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Review article

Transfusion process assessment indicators: integrative review*

Indicadores para a avaliação do processo transfusional: revisão integrativa

Indicadores para la evaluación del proceso transfusional: revisión integradora

Daiana de Mattia[I], Dulcineia Ghizoni Schneider[I], Francine Lima Gelbcke[I]

[I]Federal University of Santa Catarina. Florianopolis, Santa Catarina, Brazil

***Extracted from a thesis entitled "Gerenciamento de enfermagem no processo transfusional: construção e validação de indicadores para melhoria da qualidade", Graduate Program in Nursing, Universidade Federal de Santa Catarina, 2022.**

Abstract

Objective: to identify transfusion-related indicators. **Method:** an integrative literature review carried out between March and May 2022, in nine sources of information from 2001 to 2021. As a search strategy, the descriptors "Quality Indicators in Health Care", "Service Indicators", "Basic Health Indicators", "Hemotherapy Service", "Blood Transfusion", "Blood Safety" were used, with Boolean operators "AND" and "OR" in three languages, with 49 articles being analyzed. **Results**: a total of 53 indicators were identified, which were grouped for: blood component stock management, transfusion process production, transfusion process assessment and transfusion process support. **Conclusion**: the identified indicators make it possible to assess the transfusion process, although activities, such as care assessment, present few indicators, highlighting the need for studies on the subject and the construction of new indicators to support a more improved transfusion process assessment.

Descriptors: Quality Indicators, Health Care; Indicators of Health Services; Hemotherapy Service; Blood Transfusion; Blood Safety

Resumo

Objetivo: identificar os indicadores relacionados ao processo transfusional. **Método:** revisão integrativa de literatura realizada entre março e maio de 2022, em nove fontes de informação no período de 2001 a 2021. Como estratégia de busca, utilizaram-se os descritores "Indicadores de Qualidade em Assistência à Saúde", "Indicadores de Serviços", "Indicadores Básicos de Saúde", "Serviço de Hemoterapia", "Transfusão de Sangue", "Segurança do Sangue", com os operadores boleanos "AND" e "OR" em três idiomas, sendo analisados 49 artigos. **Resultados**: foram identificados 53 indicadores, os quais se agruparam para: gestão do estoque de hemocomponentes, de produção do processo transfusional, para avaliação do processo transfusional e de

suporte do processo transfusional. **Conclusão**: os indicadores identificados possibilitam avaliação do processo transfusional, apesar de atividades, como a avaliação do cuidado, apresentarem poucos indicadores, evidenciando a necessidade de estudos sobre a temática e construção de novos indicadores para dar sustentação à avaliação mais aprimorada do processo transfusional.
Descritores: Indicadores de Qualidade em Assistência à Saúde; Indicadores de Serviços; Serviço de Hemoterapia; Transfusão de Sangue; Segurança do Sangue

Resumen

Objetivo: identificar indicadores relacionados con el proceso de transfusión. **Método:** revisión integrativa de la literatura, realizada entre marzo y mayo de 2022, en nueve fuentes de información de 2001 a 2021. Como estrategia de busca, se utilizaron los descriptores "Indicadores de Calidad en la Atención de Salud", "Indicadores de Servicio", "Indicadores Básicos de Salud", "Servicio de Hemoterapia", "Transfusión de Sangre", "Seguridad de la Sangre", con operadores booleanos "AND" y "OR" en tres idiomas, analizando 49 artículos. **Resultados**: se identificaron 53 indicadores, los cuales fueron agrupados en: gestión del stock de hemocomponentes, producción del proceso transfusional, evaluación del proceso transfusional y apoyo al proceso transfusional. **Conclusión:** los indicadores identificados posibilitan la evaluación del proceso transfusional, aunque actividades, como la evaluación del cuidado, presenten pocos indicadores, destacando la necesidad de estudios sobre el tema y la construcción de nuevos indicadores que apoyen una evaluación más perfeccionada del proceso de transfusión.
Descriptores: Indicadores de Calidad de la Atención de Salud; Indicadores de Servicios; Servicio de Hemoterapia; Transfusión Sanguínea; Seguridad de la Sangre

Introduction

Blood transfusion is a vital and life-saving process for patients with acute and chronic conditions, aiming to replace lost blood components such as red blood cells, platelets and/or clotting factors.[1] This procedure is complex and comprises stages, such as medical prescription of blood components, blood sample collection, pre-transfusion tests, blood component selection, blood transfusion performance and monitoring and reporting of adverse events related to blood transfusion.[2] Despite the high investment that has been taking place, it has not yet been possible to find something to replace blood. Therefore, blood transfusion and its components, so far, is necessary.[3]

Every year, millions of people worldwide undergo blood transfusion, which makes it one of the most used treatments in modern medicine.[4-5] Although it is a widespread practice, it has associated risks, including immunological complications, immunomodulation or transfusion-transmitted infection. Many of the risks associated with human errors have been reported in blood transfusion processes, comprising approximately 85% of the total avoidable risks.[1,6] Data from the European Union from 2021 indicated 35 transfusion-related deaths, which led the Serious Hazards of Transfusion (SHOT), describing that "improvement in decision-making, monitoring and

professional education, addressing factors that contribute to errors, are vital to improving transfusion safety".[6] In order to improve blood safety and availability, it is recommended that facilities implement effective quality systems, including quality management, standards, good manufacturing practices, documentation, staff training and quality assessment.[7]

Among the tools used to monitor quality in the health field, there are indicators that allow institutions to identify areas of low performance and measure improvements.[8] In the field of blood transfusion, indicator use provides important information that is not only limited to comparing blood use between countries, but also allows assessing changes in blood transfusion practice over time.[9] They are measurable representations, i.e., quantitative bases of characteristics of products and processes used to control and improve the performance and quality of organizations.[10] They aim to know the external customer's perception, enable the comparative analysis of the organization's performance, diagnose the service's strengths and weaknesses, and comparatively assess different organizations, processes, problems and undertake improvement actions.[11] Thus, this article aimed to identify the transfusion-related indicators.

Method

This is an integrative literature review that allows the synthesis of multiple studies published in different journals, allowing relevant conclusions about a particular area.[12] In this review, six stages were followed: theme identification and research question elaboration; establishment of inclusion and exclusion criteria for studies; definition of the information to be extracted from selected studies; assessment of included studies; interpretation of results; and presentation of knowledge review/synthesis.[12]

For the review question elaboration, the acronym PICO was used[13] (P (person/problem): indicators; I (intervention): transfusion process; C (comparison): not applied; O (outcomes): transfusion process quality), obtaining as a review question: What is the scientific evidence of transfusion-related indicators?

The bibliographic survey was carried out between March and May 2022, using the Medical Literature Analysis and Retrieval System Online (MEDLINE) information sources, consulted through PubMed, Latin American and Caribbean Health Sciences Literature (LILACS), Nursing Database (BDENF), CINAHL, COCHRANE Library, EMBASE, Scopus, Web of Science, and Scientific Electronic Library Online (SciELO). The search strategy was developed in MEDLINE and applied to the

specificity of each source:

("Quality Indicators, Health Care"[Mesh] OR "Health Care Quality Indicators"[Title/Abstract] OR "Indicators of Health Services"[Title/Abstract] OR "Health Status Indicators"[Mesh] OR "Health Status Indicators"[Title/Abstract] OR "Indicators"[Title/Abstract] OR "Indicator"[Title/Abstract] OR "Health Status Index"[Title/Abstract] OR "Health Status Indexes"[Title/Abstract] OR "Health Status Indices"[Title/Abstract] OR "Health Metric"[Title/Abstract] OR "Health Metrics"[Title/Abstract] OR "Healthcare Global Trigger Tool"[Title/Abstract]) AND ("Hemotherapy Service"[Title/Abstract] OR "Blood Therapy"[Title/Abstract]OR "Hemotherapy"[Title/Abstract] OR "Hemotherapeutic"[Title/Abstract] OR "Blood Transfusion"[Mesh] OR "Blood Transfusion"[Title/Abstract] OR "Blood Safety"[Mesh] OR "Blood Safety"[Title/Abstract] OR "Blood Supply Safeties"[Title/Abstract] OR "Blood Supply Safety"[Title/Abstract] OR "Hemovigilance"[Title/Abstract]).

The following inclusion criteria were used: a) primary articles that contain the keywords listed in the study protocol in the abstract and/or title; b) works whose general and/or specific objectives make explicit reference to the object of study; c) in English, Spanish or Portuguese, from 2001 to 2021, available online in full. Time frame was defined, considering the publication of the book "Blood Safety and Clinical Technology: 2000-2003 Strategy" by the World Health Organization (WHO),[14] which encourages actions aimed at promoting quality health services supported by safe and economic technologies. In the Brazilian context, Law 10.205, of March 21, 2001,[15] highlights the commitment and responsibilities of public agents involved in hemotherapy.

Article selection was carried out by two independent reviewers, who selected the studies from reading their titles and abstracts, checking duplicates and reading them in full, assessing their suitability for the review question. A third reviewer was available in case there was any disagreement. Considering the eligibility criteria, analysis was composed of 49 articles, which were subjected to a new reading, seeking to extract relevant information, considering the study review question. To organize the collected data, a synoptic table was prepared in a Microsoft Excel® spreadsheet containing the following items: source, author(s), title, year, journal, study site, objective, study design, methodological approach, transfusion process indicators. Data analysis included pre-analysis, material exploration and treatment of results, inference and interpretation.[16]

Results

A total of 5,010 studies were found, and 49 were selected to compose the integrative review. Figure 1 illustrates the study search and selection process.

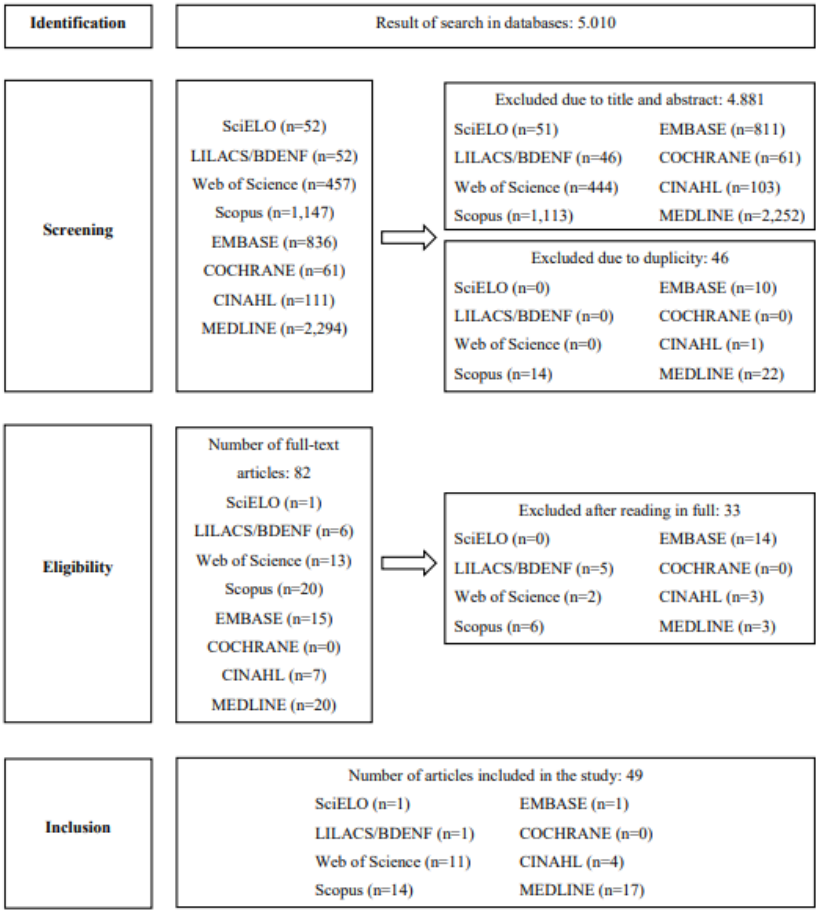

Figure 1 – Article search and selection process, Florianópolis/SC, Brazil, 2022

As for the design, 38 had a quantitative approach (cross-sectional, experimental, intervention and cohort); six were qualitative (descriptive and methodological); and five were quantitative and qualitative (descriptive and methodological).

Regarding the site of selected articles, it was found that most were developed in the United States of America (n=11), followed by India (n=6), Spain (n=4), Saudi Arabia (n=2), Canada (n=3), Netherlands (n=3), France (n=2), United Kingdom (n=2). The other countries, such as Brazil, presented only one study.

Chart 1 presents the studies included in the integrative literature review according to year, country, objective, methodological approach, study design, sample, setting and results.

Chart 1 – Characterization of included studies that address transfusion-related indicators, Florianópolis/SC, Brazil, 2022

Year/ country	Objective	Method/Sample	Results
2001/ United Kingdom[17]	Produce nationally tested audit tools, influence the content of national guidelines and allow the definition of performance indicators for the clinical transfusion process.	Cross-sectional study. 50 hospitals	More than 20% of participating hospitals did not have Hospital Transfusion Committees. Audits of transfusion practice demonstrated considerable variation in the performance of standard procedures regarding blood administration and little change in practice between the two audits.
2001/ Finland[18]	Verify whether automatically stored blood transfusion data could be used as a source of indicators for transfusion practice assessment.	Methodological study.	Key indicators include the percentage of patients transfused, the number of transfused units and costs across different diagnostic groups as well as transfusion rates by treatment episodes weighted by diagnostic groups.
2002/ USA[19]	Determine normative ratios of matched red cell concentrate (RBC) ratios to transfused, wasted, and expired RBC units, and examine hospital blood bank practices associated with more desirable rates.	Cross-sectional study. 1,639 public and private institutions	The proportion of RBC matched and effectively transfused was <1.5 in the best performing participating institutions, and 1.8 to 1.9 with intermediate performance and > 2.4 with poor performance. RBC unit expiration rates were 0.1% at top performing institutions, 0.3% to 0.9% at intermediate performers, and > 3.5% at lowest performers.
2002/ France[20]	Analyze information extracted from the experience of the first four years of the hemovigilance network under the control of the French Blood Agency.	Cross-sectional study. 24,234 transfusion incident reports.	The highest reporting rate is seen with platelet concentrates (PC), followed by RBC and fresh frozen plasma (FFP). Bacterial contamination appeared as the main cause of morbidity and mortality. ABO incompatibilities, during RBC transfusion, remained at a constant rate and accounted for 6 fatalities. After the implementation of universal leukocyte reduction, transfusion reactions were reduced.
2002/ USA[21]	Determine normative expiry and wastage rates for FFP and PC units in hospital communities and examine blood banking practices associated with more desirable rates.	Cross-sectional study. 1,639 US public and private institutions	The FFP and PC expiration rate ranged from 5.8% to 6.4%, and the FFP and PC loss rate ranged from 2.0% to 2.5%. Among the top performers, the FFP and PC expiration rate was < 0.6%, and the FFP and PC wastage rate was < 0.5%. In institutions with the worst performance, these rates were > 13.8% and > 6.8%, respectively.
2005/ USA[22]	Determine whether the amount and time of blood collection are independent risk factors	Retrospective cohort study. 275 trauma patients who received at least	Patients who received older blood had a longer ICU stay, possibly reflecting a higher level of organ dysfunction. However, these patients did not have a

	for in-hospital mortality, need for Intensive Care Unit (ICU) care, and increased length of stay in the ICU.	one unit of RBC.	higher mortality rate or a greater need for ICU care.
2008/ Italy[23]	Identify and assess the indicators of completeness and adequacy of FFP orders and the blood component's therapeutic efficacy.	Observational study. 221 FFP requests answered at regional Immunotransfusion Services.	In 50.7% of cases, data completeness in individual requests was good. There was indication and adequate dosage in 31.5% and 62.7% of requests. Comparison of pre- and post-transfusion laboratory data showed significant correction of pathological values only for the International Normalized Ratio.
2009/ USA[24]	Present the implementation of a project with blood transfusion process redesign, from the requirement of two blood samples to verify the blood type of a patient before blood transfusion.	Intervention study. Errors in patient identification and/or sample labeling.	With the implementation of the new policy, the risk of issuing the wrong blood unit due to errors in patient identification/sample labeling, at the time of collection, decreased, but the response time for requesting blood components increased.
2010/ USA[25]	Eliminate the disposal of RBC shipped in temperature validated containers and reduce RBC waste by 50%.	Intervention study. RBC disposed of in a hospital center.	Overall RBC disposal decreased from 4.4% to 2% (approximately 4,300 RBC per year), saving approximately $800,000 over the four-year study period.
2011/ Spain[26]	Investigate the impact of three national blood transfusion indicators specifically designed for critical care on appropriate blood transfusion indications.	Cross-sectional study. 1,808 patients admitted to the ICU.	13% of RBC transfusions were performed outside the established protocols. Most RBC (95%) were prescribed for a hemoglobin (Hb) threshold < 9g/dL, and there was a significant improvement in compliance with PC transfusion guidelines (36% to 52%). However, non-compliance with guidelines for FFP transfusions remained high and stable.
2011/ Saudi Arabia[27]	Determine whether the accreditation process has a positive impact on patient safety and quality of care.	Cross-sectional study. 119 performance indicators collected at King Abdul-Aziz University Hospital in Saudi Arabia.	Indicators considered sensitive to accreditation were: 4 indicators of perioperative mortality and neonatal mortality rates; 16 from healthcare-associated infections; 1 due to blood utilization; 2 related to surgeries and invasive procedures; 2 related to cardiopulmonary resuscitation; 2 related to pressure injury.
2012/ USA[28]	Determine the prevalence of Hb greater than 10.0 g/dL	Cross-sectional study. Patients with Hb level >10.0g/dl, transfused	In total, 47% of patients had Hb levels at discharge >10g/dL. The average Hb trigger for transfusion was 7.3 g/dL; the

	in patients who received RBC transfusions in hospitals served by the Community Blood Center of Greater Kansas City.	with RBC.	mean post-transfusion Hb level was 9.3 g/dL; and the mean Hb level at discharge was 9.2 g/dL. Overall, 76% of transfusions were of an even number of RBC units.
2013/ Netherlands[29]	Assess whether the reported transfusion reactions rate is correlated with the transfusion chain safety in a hospital.	Cross-sectional study. Transfusion reactions reported by 103 Dutch hospitals.	Of the 103 hospitals, 101 had complete data for some years and 93 for all five years. In all, 72 reported at least one incorrectly transfused blood component.
2013/ USA[30]	Investigate RBC emission response time for operating rooms and examine the current status of RBC emission response time benchmarks in other blood banks as well as anesthesiologists' RBC emission response time expectations.	Cross-sectional study. 416 adult elective surgical cases with requests for 4 or fewer RBC units at Vanderbilt University Medical Center (VUMC) and Stanford University Medical Center (SUMC).	Mean response times for RBC emission at the 2 institutions were 3.8 minutes at VUMC and 7.2 minutes in SUMC. Only 3 of the 24 institutions surveyed actively monitored the issue time. The internal policies established for time of issuance were 15 and 20 minutes at VUMC and SUMC, respectively, for RBC cross requests for patients with complete diagnostic test.
2014/ Malaysia[31]	Describe about the development of indicators, quality and clinical audits, quality assessment programs and hemovigilance program.	Descriptive study.	Monitoring provides information, identifies weaknesses and deficiencies that can be assessed to implement corrective actions and appropriate interventions. The hospital transfusion committee plays an important role in implementing a monitoring system in the hospital.
2014/ USA[32]	Create a reproducible metric that allows a risk-adjusted assessment of blood component use, taking into account patients' diagnosis and surgical procedures.	Cross-sectional study. Electronic medical records of 37,403 surgical patients admitted to Johns Hopkins Hospital.	It was observed that, according to patients' diagnosis, the surgical procedure, and its severity, transfusion needs were directly correlated to RBC, FFP, PC transfusions.
2014/ Saudi Arabia[33]	Raise the degree of compliance of the anesthesia team with the new policies and procedures for anesthetized surgical patients for blood transfusion administration.	Cross-sectional study. 1,142 audit files from a large teaching hospital and a reference in tertiary care.	The degree of compliance in carrying out the pre-request steps for blood collection criteria, request for blood criteria, blood products verification procedures, post-transfusion procedure was 100%.
2015/ Pakistan[34]	Assess the frequency of receipt of fully completed blood transfusion reaction	Cross-sectional study. 106 transfusion reaction forms received during a year	During the study period, 17,880 RBC, 13,200 PC, 13,620 FFP and 2,256 cryoprecipitates were transfused and 106 transfusion reactions (0.23%) were

	forms followed by the required samples.	at the Aga Khan University blood bank.	reported. Of these, non-hemolytic febrile reaction was the most common (47%), mostly caused by RBC transfusion.
2015/ Netherlands[35]	Assess compliance with the 2011 Dutch Blood Transfusion Guideline recommendations.	Cross-sectional study. All Dutch hospitals in the operating years 2011 and 2012.	Most hospitals had a transfusion committee with a representative and 23% met the recommended minimum. Compliance with the pre-transfusion hemoglobin threshold for RBC transfusion was achieved by 90% of hospitals in more than 80% of transfusions; 58% of hospitals measured pre-transfusion platelet counts in more than 80% of PC transfusions; and 87% of hospitals complied with traceability of blood components in more than 95% of transfusions.
2015/ Iran[36]	Assess the status of requests for blood products and transfusion practice in surgical patients.	Cross-sectional study. 377 records of hospitalized patients, from April to December 2013, at Al-Zahra and 17th Shahrivar hospitals in Rasht, northern Iran.	In Al-Zahra, the transfusion rate was 0.27; the probability of transfusion was 12.8%; the ratio of matched RBC to transfused RBC was 7.38. Laparoscopic surgery had the worst indicator in terms of waste. At the 17th Shahrivar hospital, the transfusion rate was 0.09; the probability of transfusion was 8.82%; the ratio of matched RBC to transfused RBC was 12.5. Appendectomy presented the worst indicators.
2015/ USA[37]	Determine whether comparison of institutional benchmarks with similar types of hospitals can be used as a surrogate means of assessing hospital compliance with evidence-based transfusion guidelines.	Methodological study. 892 patients undergoing colorectal surgery in a hospital.	The transfusion rate for colorectal surgery was 16.3%, higher than the national average. When broken down by type and size, the study hospital had a similar blood transfusion rate compared to academic hospitals, but a significantly higher rate than community hospitals, regardless of patient volume.
2015/ Egypt[38]	Investigate the frequency of auto and alloantibodies in patients with beta thalassemia in Alexandria, Egypt.	Cross-sectional study. 40 patients with beta thalassemia who received a regular blood transfusion in Alexandria, Egypt.	The direct antiglobulin test was positive in 45% of patients. Alloantibodies were detected in 42.5%, such as anti-D (4.76%), anti-c (4.76%), anti-K (4.76%), anti-Kpa (9.52 %), anti-Kpb (19.05%), anti-Lua (9.52%), anti-Lub (19.05%) and anti-Bg(a) (4.76%). A total of 23.81% of alloantibodies were not identified.
2015/ Canada[39]	Describe the benchmarking program implementation.	Cross-sectional study. 160 hospitals in the province of Ontario.	Key elements of the successful benchmarking strategy included dynamic targets, a comprehensive and evidence-based implementation strategy, continuous information

			sharing, and a robust data system to track information.
2015/ Netherlands[40]	Describe a method to develop a new set of actionable quality indicators and response checklist for the Dutch ICU.	Methodological study. 8 intensivists, participants of the National Assessment of Intensive Care registry, with the Dutch ICU as a setting.	From the study, 7 indicators emerged: protocol for blood transfusions; percentage of patients who received RBC transfusion; RBC units transfused; percentage of lost blood products; transfusion delay; percentage of patients who received FFP; and number of transfused FFP units.
2015/ United Kingdom[41]	Outline plans to harness the power of digital information to support the implementation of best practices in transfusion medicine and Patient Blood Management (PBM)	Retrospective study. UK healthcare institutions.	In transfusion, big data has been used for benchmarking, detecting transfusion-related complications, determining patterns of blood use, and scheduling blood orders for surgery.
2016/ Saudi Arabia[42]	Report the two-year experience of using transfusion-related quality indicators as a tool in the hemovigilance system implementation.	Cross-sectional study Quality indicators from King Abdulaziz University Hospital, Jeddah, Saudi Arabia.	A total of 84 transfusion reactions were reported, most of which were allergic reactions (79.7%). Errors or incident were reported with approximately 0.3% of total samples/orders shipped. FFP wastage per expiration was 21.3% of the total FFP wastage.
2016/ India[43]	study the usefulness of monitoring the central indicators of the National Accreditation Council for Hospitals and Health Professionals (CNAHP) in blood transfusion and in maintaining hemovigilance.	Cross-sectional study. 4 CNAHP core indicators in blood transfusion from a tertiary hospital accredited by this Council.	An improvement in quality was observed by monitoring the central indicators with a decrease in blood and blood product waste, a decrease in the average time of delivery of blood and blood products and a lower number of transfusion reactions.
2016/ India[44]	Measure the impact of monitoring performance indicators and their use as a continuous quality improvement tool.	Cross-sectional study. 7 performance indicators of a hospital-based blood bank with tertiary care.	Workload trended upwards, which helped plan consumable purchases and manage labor. Monitoring blood use and disposal contributed to the efficient management of blood supplies.
2016/ USA[45]	Create a blood order algorithm for cardiac surgery cases that would decrease the number of unnecessary matching tests.	Cross-sectional study. 264 adult patients undergoing cardiac surgery in a hospital.	Of the 264 patients requesting a transfusion, 98 were transfused, resulting in an overall transfusion probability of 37.12%. A total of 1.175 RBC were matched, but 370 RBC were transfused, resulting in an index of 3.17. The average number of RBC transfused per procedure was 1.4.

2016/ Pennsylvania[46]	Understand the worldwide reach of RBC match and issuance testing practices and measure efficiency using a new quality indicator.	Cross-sectional study. 52 blood transfusion services (North America, Europe, Asia, South America and Middle East).	Data for calculating the ratio of RBC matched and RBC transfused were provided by 22 respondents, and the mean was 1.30 ± 0.34. There was no difference in matching and transfusion ratios between services using electronic or serological cross-matching techniques.
2016/ Nigeria[47]	Assess routinely submitted blood transfusion requests to determine correctness, completeness, and consistency.	Cross-sectional study. 2,084 laboratory request forms sent to the Department of Hematology (DH) and Blood Transfusion Services (BTS) at Aminu Kano University Hospital, Kano, Nigeria.	The blood transfusion request completeness was 89.5% for DH and 81.2% for BTS. Patient identification information was 100% complete for DH, while only patient name was 100% complete for BTS. Incomplete information was found on BTS forms for physician signature (60.8%) and recipient laboratory signature (63.5%). None of the DH and 9.4% of BTS met all the quality indicator indices.
2017/ Kenya[48]	Examine physicians' ability to obtain blood components when needed in Kenya and examine hemoglobin measurement use as a guide to transfusion.	Cross-sectional study. 14 hospitals belonging to the Clinical Information Network, a set of Kenya county referral hospitals.	5% of admissions had requested blood transfusion. Of all requested transfusions, 82% were administered and documented, and 75% of them were administered on the same day as the request. Children who had a requested transfusion but did not receive the prescribed transfusion had a 20% mortality, compared to 12% among those transfused.
2017/ Spain[49]	Check which internal quality indicators are being used in hospital transfusion services and how they are defined, and determine the impact of these indicators on the quality system management.	Cross-sectional study. 76 hospital transfusion services located in Spain.	Indicators were assigned to some basic categories, such as transfusion process, transfusion activity and stock management, hemovigilance, stem cell transplantation, transfusion laboratory, quality management system, blood donation, apheresis and therapeutic activities, and immunohematology of pregnancy.
2017/ USA[50]	Determine what percentage of academic hospitals in the United States employ a massive transfusion protocol and learn the details of this commonly used protocol.	Intervention study. 107 medical directors of US-accredited clinical anatomy and pathology residency programs.	A total of 56 directors responded that they had a massive transfusion protocol in place, and 98.2% rely on it. The RBC to FFP ratio of 1:1 appeared in 69.9% of the institutions. The majority, 64.3%, provide six or more units of RBC in the first massive transfusion package.
2017/ Canada[51]	Summarize current limitations in indicator-based assessment of blood bank stock	Descriptive study.	The blood component journey from receipt of stock to final disposal is complex and is related to many internal and external influences, and indicators

	efficiency and propose the creation of process maps as an ideal methodology for application to stock management research.		may be inadequate to understand the complexity of supply chain. Process maps contribute to stock analysis, and modern laboratory information systems can track almost any complex blood bank process.
2017/ Denmark[52]	Reduce unnecessary exposure to RBC transfusion in patients without bleeding.	Quantitative and qualitative Study (phase 1 - cross-sectional; phase 2 - validity; phase 3 - intervention study). Two ICUs (general and cardiothoracic) and five surgical wards (urology, abdominal, vascular, orthopedic and cardiothoracic) at the Rigshospitalet hospital in Denmark.	At the hospital level, transfusion above the upper limit of the guideline decreased from 23 to 10%, and transfusion at or below the restrictive hemoglobin level of 7.3 g/dl increased from seven to 19%. The percentage of single-unit transfusions increased from 72 to 78%, and most transfusion rates and volumes decreased significantly. Red blood cell use decreased by 41% in surgical procedures and 28% in hospitalizations.
2018/ Cuba[53]	Show the results of implementing a hemovigilance program.	Cross-sectional study. 51 medical offices located in the municipality of Jovellanos, province of Matanzas, Cuba.	The degree of knowledge in transfusion medicine of professionals has increased, and donor and recipient reactions decreased, also reducing the severity of reactions. Moreover, the number of transfusions performed decreased by 40.5%.
2018/ India[54]	Study the response time for RBC emission and the contributory procedures that lead to a delay in the initiation of red blood cell transfusion in hospitalized patients.	Cross-sectional study. 2,022 blood orders from a tertiary hospital blood bank in Tier III city in a northern Indian state.	The mean time from request to start blood transfusion was 135 minutes in the study. Match and RBC emission tests accounted for approximately 47% of this delay.
2018/ India[55]	Investigate RBC temperature during transfusion chain, including storage, transport and transfusion.	Descriptive study. 100 RBC sent from the blood bank to the ICU heart surgery and the operating room at one teaching hospital located in Mashhad, Iran.	10% of the 121,262 temperature samples recorded (for 2 min) were outside the standard range. Of these, 65, 17, 13 and 5% of the samples referred to the blood bank, operating room, transport and cardiac surgical ICU, respectively.
2019/ Spain[56]	Identify critical failures in the blood transfusion process in a medium-sized urban hospital in Madrid, according to the failure modes and effects analysis scores.	Cross-sectional study. 10 members of a multidisciplinary team of blood transfusion services and a medium-sized urban hospital.	The failures identified were: transmitting information about the transfusion request; patient and sample identification; requested match tests; blood transfusion components; transfusion control document completion and submission; reporting of transfusion reactions.

2019/ India[57]	Improve blood supply chain service levels by maximizing availability and minimizing blood waste.	Cross-sectional study. Demand and supply data for blood components from 152 hospitals large and medium-sized businesses in Chennai, India.	Scarcity index and total wastage index are used as indicators of performance measures. It was found that the pull system model outperforms the existing model and the zone model by achieving zero waste.
2019/ Canada[58]	Describe the "AB" FFP adequacy index as a key quality indicator to document the appropriate use of "AB" FFP group for patients with unknown blood group and/or patients who require the use of AB FFP group.	Cross-sectional study. "AB" FFP units used at Vancouver General Hospital, located in Vancouver, British Columbia, Canada.	The "AB" FFP adequacy index showed inappropriate use in patients not belonging to the AB group, being used to prevent expiration after thawing. Comparing the pre- and post-implementation periods of this analysis, it was observed that the index improved.
2020/ Serbia[59]	Provide work quality assessment showing the ratio of RBC matched for transfusion for certain areas of surgery or particular surgical indications.	Cross-sectional study. 341 patients assisted by the Department of Pre-Transfusion Testing and Blood Distribution of the Serbian Blood Transfusion Institute.	The ratio between matched RBC and transfused RBC was 2.25, and it was verified that there are variations between departments. For the abdominal surgery and resuscitation departments, where non-compliant RBC were requested, the index was < 2. The other departments had index > 3 for almost all therapeutic areas.
2020/ India[60]	Analyze the incidence and nature of adverse events associated with blood transfusion, reported to the blood bank of a university hospital, with emphasis on corrective and preventive actions.	Cross-sectional study. Adverse transfusion reactions reported to the Blood Bank of the Department of Pathology of a hospital, during a period of 42 months.	A total of 189 transfusion reactions were found in patients aged between 12 and 80 years, with a predominance of females. Reactions associated with whole blood transfusion were common (50%), followed by RBC transfusion (1.4%) and PC (0.8%). Non-hemolytic febrile reactions occurred in 122 cases, followed by allergic reactions, 43, related to RBC transfusion, while hemolytic reactions showed association with whole blood transfusion. No late reactions or mortality were found.
2021/ Brazil[61]	Identify weaknesses and risks in the blood transfusion process and propose using a tool called an indicator matrix to prioritize indicators with a focus on transfusion safety.	Observational study. Bulletins and reports published by the National Health Surveillance Agency, Ministry of Health and General Coordination of Blood and Blood Products in the last 5 years.	Indicator selection aims to improve the processes involved in the entire blood cycle, and using the tool aims to facilitate the choice of these indicators according to the scenario of each institution, from a blood therapy service to a transfusion agency.
2021/	Describe the pilot	Descriptive cross-	Countries showed variability in

Africa[62]	results of the Integrated Global Benchmarking Tool for hemovigilance function in 10 countries in sub-Saharan Africa.	sectional study. Existing hemovigilance systems in 10 countries in sub-Saharan Africa.	hemovigilance implementation and performance. The lowest scores were for organizational indicators and human resources, and the highest were observed for the transparency promotion mechanism and for monitoring regulatory performance indicators.
2021/ Italy[63]	Identify and analyze logistical risks as well as define responses to improve the traceability of blood bags, focusing on hospital wards.	Descriptive study. Chain of blood supply that occurs within wards.	There is a need to analyze the transfusion process from the context and mapping of processes; risk identification; analysis of transfusion process criticalities and definition of risk responses; monitoring and assessment of key performance indicators.
2021/ Spain[64]	Describe the maturity assessment model, the benchmarking program and the feasibility of implementing it.	Cross-sectional study. 59 hospitals in Spain.	A total of 181,826 blood transfusion requests were analyzed, which proves the feasibility of implementing a sustainable model to measure and compare clinical practice and PBM results in hospitals in Spain.
2021/ South Korea[65]	Compare the color change of the Freshzon prototype with that of two other prototypes, Safe-T-Vue 10 and Blood Temp 10, approved by the US Food and Drug Administration, for monitoring RBC temperature based on the 30-minute rule.	Experimental study. 91 units were transfused to patients in the clinical setting at three tertiary hospitals in Seoul, Korea, from July to November 2019.	In 83 units, the average time for color change differed between prototypes. Furthermore, 95.2% of Freshzon prototype tags changed color after 30 minutes of emission, while 96.4% of Safe-T-Vue 10 and 98.8% Blood Temp 10 changed color within 30 minutes of emission. In the 8 units stored in refrigerators, color change time between prototypes was different.

Caption: RBC - Red Cell Concentrate; USA - United States of America; PC - Platelet Concentrates; FFP - Fresh Frozen Plasma; HLA - Human Leucocyte Antigen; ICU - Intensive Care Unit; Hb – hemoglobin; VUMC - Vanderbilt University Medical Center; SUMC - Stanford University Medical Center; PBM - Patient Blood Management; CNAHP - National Accreditation Council for Hospitals and Health Professionals; DH - Department of Hematology; BTS - Blood Transfusion Services.

From reading the body of analysis of this review, 53 transfusion-related indicators were identified. It is noteworthy that, among the studies, only one is Brazilian. These indicators were organized into four thematic segments, which are related to transfusion process management and described in Chart 2.

Chart 2 – Summary of transfusion-related indicators identified and organized according to segments, Florianópolis/SC, Brazil, 2022

Segment	Identified indicators
Blood component stock management indicators	1. Distribution rate of blood components[61]
	2. Disposal rate by blood component and associated causes (expired, thawed, outside the proper temperature, > 30 minutes outside the ideal storage temperature)[19,21,25,31,39-40,42-44,49,51,55,57,63,65]
	3. Average storage time of blood components[31,51,63]
	4. Mean time between blood bag collection and transfusion[22,63]
	5. Percentage of units for which there is no record in the hospital blood bank for their final destination[33,49]
	6. Rate of blood components received without temperature recording[33,63]
	7. Daily maintenance of the strategic stock needed to meet the three-day demand[61]
	8. Number of days without strategic stock/days/month[57,61]
	9. Total number of blood components stored[63]
Production transfusion process indicators	10. Whole blood transfusion rate by blood component and blood group[31-32,35,37,40,43, 53,61,63]
	11. Transfusion rate of blood components per patient and hospitalized patient[18,40,42,52,53,61]
	12. RBC cross match ratio to blood transfusion per surgical procedure[36,45]
	13. Percentage of RBC transfusion according to the surgical procedure[36,45]
	14. Number of samples received by the blood bank along with the transfusion reaction form[34]
	15. Proportion of prescribed transfusions/total transfusions[56]
	16. Percentage of blood groups performed and screening for irregular antibodies identified[44,49]
	17. Rate of patients with 1 RBC transfusion[52,64]
	18. Transfusion rate of blood components by type of procedure, clinical situation and diagnosis (pregnant women, postpartum women)[18,41-42,49]
	19. Percentage between the ratio of use of FFP and RBC[49]
	20. RBC transfusion rate associated with the surgical procedure[36,45]
	21. RBC index matched and effectively transfused[19,31,44,46,49,59,61]
Transfusion process assessment indicators	22. Rate of incidents related to blood component distribution[64]
	23. Transfusion request rate met according to transfusion protocols[23,26,28,31,33,35,37,52,61,64]
	24. Transfusion reaction rate (overall, by type of reaction, severity, by type of blood component, associated with failure, near miss, associated with transfusion, or not) [20,23,27,29,31,33-34,37-38,41-44,49,53,55-56,60-61,63]
	25. Surgical reservation request rate according to the institutional protocol[41,61]
	26. Rate of incidents related to request forms for blood components/exams (incomplete requests)[23,33,42,47,49,63]
	27. Rate of incidents related to sample collection[24,42,49]
	28. Rate of incidents related to pre-transfusion testing/exams[31,42,49,63]
	29. Rate of pre-transfusion electronic identification verification[35]
	30. Rate of transfused blood components according to the results of laboratory tests and patients' clinical conditions[26,28,31,35,37,52,64]
	31. Response time from transfusion request to start of blood transfusion[30,31,33,40,43-44,48-49,51,54]
	32. Rate of transfusion feedback sent to the Transfusion Agency.[63]

	33. Return rate of non-transfused blood bags to the blood bank and record keeping[35,49,63]
	34. Rate of returned transfusion control documents[56]
	35. Rate of completion and signature of the consent form for transfusion[33,49]
	36. Rate of compliance with match guidelines during blood component selection[49,58]
	37. Short-term morbidity and mortality rate of patients undergoing blood transfusion[23,31]
	38. Blood transfusion efficacy assessment rate[23]
	39. Rate of patients undergoing transfusion whose vital signs were monitored and documented[33]
	40. Double-check registration rate in transfusion-related procedures[33]
Transfusion process support indicators	41. Index of blood bank staff receiving training on circuit and transfusion practice[17,49,56]
	42. Technical knowledge index regarding blood transfusion[44,53,61]
	43. Availability of computer server with instructions for blood transfusion components[56]
	44. Participation rate in proficiency test and participation in external quality control[49,61]
	45. Index of professionals from clinical units receiving circuit and transfusion training[17,49,56]
	46. Active Transfusion Committee and hemovigilance (presence, number of meetings, responsible person, number of hours devoted to hemovigilance) [17,35,61-62]
	47. Rate of incidents related to quality management (lack of indicators, lack of data)[35,49,56]
	48. Rate of clinical units with availability of printed instructions on blood transfusion[56]
	49. Presence of protocol and policies for blood transfusions [17,40]
	50. Assessment of transfusion costs in different Diagnosis Related Groups [18]
	51. Assessment of massive transfusion protocol use[49-50]
	52. Rate of suggested key performance indicators for PBM monitored[41]
	53. Percentage of surgical episodes in which tranexamic acid was administered[41]

Caption: FFP – Fresh Frozen Plasma; RBC - Red Cell Concentrate; PBM - Patient Blood Management.

Blood component stock management indicators

This segment comprises the indicators related to blood component stock management, which in this study totaled nine (18%), being the "Disposal rate per blood component and associated causes (expired, thawed, out of proper temperature, > 30 minutes out of ideal storage temperature)" the most evident, as it was present in 15 (30%) articles. Another important indicator in this segment was "Average storage time of blood components", found in 3 (6%). The other indicators emerged in one or two articles.

Production transfusion process indicators

In this segment are those related to the numbers generated in the transfusion process, which comprised 12 (24%) indicators. The "Whole blood transfusion rate by blood component and blood group" was present in 9 (18%) articles, followed by "Index of RBC matched and effectively transfused", in 7 (14%), "Rate of blood transfusion components per patient and hospitalized patient", in 6 (12%), "Rate of blood transfusion components by type of procedure, clinical situation and diagnosis (pregnant women, puerperal women)", in 4 (8%). The other listed indicators were evidenced in one or two articles.

Transfusion process assessment indicators

In this segment are the indicators of transfusion process assessment, comprising 19 (38%). Among them, the "Transfusion reaction rate (overall, by type of reaction, severity, by type of blood component, associated with failure, near miss, associated with transfusion, or not)" was highlighted, being evidenced in 20 (40%) articles, followed by "Transfusion request rate met according to transfusion protocols" and "Response time from transfusion request to start of blood transfusion", which were present in 10 (20%); "Rate of blood components transfused according to with the results of laboratory tests and patients' clinical conditions", in 7 (14%); "Rate of incidents related to request forms for blood components/exams (incomplete requests)", in 6 (12%); "Rate of incidents related to pre-transfusion testing/examinations", in 4 (8%); "Rate of incidents related to sample collection" and "Rate of return of non-transfused blood bags to the blood bank and record keeping", in 3 (6 %) articles. The other indicators were identified in one or two articles.

Transfusion process support indicators

In this segment, there are 13 (26%) indicators related to actions to support the transfusion process, of which the following stand out: "Active Transfusion Committee and hemovigilance (presence, number of meetings, responsible person, number of hours devoted to hemovigilance)" present in 4 (8%) articles, "Index of blood bank staff receiving training on circuit and transfusion practice", "Technical knowledge index regarding blood transfusion", "Index of professionals from clinical units receiving circuit and transfusion training", "Rate of incidents related to quality management (lack of indicators, lack of data)" were evidenced in 3 (6%). The other indicators were found in one or two articles.

Discussion

Indicators are tools that allow us to know the situation that we want to change, establish priorities, identify objectives and translate them into goals, assess processes, plan the necessary redirections and verify the results and impacts obtained.[66] Thus, they subsidize service improvements with assertive decisions and resource optimization.[11]

When it comes to the health area, more specifically in hemotherapy, in Brazil, it is legally necessary for hemotherapy services to adopt indicators and targets for monitoring the performance of their processes throughout the blood cycle.[2] Supported by this statement, the study contributed to identifying the indicators used in the national and international literature and categorizing them according to the process that it is willing to assess.

The Indicators for managing blood component stock segment was the one that presented the least indicators, compared to the others. However, the "Disposal rate by blood component and associated causes (expired, thawed, outside the proper temperature, > 30 min outside the ideal storage temperature)" indicator was present in 30% of articles. This is due to blood components used in blood transfusion that have an expiration date and an adequate way of storage to maintain their characteristics and clinical viability.[2] However, when these are not stored or handled properly, they need to be disposed of.

In the case of disposal, it is necessary to consider, in addition to the technical aspects, the financial value. According to an estimate made by the WHO, only the disposal of RBC in the countries of Latin America and the Caribbean, in 2011, represented a loss of approximately 45 million US dollars, with a respective cost of 20 million US dollars for the Brazilian state.[67] This scenario encourages the need to know the factors that influence the disposal of processed blood units, with the aim of listing actions to prevent those considered potentially avoidable.[68]

Still on stock management, another indicator evidenced in 6% of the articles was the "Average storage time of blood components". This indicator permeates some discussions regarding the physical and metabolic alterations that RBC may undergo with storage time, even if this occurs in the recommended way. Some studies have found that storage time may be associated with the development of red blood cell oxidative stress, metabolic deficiency, decrease in ATP and 2,3-DPG, increase in inflammatory cells, adhesion to endothelial cells, activation of the complement system, changes in coagulability and hemolysis.[69-70]

Although the time of RBC collection does not influence mortality, there is evidence

indicating that adverse events related to red blood cell transfusion are more pronounced in susceptible patient populations, such as those in intensive care, trauma, cardiac surgery and newborns, while other patient populations do not appear to be affected by transfusion of older RBC.[70-71]

In the Transfusion process production indicators segment, the "Whole blood transfusion rate by blood component and blood group" was the most cited, present in 18% of articles. This incidence occurs because the numbers related to the number of transfusions performed, taking into account some variables, such as hospital size, number of beds, specialties attended, make it a necessary tool that allows the planning of work demand by blood services and guides the application of initiatives such as PBM.[72] In Brazil, it serves as a monitoring tool by the National Health Regulatory System for indicators of blood component production and use.[73] Moreover, another essential role of this indicator is the performance of benchmarking among other institutions, collaborating for continuous improvement of the transfusion process.[74]

The "RBC index matched and effectively transfused" was also representative, as data from developed countries show that 40 to 70% of units of blood prepared for transfusion are actually transfused.[75] Blood reserves for surgical patients contribute to this statistic, which requires spending on supplies and human resources and prevents using these units reserved for other hospital demands, leading to the loss of blood components due to expiration date.[76]

Another segment that emerged in the study was "Transfusion process assessment indicators", which presented the highest number of indicators. It can be said that this is due to the fact that it includes the main items for assessing the transfusion process quality, which have a direct impact on the care provided to the patient.

Among those that stood out the most is the "Transfusion reaction rate (overall, by type of reaction, severity, by type of blood component, associated with failure, near miss, associated with transfusion, or not)", evidenced in 40% of articles. Transfusion reaction is defined as an adverse event associated with blood transfusion components, observed in up to 1% of all transfusions performed, which can be fatal.[77] There is potential for error at every step of the transfusion process, and learning from incidents should lead to improvements in health care.[6] Additionally, identifying the transfusion reaction rate is an important step in an institution's risk management, as it enables the development of strategies to increase the transfusion process quality.[78]

Other indicators listed in this segment were representative, as they are part of legal aspects

related to the blood transfusion process. This is the case of "Transfusion request rate met according to transfusion protocols", "Rate of incidents related to request forms for blood components/exams (incomplete requests)" and "Rate of transfused blood components according to the results of laboratory tests and patients' clinical conditions". According to regulations, blood transfusion requests cannot be incomplete, erased or illegible, they need to present the diagnosis and clinical indication of the blood component, as well as be in line with institutional protocols.[2]

The "Response time from transfusion request to start of blood transfusion" was also frequently highlighted. This is an important quality indicator, as delays in transfusions continue to contribute to patient deaths, and communication problems were identified in 33.3% of reported cases of delays, being considered one of the contributing factors.[6,79] In addition to these, indicators such as "Rate of incidents related to sample collection" and "Rate of incidents related to pre-transfusion testing/exams" were also observed, whose incidents can lead to adverse transfusion events, including acute hemolytic transfusion reactions and death.[6]

Sample collection and pre-transfusion tests are critical steps in the transfusion process and need to be monitored and assessed. A study carried out between 2006 and 2015 in Canada described that 42,363 sample collection errors and 14,666 sample handling errors were reported in 1,736,512 samples received by the 23 blood banks. Of these errors, 24.5% were classified as high severity, which are related to sample labeled with incorrect patient identification, no identification, wrong patient collected, incomplete/illegible label for the main patient identifiers, incorrect identification wristband/ not available. The transfusion request and sample ID do not match.[80] With regard to failures in pre-transfusion tests, in 2021, in the United Kingdom, 389 events were reported, with the highest proportion of errors occurring in the stages of labeling, availability, handling and storage of components (31.4%), followed by testing (29.3%) and component selection (23.4%).[6] With this, we observe the critical areas of the transfusion process and which require more care, attention and knowledge to ensure safe transfusions.

The last segment described, "Transfusion process support indicators", included 26% of indicators, highlighting "Active Transfusion Committee and hemovigilance (presence, number of meetings, responsible person, number of hours devoted to hemovigilance)", present in 8% of articles. This indicator is related to a WHO determination that states that hospitals need to have transfusion committees to ensure the appropriate clinical use of blood, effective staff training and clinical practice monitoring and assessment. This committee is responsible for supervising and

implementing hemovigilance in the hospital, regularly reviewing results and monitoring the effectiveness of improvement measures.[81]

Another three indicators that were highlighted are related to the training process of teams that perform blood transfusions. The technical knowledge of professionals who are directly linked to the blood transfusion process is essential. These indicators are the subject of several publications, mainly in the field of nursing, as can be seen in some studies. They claim that nursing professionals' knowledge is reduced in this area, and it is necessary to improve knowledge and skills to ensure good practices in blood transfusion.[1,82-83]

In addition to those cited, the "Incident rate related to quality management (lack of indicators, lack of data)" appeared in 6% of articles. This is due to a WHO recommendation, which determines that an effective quality management system must be implemented within each organization responsible for elements of the transfusion chain. This system should ensure consistent practice, through using written procedures and regular audits, and that there is a cycle of quality improvement that produces demonstrable results.[81]

There was a concentration of indicators to assess the operational and tactical scope of the transfusion process, mainly blood component stock management and production numbers, with a gap with regard to the assessment of care provided to blood recipients and transfusion safety and low production of Brazilian articles on this topic. This evidence justifies the need for studies that address this issue, especially at the national level, in order to assess the transfusion process also at the strategic level, emphasizing the care provided.

The development of this study reinforces the importance of having indicators that monitor and assess the transfusion process in order to identify the risks related to this therapy, the improvements that can be made, thus contributing to transfusion quality and safety. Furthermore, it made it possible to show that institutions seek to adopt these indicators as a way of assessing processes and adapting them to current legislation.

Conclusion

Given the overview of scientific production presented by this review, it was observed that using an indicator is a necessary tool to assess and monitor the transfusion process, being used by

several health institutions around the world. The growing concern for improving the transfusion process quality was evidenced by the presence of a list of indicators that assess and monitor the management of blood component stocks, production numbers of the transfusion process, transfusion process stages and support actions, despite that there are few indicators related to the care provided to patients undergoing blood transfusion, indicating the need to improve studies on the subject.

In the case of the Brazilian context, which has particularities in its health system when compared to other countries, such as socioeconomic heterogeneity and access to technologies, there is a shortage of publications on the subject. It is noted the importance of using indicators for the transfusion process assessment as well as the publication of studies that address this issue, in order to disseminate best practices and contribute to benchmarking among health institutions.

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Author contributions

1 – Daiana de Mattia
Corresponding author
Nurse, Mater's Degree - daimattia@gmail.com
Research conception and development, manuscript writing, review and approval of the final version.

2 – Dulcinea Ghizoni Schneider
Nurse, PhD - dulcineia.schneider@ufsc.br
Research conception and development, manuscript writing, review and approval of the final version.

3 – Francine Lima Gelbeck
Nurse, PhD - francine.lima@ufsc.br
Research conception and development, manuscript writing, review and approval of the final version.

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