

Frame of reference and recommendations for the electronic order and prescription of blood components in Belgian hospitals

Initiative: BeQuinT - working group electronic prescription

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Content

Content.....	3
Abbreviations	4
1. Introduction	5
2. Electronic order and prescription of blood components (EOP)	5
3. Frame of reference for the EOP of blood components	6
4. Definitions related to the EOP	8
4.1. Electronic Patient Record (EPR).....	8
4.2. Computerized Provider Order Entry (CPOE).....	9
4.3. Authentication	11
4.4. Electronic signature	11
4.5. Authorization	11
4.6. Clinical Decision support system (CDSS)	12
4.7. Trusted Time Stamping.....	12
5. Functionalities of the EOP.....	12
6. Electronic communication of medical data	14
6.1. Communication standard	14
6.2. Data encoding.....	14
7. Methodology.....	15
8. Recommendations	17
8.1. Level 1 recommendations	17
8.2. Level 2 recommendations	20
8.3. Level 3 recommendations	29
9. Table with summary of recommendations.....	34
10. Mock-ups – EOP of blood components.....	35
11. References.....	36

Abbreviations

BeQuinT	Belgian Quality in Transfusion
CDSS	Clinical Decision Support System
CPOE	Computerized Physician Order Entry
EC	Erythrocyte concentrate
eID	Electronic identification
EPR	Electronic Patient Record
EOP	Electronic order and prescription
FFPVI	Fresh Frozen Plasma Virus Inactivated
HIS	Hospital Information System
BP	Blood product
HLA	Human Leucocyte Antigen
HPA	Human Platelet Antigen
INR	International Normalized Ratio
MD	Medical doctor
PC	Platelet concentrate
TAS	Type and screen

1. Introduction

BeQuinT (Belgian Quality in Transfusion) is a national platform supported by the Federal Public Service of Health, Food Chain Safety and Environment. The mission of BeQuinT is to improve the transfusion policy and the utilization of blood components in the Belgian hospitals.

The **order** and **prescription** of a **blood component** (see below for definitions) by a physician are the first acts in the transfusion process. The utilization of blood components is related to the appropriateness of the order and prescription (appropriate indication, appropriate number of components). Most Belgian hospitals have **electronic patients records (EPR) with several functionalities including the electronic order and prescription for intravenous fluids and medication**. As for the order and prescription of medication, a computerized (electronic) format of the order and prescription of blood components offers opportunities to facilitate, optimize and monitor the process. In addition, a certain degree of **standardization** of the electronic order and prescription can also make it a useful tool to optimize the utilization of blood components at the very start of the transfusion process.

Based on a national survey performed by BeQuinT in 2014 an electronic prescription of blood components was present in 7% and in development in another 29% of hospitals. To help hospitals and software providers in developing the electronic order and prescription, BeQuinT has installed a working group “electronic prescription” to write a document describing a **framework as a tool for standardization** for the electronic order prescription of blood components.

2. Electronic order and prescription of blood components (EOP)

Based on the clinical situation, the MD can decide to **order** (NL: bestellen; FR: commander/prescrire) a number of blood components for a particular patient. This order implies either classical cross-matching or type and screen methodology. In both situations the ordered blood components may remain in the blood bank or can be transported to a clinical unit (e.g. operating room) where they are kept under correct conditions until either transfusion or return to the blood bank. The ordering is generally followed by the decision of the MD to actually administer the blood component(s) which must be formalized as a **prescription** (NL: voorschrift; FR: ordonnance, la décision de l'administration des composants sanguins par un médecin) of the transfusion of the blood components.

According to the situation, the **electronic order** and the **electronic prescription** (combined: the **EOP**) of blood components can be two separate series of actions or can be integrated into one series of actions.

3. Frame of reference for the EOP of blood components

BeQuinT created the working group (members: see Table 1) to define a **frame of reference** and provide **recommendations** for the (further) development of the EOP of blood components in the Belgian hospitals. The document should be useful to **standardize** the EOP as a tool to align the need of the Belgian hospitals with the offer from the software providers.

A well designed EOP of blood components can facilitate the process of transfusion in many ways:

1. **ensuring the authentication and authorization** of the ordering and prescribing medical doctor,
2. **unequivocal coupling of patient and blood component** identifiers,
3. immediate **access to key information** (e.g. most recent hematological parameters) to make sound clinical decisions related to the indication for transfusion,
4. assist in having a quick overview of the **patient's transfusion history**, including previous reactions and previous alloimmunisation incidents,
5. assist in correct **indication for transfusion** e.g. according to certain guidelines (clinical decision support),
6. **facilitate the ordering**, the number and specific characteristics of blood components including **predefined settings** for particular situations (urgencies, massive blood loss, pediatric transfusion,...),
7. assist in the **exact timing** of the transfusion through specification of the preferred time of transfusion,
8. facilitate **data collection** to evaluate the efficiency of the transfusion.

In addition, **standardized information** derived from EOPs (by the creation of a hospital database) may allow to **monitor and improve transfusion policies** at the departmental, hospital and central authority's levels through:

1. measuring of the utilization of blood components in certain domains and/or patient populations (in combination with an electronic traceability system),
2. verification of compliance with guidelines and/or predefined settings (e.g. transfusion thresholds),
3. verification of compliance with guidelines (more restrictive or more liberal) for the total patient population or specific patient groups,
4. benchmarking at several possible levels (national level, between hospitals, between departments, between specialists).

The purpose of this document is to provide a **frame of reference** and **recommendations** for ICT hospital departments and software providers for the development of the EOP of blood components.

The recommendations are related to:

1. **standardized data integration:**
which information (data) should be included in the EOP?
2. **customization to optimize user friendliness:**
how can the interface of the EOP be adapted to facilitate the workflow?

Table 1 – Composition of the working group

Name	Institution
Timothy Devos (vice-chair)	MD, Universitair Ziekenhuizen Leuven
Anneli Keereman	Transfusion specialist, Rode Kruis-Vlaanderen
Robert Larbuisson	MD, Centre Hospitalier Universitaire de Liège
Ludo Marcelis	MD, AZ Delta
Ludo Muylle	Hemovigilance specialist, MD, Universitair Ziekenhuis Antwerpen, Federaal Agentschap voor Geneesmiddelen en Gezondheids- producten (FAGG)
Luc Nicolas	eHealth specialist, Federal Public Service of health
Lucien Noens	MD, Universitair Ziekenhuis Gent
Dominique Putzeys	Nurse, Union Général des infirmiers de Belgique (UGIB)
Rik Schots (chair)	MD, Universitair Ziekenhuis Brussel
Jana Vanden Broeck	Transfusion specialist nurse UZ Brussel, project coordinator BeQuinT (FOD VVVL)
Jamie Verelst	Software engineer, Universitair Ziekenhuis Brussel

4. Definitions related to the EOP

4.1. Electronic Patient Record (EPR)

The electronic patient record (EPR) includes information about the patient within one health care organization that can be created, managed, and consulted by authorized users within that organization.¹

As part of action point 2 of the **eHealth plan**, the Federal Public Service of Public Health started an accelerator program with the objective that all hospitals use an **integrated EPR** (for the end of 2018).¹

Quite a lot of Belgian hospitals don't have yet a real integrated EPR and still use several integrated applications in a more or less performing way. However, the integration between different functions and different modules of the electronic record is important.¹ Whether these functionalities are obtained from a single vendor or from many different vendors, is part of the information strategy the hospital must create.¹

A single vendor solution, often defined as a 'holistic system', offers the promise of integration but in practice this can be challenged by a missing or immature functionality in the product suite.¹

The opposite strategy is the 'best of breed' approach, in which subsystems are selected from multiple vendors primarily on their performance for a particular functionality. But the best in functionality might not be the best in integration and often healthcare benefits more from integration than yet another extra feature.¹

Anyway it has to be stressed that, most significantly, the industry pendulum has swung from best of breed/deep clinical functionality to the need for integration. It is still feasible to build an overall system out of modules from different vendors, but integration possibilities must be taken into account from the start and be made part of the requirements.¹

Whatever approach is chosen (single or multiple vendor(s)), it is important that the EOP is integrated in the EPR.¹

The following terms are used in the document to describe the interaction between the different modules on a functionality level. A description will clarify the small nuance differences in terminology.

Part of	The module is an integral part of the overlaying software package. It is developed by the same vendor, most likely in the same technology and has access to all the data in the software package.
Integrated	A module is integrated in a software package when a certain level of interactivity on functionality and data sharing is achieved so that for the end-user the module behaves as if it would have been a part of the software package although look & feel may differ. Integrated software can be developed by a different vendor in another technology.
Linked	A module is linked to a software package when a certain level of interactivity on functionality and data sharing is not achieved so that it doesn't behave as it would have been part of the software. For example no automatic updating of data after the module has been opened by the end-user. It may also be possible that not all necessary data is transmitted from the software package to the module or that the module is not able to receive or register this data.

4.2. Computerized Provider Order Entry (CPOE)

In the EPR a particular action is initiated upon a **Computerized Physician Order Entry (CPOE)**. A CPOE is an **electronic request** for any kind of service: clinical observations, tests, medication, blood components.¹ The entry and storage of an order in a computer-based system enhances legibility, enables planning and traceability, reduces duplication, and improves the speed with which orders can be executed.¹

The electronic CPOE process involves different steps for the user:²

- 1) authentication
- 2) invokes the CPOE application and selects a patient for order entry,
- 3) enters and modifies orders,
- 4) indicates when he or she is ready to “finalize” the set of orders to send them out for processing,
- 5) reviews and edits orders before they are dispatched to be carried out (by ancillary departments, e.g. lab, pharmacy, blood bank).

These are examples of CPOEs in the context of the transfusion chain:

- 1) ordering (NL: bestellen; FR: commander) of blood components,

- 2) order to perform pretransfusion tests such as hemoglobin, platelet count, ABOD blood group typing and other Rh antibodies, cross match, type and screen,
- 3) prescribing (NL: voorschrijven; FR: prescrire) blood components
- 4) order to perform post-transfusion tests to test the effectiveness of the transfusion (hemoglobin, platelet count,...).

The EOP may thus involve more than one CPOE.

A **prescription** is the instruction to perform a **clinical intervention**, such as the formal instruction to take a blood sample (for example for pretransfusion tests) or to administer a blood component to a patient.

The law does not differentiate between a CPOE and an electronic prescription.³ In a hospital the written prescription by a medical doctor may be replaced by an electronic document provided that the following conditions are met:

- the **identity** of the medical doctor responsible for the prescription is mentioned,
- the association is made with a precise **reference date and reference hour**
- no invisible modification possible after the mentioning of the identity of the medical doctor and after the association with the reference date and reference hour (= **trusted time stamping**).³

The involved professionals in the EOP as well as the administration of blood components should be **traceable**. An electronic blood tracking program may play an important role through the registration of (1) the person who administers the blood component and (2) the prescriber (decision to administer) and (3) the supervisor responsible for the patient after the start of the transfusion.

4.3. Authentication

Hospital-wide **authentication (= verification of identity)**, wherein users may authenticate once and subsequently have access to all relevant systems in a hospital [1]. The electronic patient record must authenticate users before allowing access.

Examples of authentication include:¹

- username and password,
- digital certificate,
- strong authentication in the form of "hardware tokens",
- biometrics.

4.4. Electronic signature

The electronic signature is a **method of authentication**. According to the European Directive 1999/93/EC⁴ an advanced electronic signature meets the following requirements:

- uniquely linked to the signatory,
- capable of identifying the signatory,
- created using means that the signatory can maintain under their sole control,
- linked to the data to which it relates in such a manner that any subsequent change in the data is detectable.

4.5. Authorization

Authorization **defines the access policy** to the EPR.¹ The system uses access control rules to decide whether access requests from (authenticated) users shall be approved (granted) or disapproved (rejected). For example, permissions can be granted or denied based on:

- the identity of an individual (user based authorization),
- the responsibility or function performed in a particular process (role based authorization),
- the context in which an access request occurs, e.g. location, patient's present condition (context-based authorization).¹

4.6. Clinical Decision support system (CDSS)

CDSS are computer systems designed to impact clinician decision making about individual patients at the point in time that these decisions are made⁵, for example the decision to order and/or prescribe blood components. Using prompts and alerts, CDSS would help improve compliance with best clinical practices such as guidelines, avoid therapeutic duplication (overlap with an already existing order of blood components), etc. Only when both patient data and clinical knowledge are available in the same system space in machine-understandable, interoperable format it is possible to provide additional support to the decision-making clinician.¹ For example, encoded medical knowledge about the meaning and significance of a certain hemoglobin value or platelet count would allow a system to provide alerts, an active function, instead of mere passive data storage. Similarly, if the system could combine the patient context with relevant clinical guidelines, it could present ordering options consistent with these guidelines.¹

4.7. Trusted Time Stamping

Trusted time stamping is the process of securely keeping track of the date and hour of the creation and modification time of (parts of) a record¹, for example the creation of an electronic prescription of blood components. No one — not even the owner of the record — is able to change the data without this being detected by checking with the original timestamp. More detailed information can be found in article 1. § 1. of the Royal Decree 07/06/2009.

5. Functionalities of the EOP

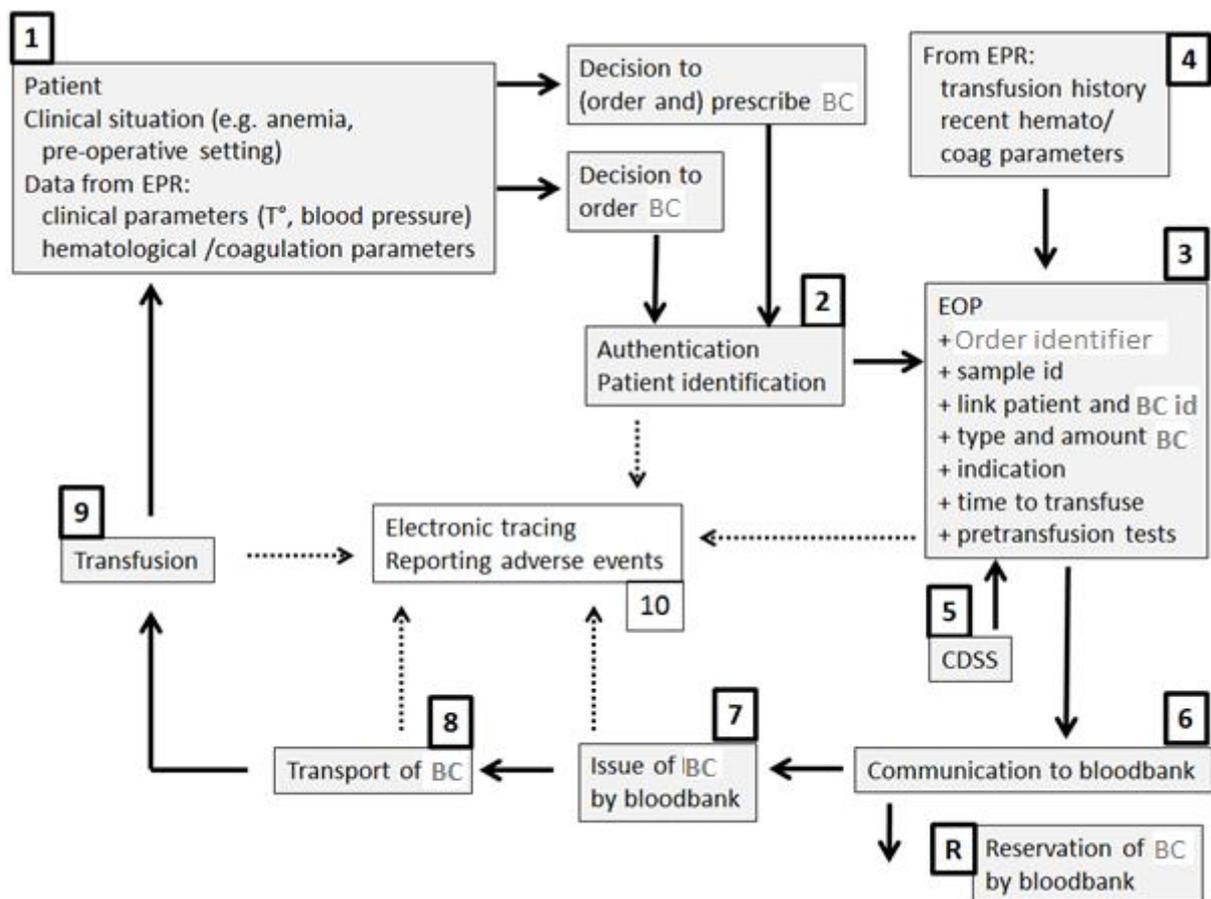
The workflow presented in Figure 1 gives an overview of these functionalities. This overview may be helpful for the IT hospital service or software providers in particularly to get to know the context of the transfusion chain:

1. Start of the workflow: based on clinical observation and clinical/laboratory parameters present in the electronic patient record (EPR), the MD makes the decision to order (NL: bestellen; FR: commander) blood or to order and immediately prescribe (NL: voorschrijven; FR: prescription) blood components.
2. This first step includes:
 - authentication of the MD prescriber
 - selection and identification of the patient.
3. The MD opens the interface for the EOP of blood components

This step includes:

- creation of an order identifier
- creation of sample identification number (and instruction to take the blood sample)
- specification of the type and number of components
- specification of indication
- indication of the timing of the transfusion
- ordering of the pretransfusion tests (blood group, cross-match or type and screen).

Figure 1. Workflow to order and/or prescribe blood components (BC)



4. Patient-related data from other parts of the EPR, such as the history of transfusion (reactions, alloimmunisation) and the latest hematological/coagulation data may be integrated in the EOP.
5. A clinical decision support system (CDSS) may help to improve compliance with transfusion guidelines by using prompts and alerts.

6. Communication of the order for the blood component to the blood bank (and communication of the order for pretransfusion testing to the laboratory). This order implies either classical cross-matching or type and screen methodology. In both situations the ordered blood components may remain in the blood bank (on hold, as a reservation) **(R)**.
7. Based on (a re-evaluation of) the clinical situation, the MD can decide to give the instruction to actually administer the blood component(s) to the patient. The latter is the actual electronic prescription for the transfusion of the blood components which will lead to the issuing of the components by the blood bank. The order and the decision/instruction to administer (prescription) may also be integrated into one action.
8. Transport of the components to the patient.
9. Transfusion of the component to the patient after verification of the blood component and the patient's identity (right patient, right product, blood group compatibility, expiry date,...).
10. Electronic tracing should render all steps in the transfusion process traceable. So the EOP should be included in the electronic tracing. Adverse events related to the transfusion should be recorded in the EPR.

6. Electronic communication of medical data

6.1. Communication standard

If the electronic patient record consists of different commercial and/or proprietary modules, a communication standard is needed to allow communication between these different parts of the hospital information system (and the blood bank information system).

HL7 is a widely used international standard for the exchange, integration, sharing, and retrieval of electronic health information between hospital information systems (HIS). The use of this standard is important to support clinical practice and the management, delivery and evaluation of health services.⁶

6.2. Data encoding

Data used in the CPOE should be encoded in a standardized way using the SNOMED CT2 standard. Examples of data that should be encoded are the type(s) of ordered blood components, indications, specifications. These data should be encoded in order to enable the

CPOE to communicate with other systems or exporting data for analysis or benchmarking. A comprehensive list of the codes in scope will be made available.

SNOMED CT is the most comprehensive and precise clinical health terminology product owned and distributed around the world by The International Health Terminology Standards Development Organization (IHTSDO).⁷ As a coding or classification system it has the goal to attribute codes to medical concepts (for example acute appendicitis) listed in a clinically validated, controlled medical vocabulary. In this way SNOMED CT provides a standardized way to represent clinical phrases captured by the clinician and enables automatic interpretation of these.

Belgium is an official member of IHTSDO since 2013 and SNOMED CT is considered the default terminology standard as such. Access to the standard is free and information can be obtained at following address: terminologie@health.belgium.be. The translation of the SNOMED CT standard into Dutch and French is currently under way.

Pretransfusion tests accompanying the order should be encoded in LOINC.

7. Methodology

This frame of references was developed in different steps:

- 1) The BeQuinT working group compared existing EOPs of blood components from UZ Gent, UZ Brussel and UZ Leuven.
- 2) Subsequently the framework for electronic patient record functionalities developed by the workgroup eHealth from the Federal Public Service Health¹ was consulted. This minimal framework was further elaborated for the specific context of the electronic order and prescription of blood components.
- 3) Involved professionals in the Belgian hospitals and software vendors were invited to review this frame of reference and recommendations to obtain feedback on feasibility and timelines.

The recommendations are defined at the **level of integration** which corresponds to the difficulty of implementation from the informatics technical point of view (see **Figure 2** for the definition of the levels). A recommendation requiring a higher level of integration (for example an overview of the transfused blood components in the transfusion history which can be consulted from the EOP) may take some time to develop. However from a medical point of view this information is very useful to avoid overlap of orders.

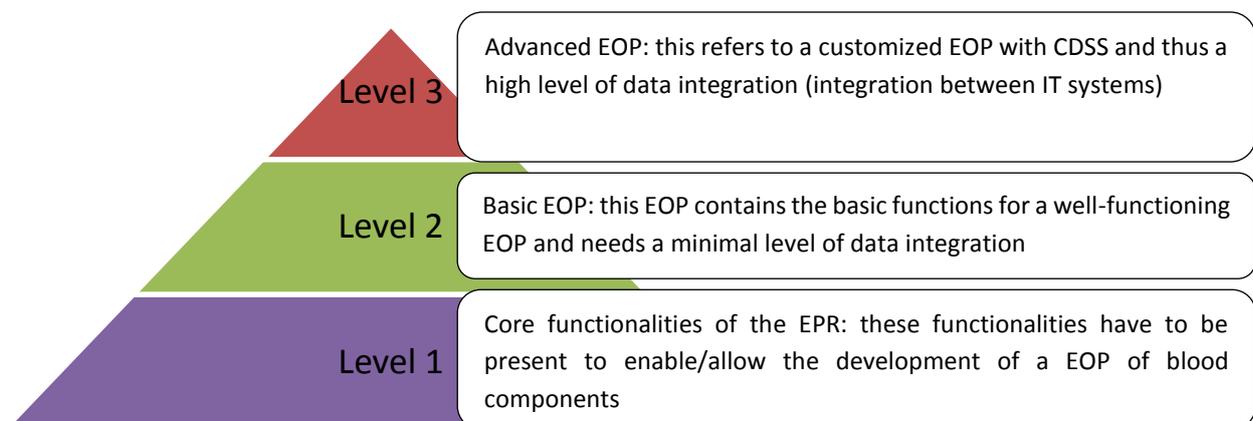
Levels of integration may also help to define a particular **timeframe** according to which the EOP can be developed and implemented, from the **practical/technical** point of view and from a **financial** point of view.

Recommendations are summarized in a table format with mentioning of the corresponding number in the text (**Chapter 9**).

The recommendations are intended for:

- 1) transfusion committees and IT services in the Belgian hospitals who want to develop or improve their EOP of blood components
- 2) commercial software developers and providers who sell software to order and prescribe blood components electronically to adjust their software to the needs of the Belgian hospitals.

Figure 2. Integration level of recommendation



EOP = electronic order and prescription, CDSS = clinical decision support system, EPR = electronic patient record.

In **chapter 10** some mock-ups of an example of an EOP of blood components can be found. A mock-up is a model of a design used for demonstrating, teaching, etc. It enables testing of a design and acquiring feedback from end-users.

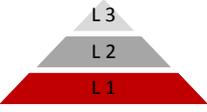
8. Recommendations

8.1. Level 1 recommendations

Level 1 recommendations refer to basic functionalities of the electronic patient record (EPR). These functionalities have to be present to enable/allow the development of an electronic order/prescription (EOP) for blood components.

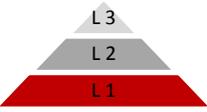
8.1.1. Authentication of the prescriber

Blood transfusion has to be prescribed by a MD.⁸ Consequently the prescriber has to “prove” that (s)he is a MD. This process is called authentication. After a successful authentication the MD can be authorized to (order and) prescribe blood components. Ideally, the prescriber is authenticated by a digital certificate such as eID. However, a username and password may also be used for authentication.

	<p>8.1.1. Hospital-wide authentication should be developed and deployed across all the clinical applications. This can be established through:</p> <ul style="list-style-type: none"> ▪ a specific procedure (e.g. login + password), or through ▪ an electronic certificate present on the eID or ▪ another specific certificate.
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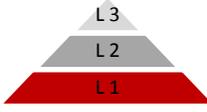
8.1.2. Selection of the patient

Blood components can only be issued based on a nominative prescription.⁸ Therefore the concerning patient who needs transfusion should be selected in an unambiguous way. This is an essential step to avoid transfusion incidents due to an electronic order or prescription for the wrong patient.

	<p>8.1.2. The patient for whom the MD wants to order/prescribe blood component(s) has to be selected in the EPR in an unambiguous way. In the EOP the</p> <ul style="list-style-type: none"> ▪ first name, ▪ family name, ▪ date of birth, ▪ patient identifier <p>should be displayed.</p>
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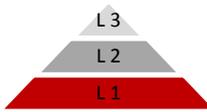
8.1.3. Creation of an order/prescription identifier

To enable the storage and use of data, each electronic order/prescription should be identified by a unique order/prescription identifier.

	<p>8.1.3. Each electronic order/prescription should be identified by a unique order/prescription identifier.</p>
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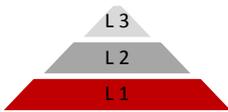
8.1.4. Prescriber information

Blood transfusion has to be prescribed by a MD.⁹ Only one physical person is allowed (possibly complemented by organization and department).

	<p>8.1.4. For prescriber information the RIZIV-INAMI number of the MD should be mentioned on the EOP. To obtain this information, it is recommended to display these data automatically based on links with the authentication of the MD. For the sake of information consistency, it should also be mentioned in the traceability system.</p>
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8.1.5. Availability of a Laboratory Information System (LIS)

Several laboratory tests may be used in transfusion practices: pretransfusion tests (such as blood group typing, cross match/type and screen), hemoglobin, platelet count, INR. It is assumed that every Belgian hospital disposes of a LIS. The available LIS allows to store and consult lab test results electronically.

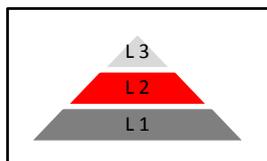
	8.1.5. A laboratory information system should be available.
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8.2. Level 2 recommendations

Level 2 recommendations refer to a basic EOP containing the basic functions and requiring a minimal level of data integration.

8.2.1. Integration of EOP in the EPR

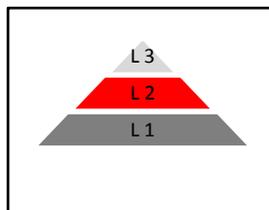
The electronic patient record may consist of a combination of several software packages. Consequently it is not always the case that the EOP of blood components is part of the EPR. However it is recommended that it should be integrated. For definition of integration: see 4.1.



8.2.1. The EOP for blood components has to be (part of or) integrated into the EPR.

8.2.2. Accessibility of the EOP

Prescribers will resist any interruption in workflow.¹⁰ To allow an efficient workflow, the time to complete the EOP for blood components should be kept to a minimum. Therefore the MD should be able to open the EOP as quickly as possible.

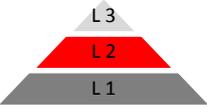


8.2.2. The EOP of blood components should be immediately accessible in the EPR. The design of the EOP should be kept as simple as possible and should be structured with the end-user in mind.

8.2.3. Workflow and design of the EOP

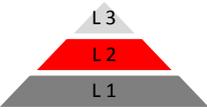
The classical workflow is to order blood components for a particular patient. This can be done as such without the decision to transfuse immediately (for example in case of a preoperative order for elective surgery). The blood bank can perform pretransfusion testing or apply the type and screen methodology to hold the blood component(s) after the pretransfusion tests.

Based on the clinical situation, the MD may decide to actually administer the blood component(s). The latter is the actual electronic prescription for the transfusion of the blood components which will lead to the release of the components by the blood bank.

	<p>8.2.3. For the design of the EOP there are several possibilities:</p> <ul style="list-style-type: none"> a) the electronic order and the electronic prescription are separate applications OR b) the electronic order and prescription are integrated in one single application and are completed at the same time, in one action OR c) the electronic prescription is completed first and then the order appears (one or more applications). Information related to the prescription may be automatically inserted here. <p>No matter which workflow is chosen, the user-friendliness has to be optimized and the necessary conditions regarding authentication, authorization, electronic signature and time stamping have to be fulfilled.</p>
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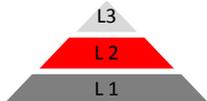
8.2.4. Time stamping

After authentication and authorization of the prescriber, time stamping is performed so that the integrity of the data is preserved (4.7). By time stamping the creation (and modification) time of the EOP of blood components will be securely tracked.

	<p>8.2.4. Time stamping has to be conducted for every EOP of blood components. This means that the date and time of the creation (and modification) of each EOP is registered automatically and that his registration cannot be changed.</p>
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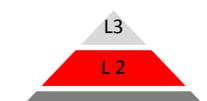
8.2.5. Information related to the prescriber

It is important that information related the prescriber is displayed on the order form so that the MD can be contacted if necessary, for example by the blood bank.

	<p>8.2.5. The name and (if possible) the phone number of the ordering/prescribing MD have to be mentioned on the EOP. To obtain this information it is recommended to display these data automatically based on links with the authentication of the MD.</p>
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8.2.6. Information related to the care unit and timing of transfusion

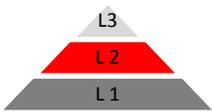
To facilitate the issuing of blood components the prescriber should report in which care unit and when the blood component(s) have to be administered.

	<p>8.2.6. The name and phone number of the care unit where the blood component(s) have to be administered and expected time (dd/mm/yyyy, hh:mm) of administration should be displayed on the EOP. To obtain this information it is recommended to display these data automatically based on links with the registered location of the patient. However, modification of these data should be possible (different phone number,...). Dependent of local procedure and blood bank facilities a standard timing of distribution can be defined. In addition, it should be possible to register a later time point of distribution (for example when ordering for elective surgeries) or order components urgently (for example in case of major hemorrhage).</p>
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8.2.7. Type and specific characteristics of blood components

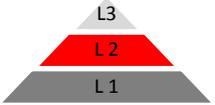
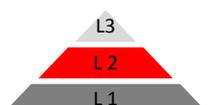
Predefined types and specific characteristics of blood components to enable the prescriber to tick off while preparing the EOP. This obviously facilitates the ordering and will reduce the time needed to complete the EOP. It is recommended to limit a dropdown list to 7 items maximum.

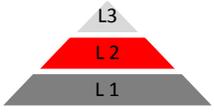
Another option is a “completer” function that allows the clinician-user to type “shorthand” word fragments, derived from the desired order name (or its synonyms). The completer then searches for potentially matching terms from the orderable dictionary, and provides the user with a “pick list” of order names, from which the user can select.

	<p>8.2.7. The prescriber has to be able to choose the type of blood component (s)he wants to order/prescribe in a user-friendly way, for example by selecting them in a predefined list (EC, PC and FFP). In case of a list, standard EC, (pooled) PC or standard FFP should be automatically selected.</p> <p>2) if applicable, specific characteristics of the blood component may be selected, <u>for example</u>:</p> <p><u>Specific characteristics of EC:</u></p> <ul style="list-style-type: none"> ▪ Irradiated ▪ Infant type ▪ CMV negative donor <p><u>Specific characteristics of PCs:</u></p> <ul style="list-style-type: none"> ▪ Single donor PC (HLA/HPA compatible)
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8.2.8. Indications for transfusion

Blood components can only be transfused based on a nominative prescription with a specified indication.⁸ The EOP of blood components should be a medical decision based on the clinical observation of the patient and evidence-based literature. To facilitate the workflow and reduce the time needed to complete the EOP, some indications should be displayed in a (dropdown) list. It is recommended to limit a dropdown list to 7 items maximum. In an advanced EOP structure a clinical decision support (CDSS) can stimulate the implementation of recent transfusion guidelines by alert and/or consult mechanisms (see level 3 of recommendation)

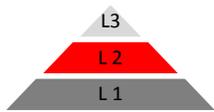
	<p>8.2.8.1. A (dropdown) list of evidence-based indications for the transfusion of EC¹¹ should be displayed in the EOP, for example:¹²</p> <ul style="list-style-type: none"> ▪ Pre-operative ▪ Acute bleeding ▪ Hemoglobin less or equal to 7 g/dL ▪ Hemoglobin less or equal to 8 g/dL and acute coronary syndrome ▪ Hemoglobin less or equal to 8 g/dL and postoperative cardiothoracic patient ▪ Other (+ free text box)
	<p>8.2.8.2. A (dropdown) list of evidence-based indications for the transfusion of FFPVI¹³ should be displayed in the EOP, for example (based on RIZIV/INAMI reimbursement criteria¹⁴):</p> <ul style="list-style-type: none"> ▪ Shortage of coagulation factor V or XI ▪ Immediate treatment of overdose of vitamin K ▪ Massive blood loss ▪ Trombotic thrombocytopenic purpura ▪ Neonatal exchange transfusion ▪ Other (+ free text box)

	<p>8.2.8.3. A (dropdown) list of evidence-based indications for the transfusion of PC¹⁵ should be displayed in the CPOE, for example:¹²</p> <ul style="list-style-type: none"> ▪ Platelet count $\leq 10 \cdot 10^9/L$ ▪ Platelet count $\leq 20 \cdot 10^9/L$ and signs of hemorrhagic diathesis ▪ Platelet count $\leq 50 \cdot 10^9/L$ and active hemorrhage ▪ Platelet count $\leq 50 \cdot 10^9/L$ with invasive procedure (recent, in progress, planned, post op) ▪ Platelet count $\leq 100 \cdot 10^9/L$ with bleeding in a closed anatomical space (e.g. CNS, eye, etc.) ▪ Platelet dysfunction with active or anticipated hemorrhage ▪ Other (+ free text box)
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8.2.9. Patient-related data visualization

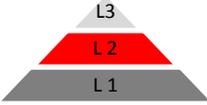
The EOP should be automatically completed with the necessary and appropriate patient information derived from the EPR. Consequently, the EOP should be well integrated within the EPR.

To facilitate the EOP a structured data input by ticking items of is recommended. Not all of the necessary information may be captured and the MD may want to add some supplementary explanation in a free text box.

	<p>8.2.9. Relevant patient information derived from the EPR should be displayed in each EOP, for example:</p> <ul style="list-style-type: none"> ▪ body weight of the patient (in case of order of platelets or exchange transfusion) ▪ latest measured blood pressure ▪ latest noted body temperature <p>A free text box should be offered in the EOP for blood components so that the MD can write some additional patient information or a specific request if necessary.</p>
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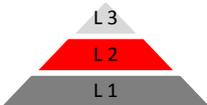
8.2.10. Previous transfusions

Consultation of transfusion history in terms of what has been ordered and/or transfused previously: the prescriber should be able to get an overview of previous transfusions.

	<p>8.2.10. The prescriber should be able to consult an overview of previous orders and transfusions at the time of ordering. This should be displayed in the EOP or be readily available via a direct link and includes at this level of recommendation at least:</p> <ul style="list-style-type: none"> ▪ first name and family name of the patient ▪ patient identifier ▪ unit number of the blood component (= donation number + product code) ▪ type of blood component (EC, PC or FFP) ▪ date and time of administration of the unit.
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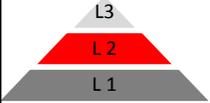
8.2.11. Number of units and combination of different types of blood components

The prescriber has to be able to choose the number of blood components. Unnecessary transfusions may be avoided by allowing only one single unit of EC to be administered to hemodynamically stable non-bleeding patients with symptomatic anemia, and requesting that the patient should be reviewed for resolution of symptoms.¹⁶

	<p>8.2.11. The prescriber must be able to choose the number of units per blood component. However, when predefined lists are used with numbers of units, the ordering of a single-unit transfusion should be favored (for example by requiring an extra click to tick off for justification when a higher number is ordered).</p>
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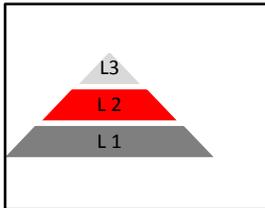
8.2.12. Pretransfusion tests

The EOP is inseparable from the order of pretransfusion tests such as blood group typing, cross-match (or type and screen, depending on local procedures). To obtain an efficient workflow these laboratory tests should be added automatically to the EOP of blood components, based on the type of blood components ordered and the number of times the blood group has been typed. Therefore the communication of the LIS with the EOP of blood components is indispensable.

	<p>8.2.12. When completing the EOP, a typed bloodgroup should appear automatically and pretransfusion tests should be ordered automatically to reduce the time necessary to complete the order and to improve the efficiency of the ordering/prescribing process.</p> <p>Different situations may occur:</p> <p>a) the patient's blood group is known in the EPR:</p> <ul style="list-style-type: none"> - the typed blood group should appear automatically, - 1 ABOD blood group typing is automatically added, - in case of EOP for EC, a cross-match / TAS should be automatically ordered. <p>b) the patient's blood group is unknown:</p> <ul style="list-style-type: none"> - 1 ABOD blood group typing is automatically added, and in case of EOP for EC, a cross-match / TAS should be automatically ordered, - a message should be shown to ask the MD to prescribe a second independent ABOD blood group typing.
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8.2.13. Traceability

The involved professionals in the completion of the EOP, the execution of the pretransfusion tests and the administration of blood components should be traceable. Consequently, if blood components remain at the blood bank after the order and the pretransfusion tests (for blood safety reasons and to avoid wastage), the prescription (instruction to bring the blood component to the care unit and administer it) should also be traceable.

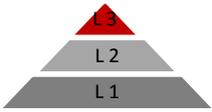


8.2.13. The EOP and involved care professionals should be traceable.

8.3. Level 3 recommendations

These recommendations refer to an advanced EOP, a customized electronic order with CDSS and thus a high level of data integration.

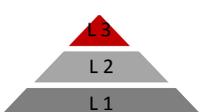
8.3.1. Authentication of the prescriber

	<p>8.3.1. The EOP is only authorized after the authentication by a digital certificate (for example eID).</p>
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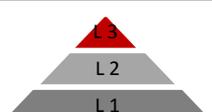
8.3.2. Link between the EOP and the blood bank information system

	<p>8.3.2. The blood bank information system should register the order identifier when receiving the order. After receipt of the order and before the release of the blood component(s) the blood bank information system should transmit the donation number and product code of the blood component to the order system which has to store it. This is necessary for electronic traceability.</p>
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8.3.3. Link between the EOP of blood components and medication

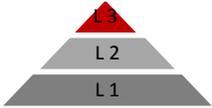
	<p>8.3.3. The order and prescription of premedication for transfusion should be linked or integrated of the EOP of blood components.</p>
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8.3.4. Patient risk profile

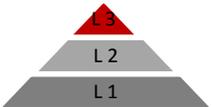
	<p>8.3.4. Patients with risk factors may be identified based on a memory function or an automatic calculation of risk factors in the EPR, for example:</p> <ul style="list-style-type: none"> ▪ polytransfused patient ▪ immunocompromised patient
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8.3.5. Patient transfusion history

When completing the EOP, the prescriber should check in the transfusion history if the patient had transfusion reactions before.

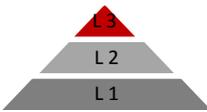
	<p>8.3.5. The prescriber should be able to consult the transfusion history of the patient to know if the patient had transfusion reactions before.</p> <p>This transfusion history should be displayed in the EOP or via a direct link and includes (see also level 2):</p> <ul style="list-style-type: none"> ▪ first name, family name of the patient ▪ patient identifier ▪ unit number of the blood component (= donation number + product code) ▪ type of blood component (EC, PC or FFP) ▪ date and time of administration of this unit ▪ transfusion reactions noted (including type and information on treatment and outcome).
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8.3.6. Predefined blood component combinations

	<p>8.3.6. To facilitate the workflow in specific clinical situations (massive hemorrhage, polytrauma) a predefined combination of different types of blood components should be possible in one single order only. The composition of the sets is based on evidence-based guidelines and local facilities (blood bank organization,...).</p>
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8.3.7. Instruction to the professional who administers the blood component(s)

The electronic prescription refers to the instruction by the MD (to the nurse) to actually administer the blood component(s) to the patient. This can be integrated into the EOP (8.2.3).

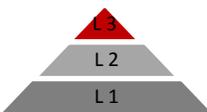
	<p>8.3.7. The instruction for the nurse to administer the blood component should be visible to the nurse (or other healthcare professional qualified for transfusion) in the EPR, for example in the electronic nursing record or in a work list.</p>
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8.3.8. Urgent blood transfusion

When the patient needs urgently blood transfusion, the time to order and prescribe blood components has to be reduced to a minimum.

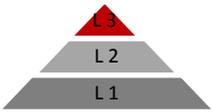
Hospital procedures must be developed:

- 1) for urgent transfusions (criteria to allow transfusion of EC without 2 independent typing of ABOD blood group or without cross match)
- 2) for massive transfusions (blood component packages, alternatives for transfusion,...).

	<p>8.3.8. In case of urgent transfusion, a concise EOP with an absolute minimum of tick offs must be available, facilitated by predefined orders sets. Ideally, the EOP should be completed in real time unless the clinical situation of the patient does not allow for this. However in the latter case, the EOP has to be completed as soon as possible after the urgent situation.</p>
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8.3.9. Memory function

The time necessary to prescribe blood components can be reduced by using a memory function for the EOP.

	<p>8.3.9. To increase the user-friendliness a memory function can be developed to retain the specifications of the last completed EOP:</p> <ul style="list-style-type: none"> a) based on the authentication of the MD: <ul style="list-style-type: none"> - the system remembers (for example) which indications are usually mentioned in the EOP by the MD in certain situations (such as hematology, stem cell transplantation,...) b) and/or based on the selected patient: <ul style="list-style-type: none"> - the system remembers (for example) if the patient usually receives irradiated or CMV negative EC.
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8.3.10. Clinical Decision Support Systems for the EOP

Several interventions intend to improve compliance with local transfusion guidelines and promote appropriate blood utilization, such as educational initiatives, clinician feedback and audits.¹⁷ In recent years, improvements in information technology have opened up new opportunities for changing physician behavior. Clinical Decision support systems (CDSSs) have been used in various fields in medicine. CDSSs provide clinicians with tailored treatment recommendations by combining individual patient information and local guidelines.¹⁷

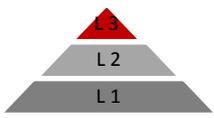
Decision support can be integrated into an EOP for blood components. For example, a CDSS could require a physician to choose the rationale for a transfusion request from a list of common transfusion indications. Based on the selected indication and the patient's most recent laboratory test results, the CDSS could advise the clinician on whether their request is within the institutional guidelines and also provide an alert and/or recommendation for modifying the order if it is inappropriately based on the patient's laboratory values.¹⁷

Different types of intervention can be provided by the CDSS:¹⁷

- Advise on transfusion suitability solely from a single laboratory value compared with an invariant institutional threshold, such as a hemoglobin value of 70 or 80 g/L. Others included certain preset criteria that would justify orders when laboratory values exceeded a threshold, such as a hemoglobin value of 70 g/L, if a patient was actively bleeding, showing signs of cardiac ischemia or early septic shock.
- CDSS can be mandatory for clinicians to use or not mandatory in the workflow.
- A reason may have to be given if CDSS advice was overruled.

Overall, there is good evidence that implementation of a CDSS improves red blood cell utilization.¹⁷

The effect of a CDSS on plasma and platelets utilization is less clear probably because fewer studies have been conducted focusing on these products.¹⁶ The available data on financial implications suggest that implementing a CDSS can produce substantial savings. Commonly, CDSS is introduced alongside educational programs as a co-intervention. It is likely that education and clinician feedback contribute to the impact of CDSS on blood utilization. A CDSS should be a part of a series of interventions designed to increase transfusion threshold compliance.¹⁷

	<p>8.3.10. The implementation of CDSS for the EOP is recommended as a co-intervention alongside an educational program to improve compliance with local transfusion guidelines and promote appropriate blood utilization. Keep guidelines and alerts simple and beware of alert fatigue.</p>
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9. Table with summary of recommendations

Item	Level 1	Level 2	Level 3
Authentication	Hospital-wide authentication (8.1.1)		Digital certificate, for example eID (8.3.1)
Patient selection	First and family name, date of birth and patient identifier in EOP (8.1.2)		
Order/prescription identifier	EOP identified by unique order identifier (8.1.3)		
Prescriber information	RIZIV/INAMI number of MD in EOP (8.1.4)	Name and phone number on the EOP (8.2.5)	
Lab info system (LIS)	LIS available (8.1.5)		
Integration of the EOP in the EPR		The EOP has to be integrated into the EPR (8.2.1)	
EOP design		EOP immediately accessible (8.2.2) as single or combined application (8.2.3). Time stamping of the EOP (8.2.4)	
Blood bank info		Care unit where patient is admitted and timing of transfusion specified (8.2.6)	Link between EOP and blood bank info system for electronic traceability (8.3.2.)
Type and characteristics of blood components		Predefined and available in drop down (8.2.7)	Predefined combinations (8.3.6)
Indications for transfusion		Dropdowns available for each component (8.2.8)	
Patient data visualization		Body weight, blood pressure, etc. (8.2.9)	Previous risk profile (8.3.4) and
Transfusion history		Overview of previous orders (8.2.10)	Previous transfusion reactions (8.3.5) available.
Number of units		Predefined lists favoring single unit EC transfusion policy (8.2.11)	
Pretransfusion tests		Depending on known results of blood group typing and cross match or type and screen (8.2.12)	
Traceability		EOP and care professionals involved in EOP are traceable (8.2.13)	
Premedication			Link between EOP of blood components and medication(8.3.3)
Prescription – communication to nurse			Electronic prescription easily visible for the nurse in the EPR (8.3.7)
Urgent transfusion			Easy access and predefined order sets (8.3.8)
Memory function			Based on login of prescriber or based on selected patient (8.3.9)
CDSS			Implementation of CDSS (8.3.10)

10. Mock-ups – EOP of blood components

A mock-up is a model of a design used for demonstrating, teaching, etc. It enables testing of a design and acquiring feedback from end-users. In this chapter an example of an EOP of blood components is displayed. However, applicability and user-friendliness have to be tested in each hospital individually.

Electronic order/prescription for Maes, Jan (A790821MS00T)

<div style="background-color: #808080; color: white; text-align: center; padding: 5px; font-weight: bold;">Prescriber</div> <p>Prescribing care unit: <input type="text" value="A757"/> <input type="text" value="Oncology"/></p> <p>Prescriber: <input type="text" value="Dr. FOSTIER, Ann"/> Tel. : <input type="text" value="3105"/></p> <p>RIZIV/INAMI number: <input type="text" value="XXX"/></p>	<div style="background-color: #808080; color: white; text-align: center; padding: 5px; font-weight: bold;">Destination</div> <p>Transfusion care unit: <input type="text" value="A757"/> <input type="text" value="Oncology"/></p> <p>Tel. : <input type="text" value="9406"/></p> <p>Planned moment of transfusion: <input type="text" value="21/08/2015 13:00"/></p>
<div style="background-color: #808080; color: white; text-align: center; padding: 5px; font-weight: bold;">Patient</div> <p>Blood type : <input type="text" value="A positive"/> (1 analysis)</p> <p>Hb : <input type="text" value="8,5"/> g/dL <input type="text" value="15/10/2015 08:00"/></p> <p>INR : <input type="text" value="..."/></p> <p>Platelets : <input type="text" value="..."/> x10³/mm³ <input type="text" value="15/10/2015 08:00"/></p> <p>Extra information:</p> <p><input type="checkbox"/> Polytransfusion (≥ 1 transfusion per week during 3m)</p> <p><input type="checkbox"/> Severe immunocompromised patient</p> <p><input type="checkbox"/> Other (for ex. premedication, weight): <input type="text"/></p> <p style="text-align: center; border: 1px solid gray; padding: 2px; display: inline-block; margin-top: 10px;">Transfusion history</p>	<div style="background-color: #808080; color: white; text-align: center; padding: 5px; font-weight: bold;">Blood component(s)</div> <p>Number: <input type="text" value="1"/> Specific requirements : <input type="checkbox"/></p> <p>EC <input type="text" value="1"/> <input type="checkbox"/></p> <p>⇒ Indication: <input type="text" value="..."/></p> <hr/> <p>Plasma <input type="text" value="0"/> <input type="checkbox"/></p> <p>⇒ Indication: <input type="text" value="..."/></p> <hr/> <p>PLC <input type="text" value="0"/> <input type="checkbox"/></p> <p>⇒ Indication: <input type="text" value="..."/></p> <p>⇒ Recently, ... unit(s) EC/FFP/PLC were ordered but not yet administered.</p>

Transfusion history

Type	Unit number	Time of transfusion	Care unit	Transfusion reaction
EC	B14382562476400 E5258V00	21/08/2015 (08:27)	ICU	Febrile non-hemolytic transfusion reaction
PLC	B14379906417100 E6600V00	21/08/2015 (02:05)	OR	-
FFP	B14379906285400 E4031V00	21/08/2015 (01:30)	OR	-
EC	B14379904417300 E5258V00	21/08/2015 (01:30)	Emerg.	-
EC	B14379906011800 E5258V00	21/08/2015 (01:30)	Emerg.	-

Irregular antibodies:

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