be totally infeasible in areas with a widely scattered population. Another concerning issue is the potential cost impact on the health care system. An initial estimate supports that, as compared to traditional hospitalisation, home care may represent a 25%–55% reduction in costs. However, there are inherent limitations to assessing costs, as these can depend on the process implemented.<sup>17,24</sup> For example, it would depend if a nurse and a physician were required to be present for a single transfusion episode, as it might not be cost-effective.<sup>12</sup> In one of the included studies the presence of a health professional during transfusion was not required,<sup>21</sup> since caregivers were trained to insert peripheral intravenous catheters and were responsible for collecting the units of blood. Costs might also differ depending on whether the professional stays only part of the time, as is the case of the Spanish study,<sup>16</sup> or during the whole of the transfusion period. Costs could also be difficult to calculate if this activity is integrated with the rest of home-care activities, as is the case of Cortés et al.<sup>24</sup>

## Strengths and limitations

The main strength of this study is that it is the first thorough systematic review done on this topic. We believe that the findings of this work are of great relevance for clinical practice and research, and they could form the basis of a strategic framework for home blood transfusion.

However, it must be acknowledged that existing studies on home blood transfusion are of low quality, basically consisting of case series of a mostly retrospective nature. Important uncertainties remain regarding clinical and procedural aspects. First, the transfusion protocols varied substantially in the included studies, and none of the studies provided a definition of what they considered a severe adverse event. This is an important limitation when it comes to drawing definitive conclusions as regard benefit–risk.

## CONCLUSIONS

The results of the systematic review suggest that both patients and caregivers might benefit from transfusion at home if it is appropriately delivered. Blood transfusion at home could serve not only to relieve overcrowding of health services but also to improve the care and quality of life of a significant portion of transfusion-dependent patients. However, future research is clearly needed to establish the real effectiveness in comparison to hospital-based transfusion and resolve pending

TABLE 3 Suggestions for further research

#### Suggestions for further research on home blood transfusion

- Prospective controlled studies which assess the effectiveness and safety of home blood transfusion in comparison with hospital-based transfusion.
- Studies determining the profile of patients who could benefit most from this procedure.
- Studies analysing the costs of home blood transfusions.
- Studies aiming to clarify personnel involvement, vascular access device choice, influence of premedication and number of blood units transfused.

procedural uncertainties, as well as organisational and economic issues (Table 3).

#### AUTHOR CONTRIBUTIONS

All authors participated in the preparation and drafting of the manuscript; LVL, CCP designed the study and supervised the work; JRC and CCP carried out the selection and extraction of data, and analysis of results; JRC wrote the first version of the manuscript. All authors contributed to drafting and made comments on the different versions. All authors approved the final version. LVL is the guarantor of the study.

#### CONFLICT OF INTEREST


The authors declare no conflicts of interest.

#### DATA AVAILABILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

#### ORCID

Cristina Candal-Pedreira  <https://orcid.org/0000-0002-1703-3592>

Leonor Varela-Lema  <https://orcid.org/0000-0001-8365-7961>

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### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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