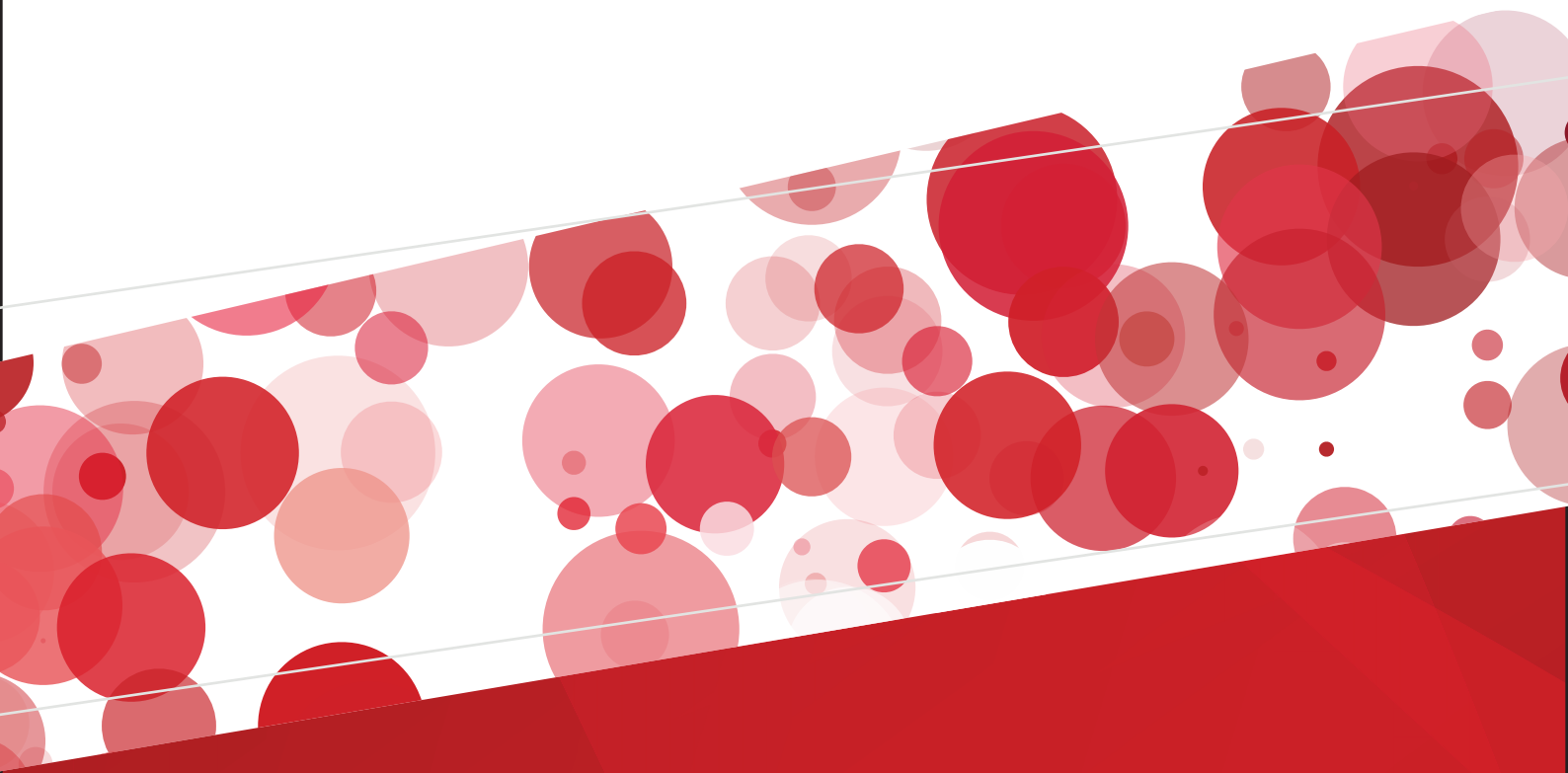
Implementation and use of electronic medical records (EMR) in blood management and transfusion practice

Blood Matters EMR survey report 2021



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Contents

Limitations

Blood Matters would like to outline the following limitations:

- Health service participation in the survey was voluntary, and some may not have contributed due to the impact on services related to COVID-19.
- The respondents were not trained; however, the surveys were accompanied with instructions for completing the survey, including definitions to ensure completeness of data.
- We included an 'unsure' field following early feedback from health services after the survey opened. In hindsight, this may have led to this field being chosen inappropriately or confused with N/A.
- The responses submitted were individual, expressed as their own experience and observations.
- Some individuals provided conflicting information within a single health service. Where possible, verification of the correct response was sought. If no response the majority response was included.

Acknowledgements

Blood Matters would like to acknowledge and thank:

- all the people and participating health services for their time and responses during challenging times
- Professor Erica Wood for your time and contributions to survey development
- Blood Matters Advisory Committee for review of the survey prior to distribution.

Blood Matters also acknowledges the publication of the Australian and New Zealand Society of Blood Transfusion (ANZSBT) *Guidelines for the implementation and use of electronic medical records for transfusion,* July 2021 (ANZSBT 2021) and a recent paper by Crispin et al. that provides helpful summaries from the ANZSBT guidelines (Crispin 2022).

Contact Blood Matters <bloodmatters@redcrossblood.org.au> if you would like to receive a copy of the summary reports provided to health services.

Executive summary

Thanks goes to the 111 people from 59 health services who completed the survey in challenging times. The survey included 113 questions that cascaded according to prior responses. This resulted in a complex and at times contradictory, large data set, and as such the report is comprehensive.

At the time of the survey, there were 20 health services using an electronic medical record (EMR) and 39 without an EMR. Of these 39, 13 plan to implement an EMR in the next five years. For those in the planning phases of EMR implementation Blood Matters encourages them to review:

- this report for lessons learnt to allow them to build on the experiences of others
- user-suggested improvements (Appendix 1)
- ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion*, July 2021, and undertake a thorough gap analysis of the planned EMR functionality with these guidelines.

Participating health services were given a summary of the guidelines (Crispin 2022) that includes aggregated survey findings and summarised individual health service responses.

Our survey focused on the inclusion of blood management and transfusion practices within an EMR. The results reinforce the importance of including subject matter experts (SMEs) in the selection, development and implementation of the EMR, along with training and ongoing support.

Design should be intuitive to the user to reduce error potential. Health services did not commonly report the presence of decision support tools, which may in part be due to the fact generic EMR platforms do not support these tools.

Our respondents shared things that have worked well and also suggested improvements that could assist health services, both with EMR development and enhancement.

The benefits of EMR can be immense if designed and implemented well. Awareness of best practice, adherence to guidelines and collaboration between healthcare groups is vital to ensure the EMR adds value to, rather than hinders, safe patient care.

Introduction

Medical records, whether electronic or paper, are a collection of information about a patient's healthcare that are essential for their present and future care. An EMR replaces paper-based medical records by electronically documenting the information relevant to a patient's healthcare.

They can be more than a simple device for recording information: they can include decision support tools and safety systems to help improve care. EMRs regularly link many information systems, and often the development and implementation of these platforms may not prioritise transfusion (Crispin 2022).

While there is no universally agreed standard definition of an EMR, for the purpose of this survey we used the Victorian Department of Health definition. An EMR encompasses the information and capabilities required to support healthcare service delivery, where the information is captured in a computer-readable form that supports interoperability and clinical decision support (State Government Victoria, Department of Health 2012), this includes both standalone systems and those interfaced with other systems in the healthcare service.

Verrall (2019) reports that there are many EMR systems used within Australia. Some jurisdictions have a common EMR throughout the jurisdiction (that is, statewide system across all hospitals), whereas others use different systems at different hospitals. Even where there are statewide systems in place, the hospitals are often at different stages of implementation.

Limited information is available about the implementation and use of EMRs with specific regard to blood management and transfusion practice. The survey's intent was to understand the value that an EMR can deliver, the unintentional risks that may come with it, and how risks could be mitigated through development, clinical engagement, and education.

The Australian and New Zealand Society of Blood Transfusion (ANZSBT) published the *Guidelines for the implementation and use of electronic medical records for transfusion* in July 2021 (ANZSBT 2021), after this survey had been completed and approved for distribution.

This report illustrates current design and implementation of blood management and transfusion practice within an EMR. Data could assist sites yet to implement an EMR, and help identify areas for optimisation for those with an EMR. Reported success factors, challenges, failures, and benefits of the various implementation approaches are highlighted.

Survey aims

The aims of the survey were to identify:

- The number of health services with an EMR
- Which staff have been involved in the design, development, and implementation of the EMR, and the extent of their involvement
- The extent and types of education associated with the EMR implementation
- If the EMR offers blood management and transfusion practice assistance and decision support
- Process and patient safety outcomes achieved, including any issues that may have occurred since implementation, both expected and unexpected.

Methodology

One hundred and thirty-one health services from four Australian jurisdictions (Victoria, Australian Capital Territory, Northern Territory and Tasmania) were invited to participate in the survey. To include perspectives of the different craft groups involved in blood management and transfusion practice, we invited up to six people in different roles across each organisation to complete the survey.

We asked for the survey to be completed by a minimum of one person (recommending the blood management/transfusion nurse/trainer/quality officer) and a maximum of six. The staff member may or may not have been directly involved in the design and implementation of the EMR.

Roles to include for survey completion:

- executive (ideally the executive sponsor for the Blood Management Standard)
- quality coordinator/consultant with responsibility for the Blood Management Standard, including blood management/transfusion nurse/trainer/quality officers
- clinical nursing, including a nurse unit manager where blood and blood products are used
- medical staff, including those in management roles, who are involved in the care of patients who require blood and blood product transfusion
- laboratory staff, including external pathology providers if relevant
- information technology staff, who have been involved with the EMR
- other staff that might be relevant to the EMR initiative in the health service.

Respondents were asked to record their own experience and observations, answering 'unsure' where they did not have information. Responses were used as aggregate information and individual health services are not identified in the data or any subsequent material developed from the survey.

The survey comprised 113 questions divided into craft group sections. Questions would cascade depending on previous responses given.

The survey was open from 2 August to 24 September 2021.

Results

A total of 59 health services responded to the survey (45 per cent of those invited), with 111 individual responses (number of responses per health service: average 1.9, median value 1, range 1–6).

EMR not used at the time of survey

Of the 59 health services that responded, 39 (66 per cent) did not have an EMR in place at the time.

From the 39 health services without an EMR there were 60 individual responses (number of responses per health service: average 1.5, median 1, range 1–5). Table 1 shows if the health services plan to implement an EMR within the next five years.

Table 1: EMR planning

Planning status	Health service count n = 39, (%)
EMR planned	13 (33%)
EMR not planned	1 (3%)
Unsure of EMR plans	25 (64%)

EMR planned in the next five years

From the 13 health services with a plan to implement an EMR in the next five years, there were 20 individual responses.

Four health services had chosen a vendor, and the remaining nine health services reported this is either still being decided or were unsure of the decision.

Table 2 shows the anticipated involvement of 20 respondents from the different craft groups for health services planning to implement an EMR in the next five years.

Table 2: Anticipated involvement in EMR implementation, by staff in different craft groups[1]

Level of involvement	Clinical nursing n = 6	Executive n = 3	Laboratory n = 1	Medical n = 1	Organisational IT n = 1	Quality n = 8
None planned	1	–	1	–	–	3
Plan to be involved	2	1	–	–	1	4
Selecting EMR	1	2	–	–	–	–
Content development	–	–	–	1	–	–
Review of content	2	1	–	1	–	1
Workflow	1	–	–	1	–	–
Functional testing	–	–	–	1	–	–
Planning go-live	–	1	–	–	–	–
Staff education	2	1	–	–	–	–

Five respondents (25 per cent) in total reported no planned involvement in the implementation process.

Of interest, three (38 per cent) respondents in quality roles (including transfusion nurses/trainers/officers and others with responsibility for the Blood Management Standard), have no planned involvement in EMR selection, content development or implementation at their institution. This may be due to plans being too far in the future to know how they will be involved or other factors not explored in the survey.

However, staff working in these quality roles who have thorough understanding of blood management and requirements for safe transfusion should be involved in the development and implementation of these aspects of an EMR. This includes workflow planning, functionality testing, go-live strategies and education.

There was one laboratory respondent, who indicated they had no planned involvement in the implementation process. Given the significance of the laboratory and clinical interface for blood management and transfusion practice it would be expected that laboratory staff would be included in planning an EMR.

1 More than one response could be selected.

Health services planning to implement an EMR within the next five (5) years are encouraged to review:

- this report for lessons learnt to build on the experiences of others
- user-suggested improvements (Appendix 1)
- ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* (July 2021) and undertake a thorough gap analysis of the planned EMR functionality with these guidelines.

EMR currently in place

There were 51 responses from 20 health services (20 of 59 health services, 34 per cent) that currently have an EMR (number of responses per health service: average 2.5, median 2, range 1–6). Table 3 shows a breakdown of respondents.

Table 3: Respondents' role at sites with an EMR in place

Role	Respondents count
Clinical nursing	6
Executive	5
IT (organisation)	3
Laboratory (senior staff)	7
Medical (clinical)	6
Other	4
Quality	20
Total	**51**

Date of implementation

Respondents reported EMR implementation from 2004 to 2021 (Table 4). The more recent EMRs are likely to have included additional functionality and sophistication as time has progressed.

Table 4: Year of reported EMR implementation

Year of implementation	Respondents count n = 20
2004	1
2009	1
2011	1
2015	1
2016	2
2017	2
2018	2
2019	2
2020	4
2021	2
Year unknown	2[2]

2 Two health services were unable to provide a year of implementation as the respondent was not working at the health service at the time of implementation

Involvement in development or implementation

Respondents (n = 51) were asked how they have been involved in the development and/or implementation of the EMR. Table 5 includes a breakdown of responses by role.

Five of the 20 quality respondents (25 per cent) reported no involvement in EMR implementation. This cohort includes transfusion nurses/trainers/quality safety officers who have thorough knowledge of blood management and transfusion safety requirements. Three of these five respondents do not have transfusion included in their EMR, which may explain why they were not involved. Two of the seven laboratory respondents (29 per cent), likewise, did not have any input into EMR development and implementation.

Table 5: Responses of role-based involvement in EMR development and/or implementation[3]

Level of involvement	Clinical nursing n = 6, (%)	Executive n =5, (%)	Laboratory n = 7, (%)	Medical n = 6, (%)	Organisational IT n = 3, (%)	Quality n = 20, (%)	Other[4] n = 4, (%)
None	2 (33%)	–	2 (29%)	1 (17%)	–	5 (25%)	–
Not at health service at the time of development and/or implementation	–	1 (20%)	1 (14%)	1 (17%)	–	1 (5%)	1 (25%)
Selection of EMR vendor	–	1 (20%)	–	–	1 (33%)	–	–
Content development	1 (17%)	2 (40%)	2 (29%)	3 (50%)	2 (67%)	8 (40%)	3 (75%)
Review/overview of content (subject matter expert)	3 (50%)	1 (20%)	3 (43%)	1 (17%)	2 (67%)	7 (35%)	2 (50%)
Consulted on workflows/ content	2 (33%)	3 (60%)	4 (57%)	3 (50%)	2 (67%)	13 (65%)	3 (75%)
Functional system testing	1 (17%)	1 (20%)	2 (29%)	2 (33%)	3 (100%)	2 (10%)	2 (50%)
Planning for go-live	3 (50%)	3 (60%)	2 (29%)	3 (50%)	3 (100%)	5 (25%)	2 (50%)
Staff education	4 (67%)	3 (60%)	3 (43%)	3 (50%)	2 (67%)	3 (15%)	3 (75%)
Other	1 (17%) (credentialed trainer)	1 (20%) (project director)	–	–	1 (33%) (deployment)	–	–

3 More than one response could be selected

4 Other roles: Extracorporeal life support clinical nurse consultant (ECLS CNC), EMR team, Nurse unit manager, EMR nursing team

Input into system development and implementation

Forty-five respondents representing 18 health services were at the health service during development and implementation of their EMR. Twenty-nine (64 per cent) of these indicated they had input into system development and implementation. Twenty-four of these 29 (83 per cent) felt their input was valued, 19 of 29 (66 per cent) felt their input was acted upon, and nine (31 per cent) felt neutral as to whether their input was acted upon. Five of the 29 who had given input (17 per cent) felt neutral towards the value of their input.

Sixteen respondents were not directly involved in the development and implementation of the EMR, eight (50 per cent) reported they would have liked some input.

EMR integration with other IT systems

The level of integration with other electronic systems such as patient registration, laboratory information and result systems varies. The following IT integration was reported by the 20 health services with an EMR in place (Table 6).

Table 6: EMR integration with other IT systems

IT system	Health service count[5] n = 20, (%)
Laboratory information system (LIS)	17 (85%)
Patient registration system	18 (90%)
Incident reporting systems (e.g. Victorian Health Incident Management System (VHIMS) or Riskman)	2 (10%)
Other	6 (30%) (medical imagery) 1 (5%) (palliative care)

It is not surprising there are high levels of integration with patient registration systems and laboratory information systems (LISs). Integration with the patient registration system would be seen as important to ensure accurate identification of all patients. Variability between the patient identification (ID) in different systems could result in significant impacts to patient outcome.

Seven of the 17 (41 per cent) health services that reported LIS integration have internal pathology providers, while nine (53 per cent) have external pathology providers. One health service reports both internal and external pathology providers. Most of the health services with LIS integration are public hospitals.

Integration with incident reporting systems is an area with low uptake, which could vastly improve ease of reporting and managing adverse events.

5 Cumulative responses from 51 respondents, that is at least one respondent per health service.

The ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* state that electronic systems must be interfaced with data transfer from the LIS to the EMR including the patient demographics (as defined by the ANZSBT *Guidelines for the administration of blood products*) and the product details (product type, unit number, expiry time and date and blood group), where applicable.

Bidirectional interfaces are considered best practice to minimise the chance of error, provide additional checking during sample collection and capture the fate of the product (ANZSBT 2021). While bidirectional interfaces provide the safest system, the EMR can still be used for transfusion with single directional interface. However, it must be noted that there is no additional safety provided by the EMR in this instance.

Education and training

Education and training underpin the successful implementation of any new system. The mode of delivery and content is most effective when it is role specific. Timing of the education can also influence its efficacy. If it is provided too early, staff may lose skills and confidence prior to implementation, while providing it too close to implementation may not allow enough time for adequate training. Simulation environments, while useful, may limit the degree of functionality that can be learned, with the risk that not all scenarios will be evident or included (Verrall 2019).

System design can influence both education and use. If the order of steps required is not intuitive, errors could occur repeatedly, as education alone cannot be relied upon to change the way people would naturally use a system. Human factors should be considered at the time of system design, rather than expecting education to overcome design faults.

Timing of education for EMR implementation

Forty-five staff (from 18 health services) who were at the health service during EMR implementation reported at least one form of education was provided prior to implementation. Table 7 indicates the timing of education provided.

Table 7: Timing of EMR education[6]

Timing of education	Respondents count n = 45, (%)	Health services n = 18, (%)
In the weeks/months prior to go-live	41 (91%)	17 (94%)
Immediately prior to go-live	14 (31%)	11 (61%)
No education provided	3 (7%)	3 (17%)

Three respondents (laboratory roles in transfusion) noted that 'no education was provided', other respondents from these health services did report at least one form of education. This may indicate that education could have been provided to staff based on organisational role, and perhaps not extended to include all staff.

When determining which staff require EMR training, some non-clinical roles may be overlooked, in the mistaken belief that it is not relevant to them, particularly if the EMR was not required in order for them to perform their daily duties. It is very important all staff are familiar with the EMR at go-live. Non-clinical staff may identify issues during the implementation phase that could prevent problems later, when the EMR is in routine use. These staff may have their daily workflow affected due to changes imposed by EMR use.

6 More than one response could be selected.

Training as part of orientation

If a staff member indicated they started with the health service after EMR go-live (n = 6), they were asked if the EMR was included as part of the orientation or pre-start program. Five reported that EMR training was included as part of the orientation (2 x quality, 1 x laboratory, 1 x other, 1 x executive respondents). One respondent from a medical role reported no training.

Ongoing education

Forty-five staff (from 18 health services) who were at the health service during EMR implementation were asked whether there was ongoing education support following go-live, including education for new staff. Of the 18 health services represented, respondents in two health services reported no ongoing education support after go-live/training.

While ongoing training, and training of new staff is a challenge, it is essential the education is available and undertaken (Murphy 2009).

Training methods used

Those who responded that training was available at any stage of the implementation process were asked which methods of training were used (Table 8).

Table 8: EMR training methods by health services[7]

Training method	Weeks prior to go-live n = 17, (%)	Immediately prior to go-live n = 11, (%)	Ongoing education n = 18, (%)
Face-to-face	17 (100%)	9 (82%)	17 (94%)
Videoconference/ virtual training	8 (47%)	3 (27%)	5 (28%)
Simulation training	11 (65%)	5 (45%)	7 (39%)
Online learning	14 (82%)	8 (73%)	14 (78%)
Other	Super users, email communications, tip sheets	Super users, handbook	Email communications, tip sheets, handbook

7 Cumulative responses, that is at least one respondent per health service. More than one response could be selected.

Some health services reported training changed due to the COVID-19 pandemic preventing face-to-face training.

A variety of training methods and time points were reported. Literature describes many training approaches as explained in Table 9.

Table 9: Different educational approaches to deliver training

Training method	Approach
Train-the-trainer	The train-the-trainer approach uses staff who are EMR experts to train other members of staff, who then in turn train the rest of the staff. This approach was found to be ineffective in driving rapid implementation at three acute hospitals in Oxfordshire in the United Kingdom, but they did find value in the creation of expert users in each clinical area with training by this method (Murphy 2009).
Direct training	Training was found to be more effective when staff were directly trained by the implementation team in shorter sessions, using teaching materials including dummy wrist bands and RBC units. Once a clinical area had reached a 'critical mass' of staff who were trained to use the new equipment (around 50 per cent), the training of the remaining staff took on its own momentum. Training staff directly also allows for reinforcement of good practice, such as positive patient identification (Murphy 2009).
Simulation training	Simulation training is an interactive learning opportunity to use EMRs within a simulated clinical setting. It is an effective method of teaching prior to implementation of EMRs (Vuk 2015). Lucas (2010) found that using hands-on interactive teaching methods enhanced staff competence and confidence in using these systems for patient care. Additional training, including mock patients in clinical settings has been used to practice clinical scenarios including deteriorating patients and outpatient workflows prior to EMR go-live (McGuire 2013).

Minimum time required for mandatory training

Survey respondents reported that minimum time requirements for mandatory training varied, and this was not always consistent within the health service. Options given ranged from no minimum time requirement up to one cumulative full day. The minimum training time required varied with respondent's role, as shown in Table 10.

Table 10: Minimum time required for mandatory training by role

Role	Minimum time required
Clinical nursing	3–4 hours One respondent reported 2 full days equivalent
Executive	Reported training dependent on role
Organisational IT	One full day equivalent
Laboratory	2–3 hours
Medical	One full day equivalent
Quality	Mixed responses – no minimum time, don't recall, training was role-based and varied from several hours to 1–2 days

Confidence following education

Forty-two (of the 45 respondents who were at the 18 health services at the time of EMR implementation) reported receiving education. Twenty-nine (29/42, 69 per cent) reported they received enough training to confidently use the EMR at implementation. Table 11 shows the training adequacy, as reported per role.

Table 11: Training adequacy provided by role

Role	Number of respondents	Adequate training provided n (%)	Inadequate training provided n (%)
Clinical nursing	6	6 (100%)	–
Executive	4	3 (75%)	1 (25%)
Laboratory	3	3 (100%)	–
Medical	5	4 (80%)	1 (20%)
Organisational IT	3	3 (100%)	–
Quality	18	7 (39%)	11 (61%)
Other	3	3 (100%)	–
Total	**42**	**29 (69%)**	**13 (31%)**

Although 29 (69 per cent) responded that they received adequate training, the response from those in quality roles highlighted only seven of the 18 (39 per cent) respondents thought their training was adequate. Staff working a quality role are rarely directly involved in hands-on patient care, suggesting that training may have been directed to the roles with the most direct clinical impact.

Three (100 per cent) of the laboratory respondents who were provided with education stated they were given enough time (ranging from two to four hours) to be able to confidently use EMR at implementation, although three other laboratory respondents from different health services (Table 7) stated they had no EMR education provided to them.

There were 13 respondents, spread across 11 different health services, who received training, but reported they felt the training was inadequate to confidently use EMR at implementation. Most of these respondents were from quality roles. The general theme from respondents' feedback centred on the system complexity, where often only basic training was given.

Some of the specific comments provided by respondents who did not feel confident in the use of EMR at implementation include:

- 'Able to use basic functions, but many different workflows across the hospital not aware of. Basic understanding was okay' (medical).
- 'Training provided for basic reporting using EMR. No access to role-based training to understand clinical workflows to assist with understanding of clinical documentation issues or variation' (quality).
- 'Long lead time with training and go-live due to Covid' (executive).
- 'Hindsight has identified there were many areas that required additional training and support that weren't included in the pre go-live education' (quality).

Assessment of training

Twenty-four respondents at 11 of the 20 health services (55 per cent) reported that an assessment was conducted following training to ensure an adequate understanding. This question was asked of all staff, whether they were present at implementation or not. Respondents from five health services (25 per cent) reported they were unsure about assessment, and a further four (20 per cent) reported no assessment was conducted.

Set up of EMR for blood management /transfusion

Subject matter experts (SME) involved in the development and review of the EMR blood management/transfusion content

The transfusion process is complex and involves many staff across a wide variety of specialties. It is therefore important when developing a system that is functional and provides patient safety that those specialty groups are involved or at least consulted. Respondents who reported blood management being included in the EMR were asked which subject matter experts (SME) were involved in the development and review of the EMR blood management/transfusion content (Table 12).

Table 12: Breakdown of the SMEs reported to be involved if blood management included in EMR[8]

Role	Health service count n = 11, (%)
Medical (including haematology, oncology, bone marrow transplant, emergency, anaesthetics, surgery and general medicine)	10 (91%)
Nursing (including haematology, oncology, bone marrow transplant, emergency, theatre, general medicine, day procedure, blood management/transfusion, intensive care and paediatrics)	10 (91%)
Clerical/administration	–
Laboratory/pathology (including directors, operation managers, quality officers, laboratory senior and non-senior staff)	9 (82%)
Pharmacy	7 (64%)
Executive	4 (36%)
EMR vendors	10 (91%)
Information technology (IT) (including health service IT, vendor IT and pathology IT)	9 (82%)

Aspects of blood management/transfusion included in EMR

The survey asked which aspects of blood management/transfusion were included in the EMR, and if the pathology provider was in-house or external (service contracted) (Table 13). There were 48 respondents (from 20 health services). A higher incidence of sample collection, blood management and transfusion were included in the EMR where there is an in-house pathology provider.

8 More than one response could be selected.

Table 13: Aspects of blood management/transfusion included in EMR at the health service[9]

Aspect of transfusion	An in-house pathology provider Health service count n = 8, (%)	An external pathology provider Health service count n = 12, (%)	All Health service count n = 20, (%)
Pretransfusion blood sample collection	7 (88%)	4 (33%)	11 (55%)
Blood component prescribing (ordering for bedside transfusion)[10]	7(88%)	2 (17%)	9 (45%)
Blood product prescribing (ordering for bedside transfusion)[10]	7 (88%)	2 (17%)	9 (45%)
Blood component preparation (crossmatching) requests to transfusion laboratory[10]	7 (88%)	3 (25%)	10 (50%)
Blood product preparation requests to transfusion laboratory or pharmacy[10]	6 (75%)	3 (25%)	9 (45%)
Blood component bedside administration[10]	6 (75%)	1 (8%)	7 (35%)
Blood product bedside administration[10]	6 (75%)	1 (8%)	7 (35%)
Recording fluid balance	8 (100%)	6 (50%)	14 (70%)
Massive transfusion – blood component ordering[10]	4 (50%)	1 (8%)	5 (25%)
Massive transfusion – administration of blood components[10]	6 (75%)	–	6 (30%)
Documenting transfusion reactions	6 (75%)	6 (50%)	12 (60%)
Decision support for preoperative anaemia assessment/management[11]	1 (13%)	–	1 (5%)
Decision support for prescription of blood/blood products[10]	5 (63%)	1 (8%)	6 (30%)

9 Health service count based on majority rules.
10 Blood components are RBC, FFP, platelets and cryoprecipitate. Blood products are manufactured or batch products.
11 Decision support in this context would include things such as: alerts; best practice advisories (BPA); and/or mandatory questions that lead to a suggested action

Process

1. Pretransfusion

Pretransfusion sample collection

Test ordering and specimen collection

Specimen collection is the first step to safe transfusion. It is essential that this important step is practised correctly.

ANZSBT guidelines provide health services with the requirements needed for safe transfusion practice (ANSBT 2019). The ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* (ANZSBT 2021) address the essential aspects of transfusion in relation to EMRs.

A recent paper by Crispin et al. (2022) summarises these guidelines.

Crispin et al. (2022) state:

- Requests may include requests for blood sample collection and testing, requests for blood products to be prepared or requests for blood to be delivered.
- Sample collection requires positive patient identification and labelling at the bedside immediately after collection.
- Where EMRs assist with patient identification, they must be identified by a barcode or radio frequency identification chip specific to the patient and distinguishing them from the patient record.

For health services (n = 11) reporting pretransfusion sample collection is part of the EMR; quality, nursing (clinical and management), medical (clinical) and laboratory staff were asked which type of pretransfusion specimen forms are used during normal operation (Table 14).

Table 14: Type of pretransfusion specimen form used during normal operation[12]

Pretransfusion specimen form type	Health service count n = 11, (%)
Electronic only	1 (9%)
Paper form only	2 (18%)
Ordered electronically and a paper form is printed from the order	10 (91%)

12 Cumulative responses, that is at least one respondent per health service

Most respondents (n = 10, 91 per cent) state the pretransfusion test is ordered in the EMR and the request form is printed at the time of sample collection for laboratory processes. Two (18 per cent) use a paper pretransfusion request form not generated in the EMR, and one (9 per cent) uses an electronic request.

One laboratory respondent reported that the reduction in paper forms has improved efficiency in the laboratory.

Use of the EMR for requesting and printing pretransfusion tests may introduce errors. Care must be taken to ensure the correct request form accompanies the sample, particularly if the form and/or sample labels are printed away from the patient bedside. Errors are more likely to occur when multiple test request forms and/or sample labels are printed from the same location, which could cause printer queues and the potential for the wrong labels and/or forms to be collected. The changed workflow could result in a mismatch between the patient identity on the request form and the sample or the more serious error of a wrong blood in tube.

Some health services allow staff to revert to paper request forms and labelling by hand, or using patient addressograph labels in emergency situations. Staff may then revert to this practice in non-emergency situations if it is perceived as quicker and easier for them. This practice bypasses the automated systems linking the laboratory processes to the clinical environment. This can influence both safety and efficiency due to the increased time taken to perform the manual processes (Verrall 2019). Additionally, it bypasses the safety inclusions found in many EMRs which assist in patient ID and procedure matching associated with barcode scanning of the patient's ID band and in some cases the sample labels.

Scanning of patient identification bands when collecting pretransfusion specimens

Quality and clinical staff (n = 19) at the 11 health services using the EMR for pretransfusion sample collection were asked if patient ID bands were scanned when collecting pretransfusion specimens. Seven health services (64 per cent) use a scanning device when collecting these samples and four (36 per cent) do not.

Issues with scanning patient identification bands

Clinical (nursing and medical, n = 8) responded to the question aimed at capturing problems associated with patient ID scanning prior to collecting pretransfusion samples. Table 15 summarises the frequency of scanning problems.

Table 15: Frequency of scanning problems[13]

Problem	Always n (%)	Usually n (%)	Sometimes n (%)	Never n (%)	Unsure n (%)
Scanner not working	–	1 (13%)	3 (38%)	–	4 (50%)
ID band issues	–	1 (13%)	2 (25%)	1 (13%)	4 (50%)
Need to override ID scanning	–	–	3 (38%)	–	5 (63%)

Most respondents report being unsure about patient ID band scanning problems.

Best practice positive patient ID is to ask the patient to state and spell their full name, and state their date of birth, which is checked against the ID band along with the medical record number. These details must match the test request patient details whether electronic or paper.

Scanning a patient ID band is not a substitute for positive patient ID. Verrall (2019) reported that ID bands attached to IV poles, beds and children's toys have been scanned (not the one attached to the patient) when collecting blood samples and administering blood products.

Organisations must have policies in place to ensure that alternative methods of patient ID are used in those extremely rare situations where a patient cannot wear an ID band.

Scanning of the sample tubes after collection

Clinical (nursing and medical) and quality staff (n = 19) at health services where scanning devices are used for collection of pretransfusion specimens (n = 11) were asked if scanning of the sample tubes is required after their collection (n = 7, Table 31).

Four of the seven (57 per cent) health services with patient ID band scanning required at collection reported scanning of the sample tube after collection is required. This may contribute to safely helping to match the patient to the sample collected based on patient ID and sample ID scanning matches.

Collector's declaration statement confirming correct patient identification

Clinical (nursing and medical) and quality respondents (n = 19) were asked how staff sign the collector's declaration statement to confirm they have followed the correct patient identification and sample labelling process. Requests for pretransfusion testing must contain a declaration as stipulated in both the ANZSBT *Guidelines for transfusion and immunohaematology laboratory practice* (ANZSBT 2020) and the National Pathology Accreditation Advisory Council (NPAAC) *Requirements for transfusion laboratory practice* (NPAAC 2019).

13 Individual responses reported.

The declaration should be similar to: 'I certify that I collected the accompanying specimen from the above patient whose identity was confirmed by enquiry and/or examination of their name band and that I labelled the specimen immediately following collection and before leaving the patient' (NPAAC 2019).

The EMR should prompt staff to complete this statement, whether it is paper or electronic, resulting in fewer specimens being rejected because the statement had not been signed. Table 16 shows the majority sign a printed form.

Table 16: Method used for pretransfusion collector's declaration statement

Declaration type	Scanning device used Health service count n = 7, (%)	No scanning device used/unsure. Health service count n = 4, (%)
Entering a unique staff identifier number into EMR	1 (14%)	–
Scanning a unique staff QR code or barcode	1 (14%)	–
Selecting a declaration box when already logged in	–	–
Signing a printed form	5 (71%)	4 (100%)

Positive patient identification

Clinical (nursing and medical) staff (n = 8) at health services using scanning devices in pretransfusion sample collection were asked if the EMR has made them more reliant on using the computer systems for positive patient ID (Table 17). This is a subjective question, but important to assess the perception of the impact of the EMR on patient safety.

Table 17: Perception of reliance on scanning devices for positive patient ID

	Always	Usually	Sometimes	Never	Unsure	N/A
Scanning device used Respondent count (n = 4)	–	–	1	1	–	2
No scanning device used/Unsure Respondent count (n = 4)	–	1	1	1	–	1

Most respondents do not feel they are more reliant on the computer/scanning device for positive patient ID.

If correct patient ID procedures are not followed, there is a genuine risk to patient safety. Patient ID band scanning can result in a 'false sense of security', so awareness and understanding of this aspect of EMR functionality is vital.

ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* (ANZSBT 2021) state that positive patient ID must occur in accordance with the ANZSBT *Guidelines for transfusion and immunohaematology laboratory practice* (ANZSBT 2020) prior to electronic confirmation of identity. Where possible, the EMR should be used to assist in patient ID at the point of sample collection although this is not always practical (for example, where pretransfusion samples are collected at outpatient pathology collection centres).

When the EMR is used to assist sample collection and patient ID, processes must identify both the blood collector and patient.

A regional hospital emergency department in Queensland, Australia found safety behaviours were an assumed skill, and education improved critical key behaviours markedly. These key behaviours were further reinforced with implementation of patient ID band barcode scanners (Spain 2015).

There is widespread recognition of risks to patient safety in relying upon electronic scanning or patient ID (Murphy 2012). Thorough training and ongoing support for staff undertaking ID procedures, robust reporting of near-miss events and their follow-up is required. Subsequent retraining may be necessary if indicated. The capacity to introduce reminders within the EMR to always ask a conscious patient to state their name and date of birth could compliment the education.

Pretransfusion specimen labelling

Quality, nursing (clinical and management), medical (clinical) and laboratory staff were asked how pretransfusion specimens are labelled during normal operation (Table 18).

Table 18: Pretransfusion specimen labelling during normal operation[14]

Pretransfusion specimen labelling	Pretransfusion sample collection incorporated into EMR Health service count n = 11, (%)	No pretransfusion sample collection incorporated into EMR Health service count n = 4, (%)
Handwritten	4 (36%)	3 (75%)
EMR printed labels	7 (64%)	–
Addressograph	–	1 (25%)

The majority of health services with pretransfusion sample collection incorporated into the EMR (n = 7, 64 per cent) use labels generated through the EMR. Whereas health services with an EMR that did not incorporate pretransfusion sample collection predominantly use handwritten labelling for pretransfusion specimens.

14 Health service count based on majority rules.

ANZSBT guidelines state that sample labelling is required after collection. Systems should prevent pre-labelling and should facilitate labelling at the patient's side where possible (for example by printing labels at the patient's side after collection). Systems must not force labelling away from the bedside (such as sample labels being printed at a distant printer such as at a nurses' station) once samples have been collected. Handwritten labelling may be required if unable to print at patient side (ANZSBT 2021).

EMRs may guide staff on which tubes to use for sample collection. In some systems, the specimen labels may contain a unique barcode for each tube (Verrall 2019). It is crucial that the correct label is placed on the corresponding tube, otherwise when the specimens are receipted in the laboratory, the sample may be directed to the incorrect department for analysis, leading to spurious results or the need for a rebleed.

Location of label printers

Labels can either be printed from a central computer (that is, not at the patient's side), or at the patient's side by a wireless/battery operated printer. There is usually a continuous roll of perforated blank labels in the printers.

Nine of the 17 (53 per cent) health services require EMR-generated printed labels for specimen labelling. They were asked where the label printers are located (Table 19).

Table 19: Location of label printers[15]

Location of printers	Health service count n = 9, (%)
Mobile printers for all printing	3 (33%)
Mobile or handheld for sample labels only	7 (78%)
Fixed outside patient rooms	1 (11%)
Fixed inside patient rooms	2 (22%)
Fixed at central station	5 (56%)

15 Cumulative responses, that is at least one respondent per health service. More than one response could be selected.

Issues with printing labels

Respondents (n = 17) were asked if there have been any issues with printing specimen labels (Table 20).

Table 20: Printing label issues[16]

	Initially an issue n (%)	Ongoing issue n (%)	Never an issue n (%)
Battery life[17]	1 (6%)	3 (18%)	1 (6%)
Wi-Fi outages	1 (6%)	5 (29%)	3 (18%)
Misaligned labels	4 (24%)	6 (35%)	2 (12%)
Printing quality	3 (18%)	5 (29%)	2 (12%)
Printer queues	1 (6%)	4 (24%)	5 (29%)
Uncollected labels	1 (6%)	5 (29%)	5 (29%)
Incorrect printer selected	2 (12%)	6 (35%)	2 (12%)
Extra specimen labels printed	–	1 (6%)	1 (6%)

The greatest ongoing issues with printing labels are misaligned labels and selecting the incorrect printer. Others include Wi-Fi outages, printing quality and uncollected labels. Many of the label printing issues reported can affect not only efficiency, but could result in risks to patient safety by selecting incorrect labels.

Two health services (12 per cent) reported the EMR font on printed specimen labels was too small. One health service also noted that the labels were easily smudged. This is not in line with the ANZSBT guidelines, which state that samples, labels and blood products must have written identification visible at all times so that identification can be performed or confirmed manually (ANZSBT 2021). If the font is too small or smudged, the printed ID is ineffective.

In addition, one health service reported that the laboratory accession (specimen) number is not always printed on the specimen label as it should be, as per ANZSBT 2021 guidelines.

Various issues have been identified depending on where labels are printed, as outlined below in Table 21, Table 22 and Table 23 (Verrall 2019).

WBITs have been detected when staff have reprinted labels using the same laboratory accession number (Verrall 2019).

16 Number of individual responses.
17 Battery life only asked of respondents from seven health services who use mobile printers (1 clinical, 4 medical, 7 quality).

Labels printed at a central printer

Table 21: Issues relating to labels printed at a central computer

Issue	Potential consequence
Delay in collecting labels from the printer, or multiple staff printing labels at the same time	• Multiple patient labels being attached to each other waiting to be collected • Wrong patient's labels removed from the printer along with some of the correct patient's labels • Wrong patient's labels used for some specimens along with some correct patient's labels
Printed labels being placed in pre-prepared blood taking trays	• The incorrect pre-prepared blood tray or labels being taken to the wrong patient
Hospital phlebotomists printing multiple labels for different patients prior to collecting blood specimens	• Incorrect labels being used for the patient being bled
Unlabelled specimens removed from patient side to label at the printer	• This may involve overriding the PPID in the system

Labels printed at the patient's side by a wireless/battery operated printer

Table 22: Issues relating to labels printed at the patient's side by a wireless/battery operated printer

Issue	Potential consequence
Printer batteries low on charge/printers not being returned to charger	• Mobile printer not available when required • Unlabelled specimens removed from patient side
Inability to find mobile printers	• Mobile printer not available when required • Unlabelled specimens removed from patient side
Inability to print due to wireless black spots/ printer going offline	• Mobile printer not available when required • When the printer comes back online, multiple patient labels printing (queuing) • Multiple patient labels being attached to each other waiting to be collected • Wrong patient's labels removed from the printer along with some of the correct patient's labels

Printed either from a central printer or printed at the patient's side

Table 23: Issues relating to labels printed either from a central printer or printed at the patient's side

Issue	Potential consequence
Delay in printing labels and queuing of printing labels	• Unlabelled specimens removed from patient side • Multiple patient labels being attached to each other waiting to be collected • Wrong patient's labels removed from the printer along with some of the correct patient's labels
Accidently selecting the wrong printer from a list of printers	• Unlabelled specimens removed from patient side • Multiple patient labels being attached to each other waiting to be collected
The wrong labels being collected from the printer	• Incorrect labels being used for the patient being bled
Incorrect patient labels printed	• Incorrect labels being used for the patient being bled
Print on the labels being small or smudged, making it difficult to read	• Correct checking procedures not followed • Specimens rejected by laboratory due to inability to meet labelling requirements
The roll of blank labels being inserted into printer incorrectly resulting in patient details printing at an angle and/or missing letters of the patient's name on the label	• Correct checking procedures not followed • Specimens rejected by laboratory due to inability to meet labelling requirements
Double labelling of specimens if staff initially label the tubes by hand or with a patient addressograph label if a printing error occurs	• Specimens rejected by laboratory due to inability to meet labelling requirements

Signing of pretransfusion samples

Prior to the introduction of EMR, some health services required all specimens to be signed by the collector. For simplicity, some now only require signatures on pretransfusion specimens. Confusion with staff may occur as to which specimen labels require a signature, and some pretransfusion specimens consequently require recollection due to the signature being omitted (Verrall 2019). Two laboratory staff respondents reported an increase in unsigned pretransfusion specimens, excluding wrong blood in tube events (WBITs). Two respondents also noted an increase in the incidence of a different signature on specimen to that on the collector's declaration.

2. Consent

Twenty-five quality and clinical (nursing and medical) staff from 20 health services, provided responses to a series of questions on consent.

Crispin et al. (2022) state that EMRs must have a process for documenting informed consent or refusal in line with institutional policies.

Method of consent documentation

The method of documenting consent varies between health services. Table 24 shows the different permutations for blood product transfusion consent identified at 16 health services by 24 respondents.

Table 24: Consent options identified at responding health services

Documentation type	Health service count n = 16, (%)
Paper-based transfusion consent form – signed by the patient and medical officer then scanned into EMR	12 (75%)
Summary of conversation between patient and medical officer entered as a note or tick box into EMR	–
Both a scanned paper consent and note of conversation or tick box in EMR	1 (6%)
An electronic consent that is signed by the patient on a tablet (or similar)	–
Other	3 (19%)

Most health services (n = 12, 75 per cent) use a paper-based transfusion consent form that is signed by the patient and medical officer and then scanned into the EMR.

Other documentation types include a paper-based consent form kept in patient medical record or scanned into scanned medical record /digital medical record.

Finding consent

Table 25 summarises the ease with which staff can access the completed consent in the EMR, based on their role.

Table 25: Ease of accessing completed consent based on role[18]

Ease of finding consent in the EMR	Clinical (nursing) n = 4	Clinical (medical) n = 6	Quality n = 14	Total n = 24, (%)
Always	1	–	1	2 (8%)
Usually	1	3	4	8 (33%)
Sometimes	1	1		2 (8%)
Never	–	1	1	2 (8%)
Not applicable	1	–	8	9 (38%)
Other	–	1[19]	–	1 (4%)

There are a range of responses regarding the ease of finding consent in the EMR, which may be related to the role of the respondent, the different EMRs used, or the method of documenting blood consent.

The hybrid style of documenting consent may be a factor in the reported low accessibility rate (Table 24). From a patient safety and governance perspective it would be expected that consent should always, or usually be easy to access prior to a procedure.

ANZSBT guidelines state that institutions must have processes for obtaining consent in accordance with the ANZSBT *Guidelines for the administration of blood products* (ANZSBT 2019). When developing processes within the EMR, consideration should be given to the availability of consumer information and resources to obtain informed consent. Health services must have a process for documenting informed consent for transfusion within the EMR, in line with the institution consent policies. In developing EMRs, consideration should also be given to the documentation and accessibility of transfusion refusal and other treatment limiting orders (ANZSBT 2021).

18 Number of individual responses.
19 Paper form

3. Prescribing, ordering and collecting (blood components and products)

Crispin et al. (2022) state:

- Prescriptions must be in accordance with national guidelines.
- The EMR must have a complete and up-to-date list of blood products, to be prescribed by the product form (e.g., units of red cells) or weight-based dosing.
- EMRs should alert prescribers to special transfusion requirements.
- Special transfusion requirements should be communicated between clinical and laboratory systems.
- EMRs may use standardised prescriptions for rates of administration but need to maintain flexibility for individual patient needs.

Prescribing blood components/products

Quality, nursing (clinical and management) and clinical medical staff were asked how blood products are prescribed/ordered for transfusion. Table 26 summarises the responses from staff at each health service.

Table 26: Methods used for prescribing blood/blood products at participating health services using an EMR[20]

Method	Health service count n = 17, (%)
Electronic – via the patient's EMR	4 (24%)
Paper form	9 (53%)
Hybrid system i.e. a combination of electronic and paper prescribing/ordering	3 (18%)
No response	1 (6%)

Most health services (53 per cent) with an EMR are still using a paper form for prescribing/ordering. Four (24 per cent) prescribe/order blood for transfusion within the EMR, and three (18 per cent) use a hybrid system (combination of electronic and paper).

20 Health service count based on majority rules.

ANZSBT guidelines (2021) suggest prescription of blood products via an EMR is an opportunity to offer prescriber decision support tools. Options include:

- links to current guidelines that are generic and require clinicians to choose to access them
- general advice actively presented to clinicians when prescribing
- specific advice using patient characteristics/test results, run through an algorithm based on best practice guidelines, presented when prescribing.

Respondents were asked if their EMR has one standard way to order blood for routine transfusion for all areas (excluding emergency or massive transfusion) (Table 27).

Table 27: Methods to order blood for routine planned transfusion within EMR[21]

Methods	Health service count n = 20, (%)
Only one way to order	5 (25%)
Unsure	1 (5%)
Not applicable	8 (40%)
Multiple	4 (20%)
Conflicting responses within a health service	2 (10%)

The conflicting responses may result from respondents providing an individual perspective (as requested), and thus may not be aware that other areas may have a modified or different prescribing option.

Increasing the complexity and individualisations of an EMR system can lead to confusion among users.

ANZSBT guidelines state that EMRs used to submit requests should restrict the ability to order blood products to groups or individuals with appropriate delegations (ANZSBT 2021).

In health services with more than one way to prescribe blood, three health services identified up to four areas with a separate option for prescribing routine transfusions, these include:

- intra-operative x 3
- day procedure x 1
- haematology x 1
- emergency department x 1.

21 Health service count based on majority rules.

EMR blood component/product ordering process in critical bleeding/ massive transfusion

Table 28 shows how blood is ordered in critical bleeding/massive transfusion situations.

Table 28: How blood is ordered in critical bleeding/massive transfusion situations[22]

Ordering process	Health service count n = 20, (%)
Phone call to lab	19 (95%)
Paper-based form	16 (80%)
EMR – same as all blood orders	4 (20%)
EMR – specific critical bleeding module	4 (20%)

ANZSBT guidelines state that processes must be in place for urgent requests to ensure that the laboratory is actively informed, and requestor immediately notified that laboratory personnel have received the request. This may be through the EMR of by other means (such as telephoning urgent orders) (ANZSBT 2021).

Nineteen health services phone the laboratory in critical bleeding/massive transfusion situations. Four health services reported using the same process for urgent blood ordering as they do for routine orders, fulfilling the guidelines as long as the laboratory is also phoned. If the routine ordering process is effective, this may be simpler and safer rather than introducing a separate critical bleeding module.

Phoning the laboratory in such situations could have the additional benefit of informing staff of the clinical urgency and creates an opportunity for critical information about the patient to be obtained. Current and anticipated blood requirements can be assessed, including discussion about timing of thawing frozen components, turn around time for patient specific blood group and antibody screen results and contact details for ongoing communication can be obtained.

Critical bleeding, massive transfusion and transfusion of uncrossmatched emergency blood need robust clinical, laboratory and electronic processes that enable rapid ordering, delivery and administration of blood products while minimising unnecessary administrative tasks and maintaining critical safety functions (ANZSBT 2021).

Sanderson et al. found that massive transfusion management by anaesthetists and anaesthetic trainees across Australia and New Zealand was limited by timely access to point of care coagulation assessment and multiple competing tasks. Clinical decision support systems were widely supported, and integrating these into an EMR system would be ideal (Sanderson 2021).

Another publication by Sanderson et al. discusses the recommendation in international guidelines to routinley collect a range of quality indicators (QI) to measure massive transfusion protocol (MTP) performance and patient outcomes (Sanderson 2020). The data captured in EMRs can facilitate the gathering and easy interpretation of this data.

22 Cumulative responses, that is at least one respondent per health service. More than one response could be selected.

Ordering of batch products

Respondents were asked whether batch products (such as Albumex) are ordered differently to fresh blood components (for example RBC) (Table 29).

Table 29: Differences in ordering of batch products to fresh blood components[23]

Different process for ordering batch products	Health service count n = 20, (%)
Yes – all batch products	8 (40%)
Yes – some batch products	3 (15%)
No	7 (35%)
Unsure	2 (10%)

Eight health services (40 per cent) order all batch products differently to fresh blood components, three (15 per cent) order some batch products differently, seven (35 per cent) have the same ordering process for batch products and fresh blood components.

Having different areas within the EMR for blood components and blood products to be ordered can lead to confusion and delay in ordering.

Issue/release of blood and blood products from the transfusion laboratory

All 20 (100 per cent) health services require some form of patient ID for collection of blood and blood products (Table 30).

Table 30: Requirement for collection of blood and blood products[24]

Form of ID	Health service count n = 20, (%)
Paper form – not EMR based (including a paper prescription or other collection slip)	14 (70%)
Form generated in EMR	5 (25%)
Other – Patient ID label	1 (5%)

Fourteen of the 20 (70 per cent) health services require a paper collection form (not EMR based, including a paper prescription or other collection slip) for blood and blood products. Respondents from five (25 per cent) health services state that a form generated within EMR is required and one health service (5 per cent) indicated only a patient ID label is required to collect blood or blood products.

Crispin et al. (2022) state that processes for blood product tracking, identification and collection are required for blood issued to satellite blood fridges.

23 Health service count based on majority rules
24 Health service count based on majority rules

4. Administration of blood components/products in the EMR

Eleven health services reported including blood management in the EMR, seven health services include blood administration.

Type of compatibility report issued

Respondents were asked if the type of transfusion/compatibility report has changed after the introduction of the EMR. Three of the 11 (27 per cent) health services who include blood management in the EMR have changed the type of report provided, a paper compatibility report is no longer issued and only an electronic report provided. Six (55 per cent) health services reported that they continue to provide paper compatibility reports after the introduction of EMR. Two (18 per cent) health services were unsure.

Crispin et al. (2022) state:

- Positive patient ID is required prior to administration of blood products.
- Independent confirmation of patient and product ID needs to be performed by a second practitioner or the EMR. If performed by the EMR, it must be able to identify the patient, confirm the blood product and group and that it has been specifically issued to the patient.

Scanning during blood administration

Respondents indicated when a scanning device is required for blood administration with an EMR (Table 31).

Table 31: Scanning requirements for blood administration using the EMR[25]

Scanning required for	Health services n = 7, (%)
Patient ID band only	1 (14%)
Blood/blood product only	–
Patient ID and blood/blood product	6 (86%)

25 Health service count based on majority rules.

One health service (14 per cent) requires scanning of only the patient ID band, six (86 per cent) health services require both the patient ID band and blood/blood product to be scanned.

As described in the ANZSBT 2021 guidelines, scanning all of the following: patient ID, blood component, blood group and compatibility confirmation are required for EMR. If all of these steps are not performed within the EMR process, two-person independent checks must still be performed.

Correct use of the scanner

Where clinical staff responded that scanning is required (n = 6 from 5 health services), they were asked how often the scanning device is used as intended (Table 32).

If the scanning device is not used as intended, important built-in safety steps are bypassed. The risk of errors increases which may result in patient safety being compromised.

Table 32: Frequency of scanning device being used as intended (n = 6)[26]

Used as intended	Always	Usually	Sometimes	Never	Unsure
Patient ID and blood product	2	2	–	–	2

Errors during scanning

If clinical and quality staff responded that scanning is required (n = 12), further details regarding the frequency and type of errors that occurred was obtained (Table 33).

Table 33: Scanning errors encountered during blood administration[27]

Error	Always n (%)	Usually n (%)	Sometimes n (%)	Never n (%)	N/A n (%)
Unable to scan patient ID	–	–	8 (67%)	3 (25%)	1 (8%)
Incorrect patient ID details	–	–	3 (25%)	7 (58%)	2 (17%)
Patient not wearing an ID	–	–	5 (42%)	5 (42%)	2 (17%)
Unable to scan barcodes on blood/blood products	–	1 (8%)	8 (67%)	1 (8%)	2 (17%)
Uncertain which barcodes on blood/blood product to scan	–	–	8 (67%)	2 (17%)	2 (17%)
Information on more than one barcode is unintentionally detected	–	–	7 (58%)	3 (25%)	2 (17%)

26 Number of individual responses.
27 Number of individual responses.

Error	Always n (%)	Usually n (%)	Sometimes n (%)	Never n (%)	N/A n (%)
Specimen request/blood or blood product ordered on incorrect patient	–	–	5 (42%)	5 (42%)	2 (17%)
Difficulty in scanning either patient ID band or blood/blood product due to Wi-Fi issues	–	–	5 (42%)	6 (50%)	1 (8%)
Need to revert to manual checking processes for any reason	–	–	10 (83%)	1 (8%)	1 (8%)
Other	–	–	2 (17%)	–	10 (83%)

Other problems reported included:

- occasional issues where scanning has failed due to the LIS/EMR interface
- staff reluctance to submit an ICT request when scanners need recalibration.

Barcode scanning on units was one of the major challenges highlighted by Verrall (2019). The number and proximity of barcodes on a unit make it difficult to scan the correct barcode. If the EMR locks the user out after multiple incorrect attempts, this could delay the transfusion. This may result in product waste due to non-compliant storage (Verrall 2019).

This frustration has been captured by one respondent who stated that they 'usually' had errors scanning the blood product during administration.

Most EMRs do not detect if blood is issued with the wrong compatibility label (for example, patient's blood group is not compatible with the donor's blood group). Nor may it detect if blood or crossmatch has expired, or if it was issued without necessary special requirements (Verrall 2019).

Staff involved in checking blood should not rely on barcode scanning and should understand its limitations without gaining a false sense of security. They must still fulfil the safety requirements of the pre-transfusion patient and product checks. The ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* state that product labels must always have written ID in addition to machine-readable ID (ANZSBT 2021).

Where the EMR is interfaced with the laboratory information system (LIS), use of single operator ID for transfusion could be used. These requirements are found in the ANZSBT *Guidelines for transfusion and immunohaematology laboratory practice* (ANZSBT 2020) and *Guidelines for the administration of blood products* (ANZSBT 2019).

We are not aware of any health services using an EMR for single operator checking, and specific questions on these topics were not included in the survey.

5. Adverse reactions

The ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* state that the EMR should record any adverse transfusion reactions that occur. If there is a potential risk or requirement to modify future transfusions, appropriate warnings should be recorded in the EMR.

If the EMR played a role in an adverse event, including human interactions such as work arounds or overrides, this should be captured to determine if system improvements are required (ANZSBT 2021). The Victorian Serious Transfusion Incident Reporting (STIR) system includes such a category.

Development of algorithms to aid the diagnosis of transfusion-related complications is possible when using an EMR (Pendry 2015).

Twelve of the 20 (60 per cent) health services surveyed use the EMR to document transfusion reactions, although the extent of support the EMR provides was not explored. Two of these health services have EMR integrated with incident reporting systems (Table 6).

Crispin et al. (2022) state that adverse events are recorded in the EMR and warnings provided to clinicians where a patient has special transfusion risks.

Blood management

Decision support functionality for patient blood management (PBM) alerts or guidance

Decision support needs to be carefully designed as a guide to aid appropriate care. It should not allow dangerous practices, nor prohibit practices that may be appropriate under some circumstances, such as during critical bleeding (Crispin 2022).

Questions relating to the availability of decision support were asked to respondents (n = 26, from 16 health services) with clinical and blood management quality roles (Table 34).

Table 34: Availability and use of decision support tools[28]

Decision support tool available	Health service has included n = 16, (%)
Patient blood management	6 (38%)
Special conditions/products	4 (25%)
Single unit transfusion	3 (19%)
Transfusion triggers	5 (31%)
No decision support tools available	8 (50%)
Decision support tools available, but not used	2 (13%)

28 More than one response could be selected.

Six (38 per cent) include patient blood management (PBM) alerts or guidance, while the requirements for special products, single unit transfusion practice including transfusion triggers were less common. Two health services (13 per cent) reported while decision support tools are available within their EMR, they are not used. Decision support tools are not available at eight (50 per cent) health services.

Dunbar (2014) describes a significant decrease in the percentage of two-unit transfusions by removing the ability to order more than one unit with a 'single click'. Clinicians must first reassess the patient and obtain a post-transfusion haemoglobin before ordering additional RBC units (Dunbar 2014). Single unit transfusion is recommended by the PBM guidelines (2012) based on the need to relieve clinical signs and symptoms of anaemia and the patient's response to previous transfusion and implementation should align with the local policy. With the majority of health services not employing single unit transfusion decision support, there appears to be a lost opportunity for better patient outcomes and reduction in unnecessary transfusions.

Different questions were asked to the quality and executive respondents (24 from 18 health services) regarding inclusion of decision support functionality for PBM. Five health services (28 per cent) use PBM decision support tools and 13 (72 per cent) reported no decision support tools are included.

The blood management quality and executive respondents at the health services who do not use PBM alerts or guidance were asked why these were not included (Table 35).

Table 35: Reasons given for not implementing an alert/guidance system

Reason for no alert system[29]	Health service count n = 10, (%)
EMR does not include blood management	5 (50%)
Considered but not actioned due to cost	2 (20%)
Considered but not actioned due to no support from clinical staff	1 (10%)
Considered but not actioned due to not available in the system	3 (30%)
Considered but not actioned due to blood management a mix of paper and EMR	2 (20%)
Unsure	2 (20%)

Five of the 10 health services which include blood management in their EMR, considered PBM alerts or guidance, however this was not actioned as it was not available in the platform. Other reasons included cost, and the use of a hybrid system for blood management (paper and EMR). Respondents at two health services were unsure why they were not actioned.

29 More than one 'considered but not actioned' options could be selected.

Decision support tools can take a variety of forms and needs to be regularly reviewed, maintained, and updated by SMEs to accommodate new products, evidence and guidelines. While decision support should not be easily bypassed, implementation needs to be balanced against individual patient requirements and urgent care events (ANZSBT 2021).

There is good evidence that implementation of decision support tools with computerised physician order entry (CPOE) supports increased compliance with transfusion guidelines, decreased blood product/component usage, transfusion-related complications and associated costs (Dunbar 2014; Smith 2014, Swart 2020; Murphy 2012; Jenkins 2017; Pendry 2015; Sadana 2018; Staples 2020; Shaw 2018; Sroujieh 2016; Sardar 2018).

Adaptive alerts, which are decision support tools that combine individual patient information and local guidelines, provide the most assistance. By using data within the LIS, alerts are triggered in the CPOE system at the time of ordering. Individualised recommendations are based on clinical (for example, patient vital signs) and/or laboratory parameters. The alert can also display a link the clinician could follow to obtain more information about the evidence supporting the local transfusion guidelines. This results in the EMR supporting appropriate transfusion practice to improve the quality and value of healthcare (Dunbar 2014; Sadana 2018).

Successful decision support tools included as part of the clinician workflow at the time and location of decision-making, reduce the need for additional clinician data entry. As they allow for the opportunity to cancel the order based on the adaptive alert, they also provide a recommendation, not just an assessment (Dunbar 2014).

The audit results show decision support for blood management and transfusion practice has gained little traction. There is good evidence of its value and therefore remains an opportunity for improvements within most health services.

Crispin et al. (2022) state:

- **Prescription of blood products through an EMR is an opportunity to offer decision support.**
- **Decision support, standardised prescription protocols and product information need to be regularly reviewed and updated by transfusion professionals.**

Education and feedback

EMRs provide the unique opportunity to analyse readily available transfusion data to ensure that transfusion practice is consistent with evidence-based recommendations. Education or regular feedback can then be targeted to specific clinicians or units if practice is outside of guidelines (Dunbar 2014; Swart 2020; Staples 2020; Sadana 2018). The role of targeted education is to educate those who might be unaware of the evidence supporting restrictive transfusion, and to create buy-in for adherence to the guidelines (Sadana 2018).

Potential errors

Decision support tools may lead to errors of omission (individuals miss important data because the system does not prompt them to notice the information) or errors of commission – automation bias (individuals do what the system tells or allows them to do, even when it contradicts their training and other available information) (Bowman 2013).

Automation bias can be reduced when individuals understand they are personally accountable for their clinical decisions. Decision support tools provide recommendations, and clinicians need to know when it is appropriate to follow the advice and when it should be overridden (Bowman 2013). This, however, may be difficult for junior staff that may be time and knowledge pressured.

Alert fatigue

Decision support tools must be designed to maximise the impact of alerts on the user. Users need to be aware of clinically significant errors or potential adverse events without being overwhelmed with insignificant alerts, which result in alert fatigue (Bowman 2013). End user input into decision support tools and monitoring the incidence of overrides can assist with maximising their impact. Healthcare professionals who have been affected by alert fatigue or practitioner bias have suggested that critical processes should stop progression until serious errors are corrected (Crispin 2022).

EMR effect on aspects of transfusion

A well-designed EMR has the potential to improve patient blood management and safety, although the literature on this is sparce.

Respondents from all craft groups at health services with an EMR (n = 17) were asked how the EMR has affected blood management/transfusion practices (Table 36).

Table 36: EMR effect on various aspects of transfusion[30]

Aspect of transfusion	Decreased n (%)	Increased n (%)	No change n (%)	Unsure/ N/A n (%)
Number of RBC transfusions	–	1 (6%)	13 (76%)	3 (18%)
Single unit transfusions	1 (6%)	2 (12%)	10 (59%)	4 (24%)
Transfusion consent rate	–	3 (18%)	11 (65%)	3 (18%)
Documented indication for transfusion	–	5 (29%)	8 (47%)	4 (24%)
Documentation of transfusion history	–	6 (35%)	7 (41%)	4 (24%)
Rate of WBIT	3 (18%)	2 (12%)	9 (53%)	3 (18%)
Rate of sample errors	3 (18%)	2 (12%)	8 (47%)	4 (24%)

30 Multiple respondents from within a health service, that is at least one respondent per health service.

Most respondents reported no change in blood management/transfusion practices after EMR implementation. The most positive changes observed are an increase in documented indication for transfusion and documentation of transfusion history. Transfusion consent rate was also noted as improved at three health services.

One health service noticed an increase in the number of RBC transfusions, with the same health service reporting a decrease in single unit transfusions. No additional information was provided.

The results show a variable change in the rate of wrong blood in tube (WBIT) and other sample errors. Three health services reported a decrease in WBIT and sample errors while two reported an increase for each of these events. These results conflict with Kaufman (2019), who found that using electronic patient ID at the time of pretransfusion sample collection was associated with approximately fivefold fewer WBIT errors compared with using manual patient ID.

Where a change was noted to have taken place (either decreased or increased) respondents were asked to indicate when the stated changes took effect, and whether any of these stated changes have been sustained. Most health services reported the changes to have occurred immediately or within a short time frame from EMR implementation and that the changes have been sustained.

Wrong blood in tube (WBIT) with electronic patient ID systems

Wrong blood in tube (WBIT) errors are a preventable cause of ABO-mismatched RBC transfusions which are often a result of human error (Kaufman 2019; Crispin 2022). The effectiveness of electronic patient ID systems (for example, scanning a patient's wristband barcode before sample collection) is unclear.

WBIT rates were high among mislabelled (rejected) samples, confirming that rejecting samples with even minor labelling errors helps mitigate the risk of ABO-incompatible transfusions (Kaufman 2019).

Electronic ID using patient-specific barcodes or RFID may minimise errors both at the point of specimen collection and the point of transfusion (Crispin 2022).

Quality, performance, and patient safety

A true return on the significant investment in EMR will be delivered when the data collected can be used to improve the quality and efficiency of health care for patients (Sullivan 2016). Policy makers, EMR vendors and healthcare providers must work together to ensure EMR systems prevent, rather than cause, errors and lead to improved patient care (Bowman 2013).

Questions relating to quality, performance and patient safety were directed to respondents with quality or executive roles in the health service.

There were 25 respondents (20 from quality and five executive) from 19 health services.

Key performance indicators

Respondents were asked which, if any, key performance indictors (KPIs) are used to assess or evaluate EMR performance of blood management/transfusion practice (Table 37).

Table 37: KPIs used for assessment/evaluation[31]

KPI	Health service count n = 19, (%)
Performance indicators specific to EMR functionality	6 (32%)
Patient safety indicators	6 (32%)
Product usability surveys	2 (11%)
Adverse event reports	9 (47%)
No KPIs are measured for blood/blood management	3 (16%)
Unsure	3 (16%)

EMR functionality

The six health services using KPIs specific to EMR functionality were all related to compliance/overrides:

- compliance/override of patient ID band scanning (n = 5)
- compliance/override of blood product barcode scanning (n = 4)
- compliance/override of blood management or transfusion alerts (if available) (n = 1).

One health service noted that their available report does not correlate with the number of blood products issued from the transfusion laboratory, and because of this it is not used as a KPI.

O'Brien (2021) found that 34 per cent of platelet transfusion prescriptions at one institution resulted from overriding organisational guidelines. This suggests feedback of such data could be used to improve clinical practice; however our survey has shown only one organisation collects similar types of data. This is an opportunity for health services to identify areas of clinical practice improvement or refinement of alerts through information inherently collected by the system.

31 More than one response could be selected

Crispin et al. (2022) state:

- Overrides should be recorded when they are needed.
- All overrides should be evaluated to determine whether systemic improvements are required.
- Wherever possible, overrides should not create a process that is easier for the electronic process to avoid shortcuts that may affect safety.

Patient safety indicators

Table 38 shows which patient safety indicators are included at the six health services who use them for assessment or evaluation of the EMR.

Table 38: Patient safety KPIs used for assessment/evaluation of the EMR[32]

Patient safety KPIs	Health service count n = 6, (%)
Invalid blood sample – wrong blood in tube (WBIT)	5 (83%)
Invalid blood sample – other reasons	5 (83%)
Incorrect blood product transfused	5 (83%)
Appropriate blood component/product usage	5 (83%)
Proportion of single unit transfusions	3 (50%)
Transfusion rate in specific elective surgery	2 (33%)

One health service noted that transfusion thresholds and single unit transfusion KPIs are under development.

Quality markers/changes

Quality and clinical (nursing) respondents from health services with an EMR were asked if they noted variation to sample collection procedures (Table 39).

There were 24 respondents (20 quality, 4 clinical nursing) from 20 health services. Respondents from 10 (50 per cent) health services reported variations to procedures sometimes and six (30 per cent) never varied.

32 More than one response could be selected.

Table 39: Variation to procedure – sample collection[35]

Variation	Health service response: Always n = 20 (%)	Health service response: Sometimes n = 20 (%)	Health service response: Never n = 20 (%)	Health service response: Unsure n = 20 (%)	Health service response: N/A n = 20 (%)
Overriding the electronic patient ID declaration for specimens	–	2 (10%)	3 (15%)	4 (20%)	9 (45%)
A staff member asked to sign on or off for someone else taking the specimen	1 (5%)	4 (20%)	2 (10%)	3 (15%)	8 (40%)
EMR documentation problems when there is a delay to sample collection	–	4 (20%)	1 (5%)	5 (25%)	8 (40%)

Change in incidence of errors

Twenty-five quality and executive respondents from health services (n = 19) with an EMR were asked a series of questions related to changes in the incidence of significant patient safety events (Table 40).

Table 40: Change in incidence of error events[33]

Error	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Positive patient ID (PPI) not followed	–	3 (16%)	4 (21%)	4 (21%)	8 (42%)
Unlabelled specimens	3 (16%)	–	3 (16%)	7 (37%)	6 (32%)
Labelling of specimens with two different patient's details	3 (16%)	1 (5%)	3 (16%)	6 (32%)	6 (32%)
Pretransfusion request form or sample labels generated at a time other than immediately before specimens collected	–	–	3 (16%)	7 (37%)	9 (47%)

33 Health service count based on majority rules

Error	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Duplicate samples with the same accession (specimen ID) number	–	1 (5%)	2 (11%)	7 (37%)	9 (47%)
Extra specimen labels printed	–	1 (5%)	3 (16%)	7 (37%)	8 (42%)
Wrong blood in tube (WBIT)[34]	1 (5%)	1 (5%)	6 (32%)	5 (26%)	6 (32%)
Incorrectly labelled specimens, including unsigned pre-transfusion specimens (excluding WBITs)[34]	2 (11%)	–	4 (21%)	7 (37%)	6 (32%)
Unsigned collector's declaration on request form	–	1 (5%)	5 (26%)	6 (32%)	7 (37%)
No request form received with specimen	1 (5%)	2 (11%)	3 (16%)	6 (32%)	7 (37%)
Two patients' specimens in one biohazard bag	–	–	5 (26%)	7 (37%)	7 (37%)
Rejection of specimens for any reason other than stated above	–	–	4 (21%)	8 (42%)	7 (37%)
Difficulty following up who took the specimen if a problem occurs	4 (21%)	–	5 (26%)	3 (16%)	7 (37%)
The number of transfusion reactions reported	–	3 (16%)	6 (32%)	3 (16%)	7 (37%)

There are conflicting responses relating to increases and decreases in incidence of errors as shown in Table 40 and Table 41. It is hard to draw any conclusions due to the small numbers reported. There were significant numbers of unsure or N/A, which may indicate the people completing the survey were not aware of the actual incidence of this occurring.

34 Figures differ from Table 36 due to a different group of respondents.

A summary of the different responses between quality/executive and laboratory respondents is shown in Table 41.

Table 41: Different responses between quality and laboratory staff about incidence in errors

Unlabelled specimens

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	3 (16%)	–	3 (16%)	7 (37%)	6 (32%)
Laboratory n = 7	2 (29%)	1 (14%)	3 (43%)	–	1 (14%)

Labelling of specimens with two different patients' details

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	3 (16%)	1 (5%)	3 (16%)	6 (32%)	6 (32%)
Laboratory n = 7	–	–	4 (57%)	2 (29%)	1 (14%)

Pretransfusion request form or sample labels generated at a time other than immediately before specimens collected

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	–	–	3 (16%)	7 (37%)	9 (47%)
Laboratory n = 7	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)

Duplicate samples with the same accession (specimen ID) number

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	–	1 (5%)	2 (11%)	7 (37%)	9 (47%)
Laboratory n = 7	–	1 (14%)	4 (57%)	1 (14%)	1 (14%)

Wrong blood in tube (WBIT)

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	1 (5%)	1 (5%)	6 (32%)	5 (26%)	7 (37%)
Laboratory n = 7	–	2 (29%)	3 (43%)	1 (14%)	1 (14%)

Incorrectly labelled specimens, including unsigned pre-transfusion specimens (excluding WBITs)

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	2 (11%)	–	4 (21%)	7 (37%)	6 (32%)
Laboratory n = 7	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)

Unsigned collector's declaration on request form

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	–	1 (5%)	5 (26%)	6 (32%)	7 (37%)
Laboratory n = 7	–	3 (43%)	2 (29%)	1 (14%)	1 (14%)

No request form received with specimen

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	1 (5%)	2 (11%)	3 (16%)	6 (32%)	7 (37%)
Laboratory n = 7	1 (14%)	4 (57%)	1 (14%)	–	1 (14%)

Specimens from more than one patient sent in a single biohazard bag

Quality or laboratory	Decreased n (%)	Increased n (%)	No change n (%)	Unsure n (%)	N/A n (%)
Quality/exec n = 19	–	–	5 (26%)	7 (37%)	7 (37%)
Laboratory n = 7	–	1 (14%)	3 (43%)	2 (29%)	1 (14%)

Changes to pretransfusion patient identification and product safety checks

Quality respondents (n = 20) with an EMR were asked if there has been a change in the pretransfusion patient ID and product safety checks since implementing the EMR, with the majority remaining unchanged (Table 42).

Table 42: Changes in pretransfusion patient ID and product safety checks[35]

Changes to checks	Health service count n = 19, (%)
Yes, Reliance on barcode scanning alone for patient ID	1 (5%)
Yes, Barcode scanning is used for product checking	1 (5%)
Yes, Barcode scanning for patients and the product as an adjunct to the positive patient ID and product checking process	4 (21%)
No change, positive patient ID and product checks are performed as usual	10 (53%)
Unsure	4 (21%)

Historic data transfer

The inclusion of historic data in an EMR varies between health services. Some transferred patient's medical data prior to EMR implementation and some retained the previous records 'as is' moving forward with EMR from go-live. This is a lengthy process and sometimes data is lost (Verrall 2019)

Quality and executive respondents (n = 25) from health services with an EMR were asked how patient's historical records were transferred into the EMR (Table 43).

Table 43: How patient's records from prior to go-live were transferred into the EMR

Method of transfer	Health service count n = 19, (%)
Manual entry the first time the patient presented after go-live	1 (5%)
Manual entry of all historic patient records	2 (11%)
No historic records entered, EMR captures new episodes only	5 (26%)
Unsure	8 (42%)
Other	3 (16%)

Other responses included:

- already there, as IT system already in place
- digital medical record
- not documented.

35 More than one response could be selected.

The six health services who indicated historic data was entered were asked if there have been any associated problems with that data (Table 44).

Table 44: Problems associated with the historic data entered[36]

Problem	Never an issue n (%)	Sometimes an issue n (%)	Unsure n (%)	N/A n (%)
Accuracy of information	3 (50%)	1 (17%)	1 (17%)	1 (17%)
Absence of information	3 (50%)	1 (17%)	1 (17%)	1 (17%)

The accuracy or absence of historic medical data does not appear to be a significant issue. However, only one error is required in this data entry for a patient's care to be affected. Blood Matters' STIR program has received a number of reports where manual entry of historic details into the EMR has led to incorrect information being entered for the patient. In one instance, migration of data did not occur after EMR implementation and known patient antibodies were not available to the laboratory.

Set-up/useability

Clinical (four nursing, six medical) and blood management quality (15) respondents from 17 health services were asked about set-up and useability of the EMR.

Multiple patient records open

Having the correct patient record open in the EMR is of paramount importance for patient safety. Allowing for only one patient record to be open at a time minimises the risk of viewing, editing or actioning health records for the wrong patient.

Respondents were asked if it is possible to have more than one patient's record open at a time (Table 45).

Table 45: Capacity to have multiple patient records open at a time[37]

Multiple records open at a time	Health service count n = 17, (%)
No	8 (47%)
Yes	5 (29%)
Unsure	4 (24%)

36 Number of health services
37 Health service count based on majority rules

Location of computers

To ensure correct patient ID checks, the computer terminal needs to be located close to the patient bedside. If a computer is not accessible from the patient bedside, positive patient ID and correct blood unit checking processes may not be followed. Staff may also have less interaction with the patient while they are looking at the computer (Verrall 2019).

Respondents were asked where the computers are located (Table 46).

Table 46: Location of computers[38]

Location	Health service count n = 17, (%)
Mobile computer on wheels	15 (88%)
Handheld	5 (29%)
Fixed outside patient rooms	3 (18%)
Fixed inside patient rooms	6 (35%)
Fixed at central station	12 (71%)
At a fixed location remote from the patient	13 (76%)

The survey indicates most health services have incorporated flexibility for different bedside options to ensure computer accessibility at the patient's bedside.

Sufficiency of EMR computer terminals

For EMR to integrate into workflow safely and efficiently, computer terminals need to be available for each staff member when needed. If a computer is unavailable, care providers may use a colleague's EMR session, therefore increasing the risk of an incorrect patient record being open and invalidates the electronic audit trail.

Respondents were asked if there are sufficient computer terminals for all staff to access them when needed (Table 47).

Table 47: Sufficient EMR computer terminals to access

Sufficient terminals to access when needed	Clinical (nursing) n = 4, (%)	Clinical (medical) n = 6, (%)	Quality n = 15, (%)
Always	3 (75%)	1 (17%)	1 (7%)
Usually	–	4 (67%)	8 (53%)
Sometimes	1 (25%)	1 (17%)	–
Never	–	–	–
Unsure	–	–	6 (40%)

38 Cumulative responses, that is at least one respondent per health service. More than one response could be selected.

Most respondents report there are always or usually sufficient computer terminals available for when they need them.

Patient safety concerns

EMR use has been identified as a strategy to improve patient safety. EMR implementation can however, have unintended adverse consequences. Early adoption of safety enhancing EMR features can promote safety culture improvements and providers' positive response to the EMR (McGuire 2013).

Some risks cannot be eliminated entirely, the goal should be to implement processes that minimise patient harm and manage known but unavoidable safety hazards. Safe organisational practices and cultures should be established. This includes training users properly, establishing a working environment that is conducive to safe practices, and ensuring that the decision support system is appropriate for the clinical tasks for which it is being used (Bowman 2013).

EMR rollouts can involve a series of potential risks for patients, including:

- difficult or incorrect system integration leading to errors from delays or lost information
- changes to clinical workflows
- staff learning to use the system
- loss of patient focus as attention is directed to new technology (Sullivan 2016).

Respondents were asked how their perception of patient safety has changed since the EMR was implemented (Table 48). While this is not an objective measure, clinical staff are an important hazard barometer.

Table 48: Changes to perception of patient safety since EMR implementation (n = 41)[39]

Issue	Decreased n (%)	Increased n (%)	No change n (%)	Unsure/N/A n (%)
Your perception of patient safety	4 (10%)	13 (32%)	12 (29%)	12 (29%)

Four (10 per cent) respondents felt that patient safety has decreased since EMR implementation. It would be valuable to explore this further in future studies. Thirteen (32 per cent) report an increase in perception in patient safety, while 12 (29 per cent) report no change.

The opportunity exists to improve the safety, quality and efficiency of transfusion practice by incorporating transfusion practice into EMRs. Particularly through utilising decision support and optimising patient ID checking procedures. Poor design of electronic systems and electronic-human process interfaces may increase risk while creating an impression of safety (Crispin 2022).

39 Number of individual responses

Laboratory aspects of EMR implementation

Laboratory staff play a vital role in healthcare. As they are removed from direct patient contact, they can be overlooked in important decision-making processes. Consideration of how the laboratory workflow and processes integrate into new systems are often secondary with the focus on the clinical environment. Laboratory staff experiences were captured, including how much input they had, and the impact of the EMR on their daily workflow and perspective on changes to patient safety.

EMRs can lead to challenges when established safe work practices are required to be modified to accommodate the system (Gagnon 2010). This is particularly true in the transfusion laboratory environment.

There were seven laboratory staff from seven health services (n = 7) who responded to this set of questions.

Laboratory workflow/processes

Respondents were asked if workflow/processes have changed in their transfusion laboratory after the implementation of the EMR (Table 49).

Table 49: Changes to laboratory workflow/processes after implementation of the EMR[40]

Change	Decreased n (%)	No change n (%)	Increased n (%)	Unsure n (%)	N/A n (%)
Ability to view whether a pretransfusion specimen has been requested and/or collected	–	–	5 (71%)	1 (14%)	1 (14%)
Availability of clinical details and relevant patient information	–	–	5 (71%)	1 (14%)	1 (14%)
Availability of contact details for treating clinician or location of patient	1 (14%)	–	4 (57%)	1 (14%)	1 (14%)
Clarity of blood products transfused to individual patients, e.g. in a massive transfusion setting	–	2 (29%)	3 (43%)	1 (14%)	1 (14%)
Appropriateness of blood product ordering.	1 (14%)	4 (57%)	–	1 (14%)	1 (14%)

40 Number of individual responses

Change	Decreased n (%)	No change n (%)	Increased n (%)	Unsure n (%)	N/A n (%)
Ability to pre-emptively crossmatch blood or blood products before the order is placed	3 (43%)	–	–	1 (14%)	3 (43%)
Ability to crossmatch one unit at a time even if multiple units are requested	–	4 (57%)	1 (14%)	1 (14%)	1 (14%)
Ability to use professional judgement when deciding to action crossmatch request or not	2 (29%)	1 (14%)	2 (29%)	1 (14%)	1 (14%)
Ability to return unused blood components/ products to the inventory if not used on day allocated/ issued	–	5 (71%)	–	1 (14%)	1 (14%)
Need to generate own specimen accession (ID) numbers in the lab	–	3 (43%)	2 (29%)	1 (14%)	1 (14%)
Ability to view when there are outstanding crossmatch requests or sample collection orders	–	1 (14%)	4 (57%)	1 (14%)	1 (14%)
Ability for ward staff to view when a blood product is ready for collection	2 (29%)	1 (14%)	–	3 (43%)	1 (14%)

Change	Decreased n (%)	No change n (%)	Increased n (%)	Unsure n (%)	N/A n (%)
Change in terminology for blood and blood products, e.g. two units of FFP per bag has changed to one unit equals 1 bag with the EMR	–	1 (14%)	4 (57%)	1 (14%)	1 (14%)
Impact on overall productivity	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)
Impact on overall staffing requirements	–	4 (57%)	1 (14%)	1 (14%)	1 (14%)
Impact on overall transfusion laboratory workflow management	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)

While the numbers of respondents were small, they generally reported that the EMR has resulted in many positive workflow changes. Some laboratory activities were decreased, such as the ability to pre-emptively crossmatch before an order was placed. The ability of ward staff to view when blood/blood products are ready for collection was also reported as decreased.

Respondents provided some additional comments related to other workflow/processes changes:

- 'Nothing has changed, the transfusion laboratory is still using written request form and hand-written specimen labels'.
- 'Sometimes confusion with massive transfusions as they are verbally activated, but then the product is ordered again in the EMR. Duplicate requests for blood products that require a number of keystrokes to resolve'.
- 'Better access to clinical records and medication records has been helpful in the laboratory'.

Change in transfusion process error rates

Respondents (n = 7) were asked if there has there been a change in any of the following events since introducing EMR (Table 50).

Table 50: Changes in the occurrence of events since introduction of EMR[41]

	Decreased n (%)	No change n (%)	Increased n (%)	Unsure n (%)	N/A n (%)
Unlabelled specimens	2 (29%)	3 (43%)	1 (14%)	–	1 (14%)
Double labelling of specimens	–	4 (57%)	–	2 (29%)	1 (14%)
Duplicate samples with the same accession (specimen ID) number	–	4 (57%)	1 (14%)	1 (14%)	1 (14%)
No request form received with specimen	1 (14%)	1 (14%)	4 (57%)	–	1 (14%)
Specimens from more than one patient sent in a single biohazard bag	–	3 (43%)	1 (14%)	2 (29%)	1 (14%)
Pretransfusion request form or sample labels generated at a time other than immediately before specimens collected	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)
Wrong blood in tube (WBIT)[42]	–	3 (43%)	2 (29%)	1 (14%)	1 (14%)
Incorrectly labelled specimens, including unsigned pretransfusion specimens (excluding WBITs)[42]	1 (14%)	2 (29%)	2 (29%)	1 (14%)	1 (14%)
Unsigned collector's declaration (on request form or electronic signature)	–	2 (29%)	3 (43%)	1 (14%)	1 (14%)
Different signature on specimen to collector's declaration	–	3 (43%)	2 (29%)	1 (14%)	1 (14%)
Specimens or request forms that cannot be barcode scanned in the laboratory	1 (14%)	3 (43%)	1 (14%)	–	2 (29%)
Barcode read errors on instruments	1 (14%)	4 (57%)	–	–	2 (29%)

41 Number of individual responses.
42 Figures differ from Table 36 due to a different group of respondents.

If the responder reported an increase in any of the following, we asked further questions to clarify responses:

- pretransfusion request form or sample labels generated at a time other than immediately before specimens collected
- incorrectly labelled specimens, including unsigned pretransfusion specimens (excluding WBITs)
- unsigned collector's declaration (on request form or electronic signature).

One health service reported an increase in tolerance for specimen collection errors after implementation of EMR, which was still in place at the time of the survey. The remaining two health services reported no increased tolerance of specimen errors.

Availability of blood/blood products

Scientists can spend a lot of time fielding calls regarding blood product readiness. Where clinical staff can view when orders are ready without phoning or arriving prematurely at the transfusion laboratory, everyone benefits. Prior to EMR implementation some laboratories had blood/blood product availability transparency via the laboratory information systems. We asked if the EMR has changed the visibility.

Respondents (n = 7) were asked if there have been any changes to how clinical staff know when blood or blood products are available for collection (Table 51).

Table 51: Changes to method for knowing if blood/blood products are available[43]

Method	Decreased n (%)	No change n (%)	Increased n (%)	Unsure n (%)	N/A n (%)
Phone calls to transfusion laboratory	2 (29%)	1 (14%)	2 (29%)	–	2 (29%)
Look up in computer system (either EMR or another system)	2 (29%)	–	2 (29%)	–	3 (43%)
Staff arrive to collect product without checking availability	–	3 (43%)	2 (29%)	–	2 (29%)

One health service reported that: 'EMR does not update when products are issued from the transfusion laboratory. Clinical staff need to use a different computer program and because the information is not easily visible on the EMR, they just ring the laboratory instead.'

The frequency of calls to the transfusion laboratory were reported equally as increased and decreased at two health services (29 per cent). Similarly, health services reported an equal increase and decrease in clinical staff looking up blood product availability in the computer (either EMR or another system). There were no reports of decreased numbers of clinical staff arriving for blood product collection prior to availability, whereas two (29 per cent) health services have had an increase in incidence and three (43 per cent) no change.

43 Number of individual responses.

EMR troubleshooting requests

If clinical staff are unable to perform a transfusion-related task in the EMR, often the transfusion laboratory can be the first point of contact, due to the perception they will be able to assist. This can lead to increased disruptions and reduce efficiency.

Respondents (n = 7) were asked if the transfusion laboratory receives phone calls from clinical staff trying to troubleshoot an EMR transfusion ordering/administration issue (Table 52).

Table 52: Transfusion laboratory receiving phone calls for EMR transfusion ordering/administration troubleshooting[44]

Does the transfusion laboratory receive phone calls from clinical staff trying to troubleshoot an EMR transfusion ordering/administration issue?	Respondents count n (%)
Yes, transfusion laboratory staff are able to assist	–
Yes, transfusion laboratory staff are unable to assist	5 (71%)
No	1 (14%)
Unsure	1 (14%)

Five (71 per cent) report that they receive troubleshooting phone calls, and they are not able to assist with these queries. No respondents reported they could help with the phone calls they receive, and they would not be expected to know; which reinforces the need to communicate clear pathways for staff to obtain EMR assistance.

One respondent reported that they do not receive troubleshooting phone calls.

44 Number of individual responses.

EMR support

Questions about EMR support were asked to all respondents with an EMR, n = 51.

Availability of support

The type and availability of EMR support is reported in Table 53.

Table 53: Reported EMR support available

Support type	Clinical nursing n = 6, (%)	Executive n = 5, (%)	Laboratory n = 7, (%)	Medical n = 6, (%)	Organisational IT n = 3, (%)	Quality n = 20, (%)	Other[45] n = 4, (%)
IT – direct support	3 (50%)	2 (40%)	2 (29%)	3 (50%)	1 (33%)	9 (45%)	–
IT – in-house support	5 (83%)	5 (100%)	5 (71%)	6 (100%)	3 (100%)	15 (75%)	2 (50%)
EMR trained super user	2 (33%)	4 (80%)	3 (43%)	5 (83%)	3 (100%)	14 (70%)	2 (50%)
Other	–	–	1 (14%)	–	–	2 (10%)	1 (25%)

Other support available included specific EMR help desk support, blood champions and tip sheets. IT in-house support and the use of EMR trained super users were highly reported by all groups.

Accessibility and sufficiency of support

The survey asked whether the ongoing EMR support is accessible and sufficient. Twenty-six (51 per cent) responded that support is accessible and sufficient, 14 (27 per cent) said support is not accessible and/or sufficient, while 11 (22 per cent) were unsure.

The 14 respondents who indicated the ongoing EMR support is not accessible and sufficient, were asked how the support was deficient.

Three (21 per cent) said their support is not accessible, 12 (86 per cent) said their support is not sufficient and seven (50 per cent) said issues raised are not solved appropriately. Other stated reasons include:

- there are not enough people
- not timely updates/improvements
- requests completion times were long.

EMR support needs to be timely and easily accessed by all. As evidenced by laboratory staff indicating they are receiving calls about EMR problems, it is important staff are aware of where and how to access advice and assistance.

45 Other roles: extracorporeal life support clinical nurse consultant (ECLS CNC), EMR team, nurse unit manager, EMR nursing team.

Aspects of the EMR considered to have worked well

All respondents with an EMR were asked which aspects of the implementation they considered have worked well, as shown in Table 54.

Table 54: Aspects of EMR implementation reported as working well[46]

Aspect	Health service count n = 20, (%)	Respondent count n = 51, (%)
Staff training	13 (65%)	22 (43%)
Super users to support staff become familiar with the system	16 (80%)	30 (59%)
A long lead time from planning to go-live of EMR	10 (50%)	19 (37%)
Clinical staff participation in development of content	11 (55%)	18 (35%)
Multidisciplinary team involved in content development	10 (50%)	23 (45%)
Easy to use/simple clinical interface	9 (45%)	13 (25%)
Enough equipment at the patient bedside	11 (55%)	18 (35%)
Unsure	6 (30%)	7 (14%)

The availability of super users to support staff to become familiar with the system is the single most common factor which was considered to have worked well with EMR implementation, followed by staff training. Having clinical staff participation in development of content ranked highly along with having enough equipment available.

46 Cumulative responses, that is at least one respondent per health service. More than one response could be selected.

Suggested improvements to EMR currently in use

All respondents were asked what could be improved in the system you currently use, there were 41 responses to this question (Table 55).

Table 55: Suggested improvements to EMRs currently in use (n = 41)

Support type	Clinical nursing n = 4, (%)	Executive n = 5, (%)	Laboratory n = 6, (%)	Medical n = 5, (%)	Organisational IT n = 3, (%)	Quality n = 15, (%)	Other[47] n = 4, (%)	Total n = 41, (%)
More mobile computers	–	1 (20%)	–	1 (20%)	1 (33%)	5 (33%)	–	8 (20%)
More scanners	1 (25%)	–	–	2 (40%)	–	4 (27%)	–	7 (17%)
More printers	2 (50%)	–	1 (17%)	1 (20%)	–	9 (60%)	–	13 (32%)
Improved Wi-Fi	2 (50%)	1 (20%)	–	1 (20%)	–	3 (20%)	–	7 (17%)
More training	–	–	4 (67%)	2 (40%)	1 (33%)	7 (47%)	–	14 (34%)
A more intuitive interface	1 (25%)	2 (40%)	3 (50%)	2 (40%)	1 (33%)	9 (60%)	1 (25%)	19 (46%)
Ability to make system changes to suit your health organisation	2 (50%)	3 (60%)	3 (50%)	2 (40%)	2 (67%)	10 (67%)	2 (50%)	24 (59%)
Local/ consistent terminology used	–	–	2 (33%)	–	–	5 (33%)	–	7 (17%)
Improvement/ problem resolution in a timelier manner	–	3 (60%)	3 (50%)	2 (40%)	–	9 (60%)	1 (25%)	18 (44%)
More IT support direct from vendor	–	1 (20%)	2 (33%)	1 (20%)	–	4 (27%)	–	8 (20%)
More in-house IT support	2 (50%)	1 (20%)	4 (67%)	2 (40%)	–	5 (33%)	–	14 (34%)
More EMR trained super users	–	1 (20%)	2 (33%)	3 (60%)	2 (67%)	6 (40%)	1 (25%)	15 (37%)

47 Other roles: extracorporeal life support clinical nurse consultant (ECLS CNC), EMR team, nurse unit manager, EMR nursing team.

The most common suggested improvement to the EMR currently in use was the ability to make system changes to suit the respondents' health organisation. This was followed by a more intuitive interface and improvement/problem resolution in a timelier manner.

Other improvements provided, included:

- reduce hybrid records/eliminating paper where possible/use EMR for fresh blood product ordering and administration
- integration of the laboratory system to simplify blood processes and workflows
- improved device functionality/a better scanning system that is less prone to user error, for example multiscanner that does not require a specific scanning technique
- a less step-intensive workflow to obtain intra-op blood.

Summary

The increasing use of electronic medical records (EMR) provides opportunities for a range of potential benefits to the healthcare system, they can however also present challenges. ANZSBT *Guidelines for the implementation and use of electronic medical records for transfusion* were published in July 2021 to assist health service organisations implement safer transfusion practice using EMRs (ANZSBT 2021).

Hospitals may inadvertently overlook the importance of their own processes and human components of the system in achieving the desired outcomes. Guidelines promote a set of expectations around EMR design and clinical practice workflow. Having a set of standards enables vendors to understand the expectations of the EMR and to design accordingly (Crispin 2022).

The Australian Commission on Safety and Quality in Health Care (ACSQHC) published the *Impact of digital health on the safety and quality of health care* in 2018 (Shaw 2018). This document provides a broad overview of EMRs. Verrall (2019) suggests that there may be a role for the ACSQHC to consider EMR implementation in the national standards and consequently reviewed as part of the hospital accreditation process.

Lessons learnt

While EMRs offer huge potential to improve quality and patient care, they also represent one of the most significant changes a health service may undertake. Leadership support, efficient training, optimisation of the system, flexibility from the implementation team and utilising clinician champions will make the implementation process more efficient. If any components of the EMR system are new or require a new workflow to be introduced, specific attention in training and support contribute to a more effective learning process (Rizer 2015). This was evident in the survey responses, particularly regarding super users and education being a positive aspect of EMR implementation.

Success factors

Barcode or radiofrequency ID (RFID) may reduce errors in patient ID at the time of sample collection and blood administration. The majority of health services with an EMR have barcode scanning as an adjunct to positive patient identification at the time of pretransfusion sample collection and blood product administration, although there was variability regarding its relationship to improving safety.

The use of integrated decision support tools when prescribing and monitoring vital signs may improve clinical transfusion practice. It can provide opportunities to ensure that consent has been obtained, and staff receive best practice reminders. Another opportunity for improvement with EMR is the detection of and decision support for managing adverse transfusion reactions (ANZSBT 2021). Decision support was evident in some but not all EMR systems. There is evidence of its value and therefore it remains an opportunity for improvement within most health services.

The reduction in paper forms has improved efficiency in some organisations, while it is reported as a desirable improvement by others.

The EMR can be used to facilitate or enforce best practice to improve patient care rather than simply record the events as they occur (Crispin 2022). A small number of health services have included the use of alerts and reminders in the EMR. Of these some have included KPIs to monitor their use to improve practice.

Areas for improvement

Clinical content, the computer–human interface and human factors are responsible for the largest proportions of contributing factors for reported safety events. Healthcare services and vendors need to consider safety and workflow integration of any proposed hardware and software solutions, promoting best practice, particularly in matters of patient safety. The use of workarounds may offset any potential benefits of patient ID safety systems. (ANZSBT 2021).

Despite health services employing different EMR systems, the difficulties surrounding implementation and clinical transfusion practice are similar. Concerns have been raised that staff are treating EMRs as a safety system that will ensure safe process. Unless these safety systems are deliberately incorporated, the EMR may simply be a passive documentation tool. This may result in basic principles of patient ID and the correct checking procedures not being followed during specimen collection and blood administration (Verrall 2019). To enable EMR to shape safe practice, significant integration between information technology systems and human factors must exist. Where a system is perceived by users as contributing to safety, but is not designed to do so, risks are potentially increased (ANZSBT 2021).

Many EMR systems implemented in Australia have been developed internationally and implemented without local clinical consultation (Verrall 2019). This has led to EMRs using terminology that some survey respondents found unfamiliar, and forcing them to change their practices and protocols, potentially affecting staff comfort with the system and patient care.

Conclusion

This survey generated a complex, and at times contradictory, dataset exploring end-user experiences of EMR design, implementation and use.

Each health service has unique operating considerations, constraints and workflows that the implementation of an EMR will affect in different ways. Important lessons can be learned from those who generously provided insights into EMR processes and experiences through our survey. Health services that are yet to implement an EMR can integrate and incorporate these experiences for their own journey.

Wide consultation and collaboration between all groups in healthcare is vital. Systems must be well planned and tested prior to go-live, with consideration given to established safe workflows, so they are not forced to change to suit the EMR. Education and ongoing training are paramount to efficient implementation, with robust processes in place for accessing timely EMR support.

Optimisation of EMR processes can be enhanced by providing defined pathways for end-user feedback, along with regular review of this feedback and any data associated with alert overrides or system bypass that can identify deficiencies in processes.

The benefits of EMR can be immense if designed and implemented well. Awareness around best practice, adherence to guidelines and collaboration between healthcare groups is vital to ensure the EMR adds value to, rather than hinders, safe patient care.

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Appendix 1: Improvements suggested by individual respondents

Workflow

- Thoroughly work through the transfusion workflows and recognise that it is a circular workflow.
- Clear workflow development pre-implementation to direct staff education.
- Plan early and that it is a complicated workflow that you must pay attention to.
- Longer lead-in time to adequately test the workflows, re-design workflows, if necessary, re-test. Testing of the hardware to ensure functionality and integration with existing systems.
- Improving the workflow, the hybrid system and the different workflows for blood products, there is one for fresh products, another for batched and another for stem cell therapies.
- Has been hit and miss as to when it works, so changing between EMR and an alternative electronic system required. Planning to include transfusion (and anything else that requires consent) into next phase of development. Very messy to audit/trace etc. having EMR and not all documents etc. used with it. Need to wait for things to be scanned in and often these go missing.
- Auditing now takes a lot longer trying to wade through all sections on EMR as well as things sometimes being scanned into wrong place.

Support

- The laboratory staff do not know how to generate EMR requests, so cannot help clinicians if they are having problems – ongoing education for clinical staff is important.
- Different practices around the hospital. Need a lot of support after implementation.
- Good contracts for ongoing improvements in systems.
- Like with all IT projects – they need a lot of work post-implementation and lots of ongoing resources.
- Not enough mobile printers ordered or supplied has meant rollout onto wards has been delayed so only used in one department.

Education

- Provide adequate training to the transfusion nurses and ensure they are fully equipped to provide the necessary education to staff post go-live.
- Integrate the SMEs with training so the workflows are taught to completion/as intended (we had staff being told different things, two different lab processes were confusing and trainers occasionally got mixed up/mixed messages).
- Allow your quality and safety staff to train, we had a simple chart review session, and it was inadequate.
- Lots of training and lots of personnel on the flow teaching for months.
- Adequately train staff, including simulated training, where possible.
- I would suggest much more in depth and widespread education
- Ability to simulate and test would be very useful. Multidisciplinary development and training.
- Have the scanners used in training match how the scanners work in the clinical setting. i.e. the scanners are programmed to do a sweeping/all in one scan to pick up the barcodes required; in training we still have to demonstrate using the one bar code at a time method.

- Transfusion laboratory staff training in product administration will assist in answering some of the questions nursing staff have regarding product administration.
- Lab staff have largely been left out of EMR education as they do not directly need to use the EMR, however the EMR is a source of lots of information about the patient that can be useful for laboratory staff to know.

EMR and transfusion module

- Have the prepare order separate to the transfuse order. The prepare order is the laboratory order to crossmatch blood and the transfuse order is the administration order for the clinician to administer the blood.
- We implemented the EMR without including the Blood Module. All pretransfusion ordering / testing / and blood product requests / issue are paper based. All results are transferred to the EMR, and blood product availability is visible via the EMR, but there is no electronic means of requesting tests or blood components at present. If there was any advice it would be to include the Blood Module / or IV Module in the initial EMR implementation. The cost to implement now – 10yrs afterwards is very expensive and requires funding proposals to be made to DHHS. As a consequence, we have an incomplete EMR with no clear timeframe for full implementation.
- Recommend specific blood management module.
- ID scanning for administration of blood products.
- Clear visibility of order at point of administration.
- Include blood & blood product consent, blood component ordering, transfusion requests (Cross match and group & screen) ordering in the EMR, as well as bedside patient ID confirmation scanning prior to blood sampling and ID scanning of patient, blood component and request as part of ID blood component administration process.
- Early involvement. Important to get the right system with good interface and basing decisions on evidence base. We are in process of introducing EMR for blood administration for fresh products as system recommended at time of EMR rollout was not felt to be safe for fresh products. It was introduced for derivative products, and this works quite well. Would be better to have introduced an EMR for fresh products administration earlier as this is the riskiest blood administration process.
- EMR has been implemented but does not include transfusion practice other than pathology collection. This has also been an issue along with IT issues with EMR talking to other systems.
- Auditing now takes a lot longer trying to wade through all sections on EMR as well as things sometimes being scanned into wrong place.
- Blood barcode scanning is a challenging workflow and requires significant collaborative effort from a number of teams including technical, laboratory, point of care equipment, clinical and EMR.
- Do not tailor the EMR to different areas/different views – KISS principle! This just adds confusion.
- Don't tailor the system – too much – keep its blood ordering process standard across the different clinical areas.
- A complete integration of the remaining paper-based documents into the EMR (we have EMR, but not for blood component/product administration.
- A better scanning system that is less prone to user error. Perhaps a multiscanner that does not require a specific scanning technique which is a common point of error. A less step-intensive workflow to obtain intra-op blood.

Set-up and testing

- Making the system more focused on the patient's needs.
- The interaction between the LIS and the EMR is pivotal.
- Clinical notes will be very important.
- Spend lots of time working with clinicians and SMEs to ensure it meets requirements of the end user and the laboratory.
- Ensure as many scenarios are tested and you know exactly what the paper requests look like from each workflow, have all details as required.
- Seek consultation widely from all involved in the development of transfusion modules.
- Recommend Transfusion Nurse Consultant are part of the EMR team.
- Involvement of Transfusion staff with the implementation.
- Longer lead-in time to adequately test the workflows, re-design workflows, if necessary, re-test. Testing of the hardware to ensure functionality and integration with existing systems.
- Involve the blood management / transfusion nurse in the implementation.
- More consultation with different areas of the health organisation. I think utilising coal face staff members more in the initial phases would be very helpful.
- Have as integrated systems as possible that can be maintained. Ensure multidisciplinary input into all stages of implementation including design, development, testing, training, go-live support and follow-up maintenance.
- EMR implementation is not necessarily a single event and often involves implementation of a number of solutions over time. At our health service we have been on our EMR implementation for over 20 years, and only have a partial EMR for bloods at the moment.
- Easy for all clinicians to use and to navigate especially in times of Massive Transfusion Protocols.
- Buy an EMR system that is integrated with the laboratory LIS.
- Reduce hybrid records.
- Integration of the laboratory system to simplify workflows.
- Eliminating paper were possible by moving fresh blood products onto the EMR. Improved device functionality which we are working on.
- Request form to have options for unusual circumstances – e.g. when extra tubes need to be collected for certain conditions, or collected at 37 degrees C.

Safety (including downtime)

- Always log out. Staff leave PC open with their log-ins and others jump in and use the wrong ID / doctors leaving charts open and they have prescribing rights.
- Ensure your downtime plans are well known before go-live for all as unplanned downtime occurs suddenly.

Quality reports/key performance indicators

- Ensure you have requested reports to pull data out and know how to use the tools, very hard to set these up without support.

Appendix 2: Definitions/glossary

Barcode	A visual representation of data that may be scanned to read complex identifying information (ANZSBT 2021).
Batch product	Plasma-derivatives and recombinant products Albumin Factor concentrates Immunoglobulins, including immunoglobulin replacement therapy (e.g. IVIg and SCIg) and hyperimmune globulins Also referred to as 'blood products'
Blood component	Fresh blood components which are derived directly from donated whole blood Red blood cells (RBC) Platelets Fresh frozen plasma (FFP) Cyroprecipitate Cryodepleted plasma
Blood product	Plasma-derivatives and recombinant products Albumin Factor concentrates Immunoglobulins, including immunoglobulin replacement therapy (e.g. IVIg and SCIg) and hyperimmune globulins Also referred to as 'batch products'
Consent	Informed consent is a person's decision, given voluntarily, to agree to a healthcare treatment, procedure or other intervention that is made: • following the provision of accurate and relevant information about the healthcare intervention and alternative options available, and • with adequate knowledge and understanding of the benefits and material risks of the proposed intervention relevant to the person who would be having the treatment, procedure or other intervention (ACSQHC 2021).
Double independent check	The process of confirming patient ID whereby two professionals independently confirm, and take responsibility for confirming patient ID, prescription and product issued immediately prior to transfusion at the patient's side in line with ANZSBT *Guidelines for the Administration of Blood Products* (ANZSBT 2021).
Electronic medical record (EMR)	Computer system used by healthcare providers for patient documentation, monitoring and management without using paper. Includes both stand-alone systems and those interfaced with other systems in the healthcare service.

Emergency transfusion/ critical bleeding	Transfusion in extreme or life-threatening situations where the immediate correction of blood loss or anaemia outweighs the potential risk of delaying transfusion (Australian Red Cross Lifeblood, 2021).
Go-live	The date that EMR was initially utilised at the health service.
Interface	A connection between two separate software components within EMRs, often provided by different vendors, or to external information systems (ANZSBT 2021).
Laboratory information system (LIS)	The electronic system in the transfusion laboratory for managing requests, blood products and results. This is a subset of an EMR (ANZSBT 2021).
Lifeblood	Australian Red Cross Lifeblood
Massive transfusion	Defined, in adults, as replacement of >1 blood volume in 24 hours or >50% blood volume in 4 hours. In children, it is defined as transfusion of > 40 mL/kg (Australian Red Cross Lifeblood 2021).
Organisation	The health service as a whole. All areas/wards/campuses of the health service.
Override	Bypassing a process designed to assist with safety and quality within an EMR. The ability to override may be built into system designs to enable a process to proceed in the event of a simple step in a process failing (for example, a failed barcode or RFID read) and usually requires and alternate process (ANZSBT 2021).
Patient blood management	The timely application of evidence-based medical and surgical concepts designed to maintain haemoglobin concentration, optimise haemostasis and minimise blood loss in an effort to improve patient outcome (ANZSBT 2021).
Precinct	More than one health service grouped together by location/ proximity. A means to share facilities and resources.
Prescription	The prescription is the written authorisation to administer the blood product. Blood or blood products must be prescribed by a health professional accredited to prescribe blood products. The prescription must contain: • patient ID details • date, timing and urgency of the transfusion • the route and rate of administration • the number of units or dose of blood product to be given • the product type and any special requirements (e.g. irradiation) (ANZSBT 2019).

Pretransfusion specimen	Specimen taken before transfusion whereby the laboratory performs analysis to determine: Group and screen • patient's ABO and RhD group • antibody screen to detect antibodies in patient's plasma • ID of red cell antibodies (performed if positive antibody screen detected). Crossmatching appropriate donor red blood cells if required.
Radiofrequency ID (RFID)	The process of detecting and identifying the close presence of an object or individual using an attached electronic chip that can be detected by radiofrequency detectors in close proximity (ANZSBT 2021).
Transfusion	The administration of all blood components and products regardless of their route of administration. Includes blood components and blood products (ACSQHC 2017).
Usability	Useability is a general term concerning the effectiveness, efficiency, and satisfaction with which users achieve goals with an interface (International Organization for Standardization 1998).
Wi-Fi	W-Fi is the wireless technology used to connect computers, tablets, smartphones and other devices to the internet (Verizon 2022).

Appendix 3: Abbreviations

ABO	ABO blood group system
ACSQHC	Australian Commission on Safety and Quality in Healthcare
ANZSBT	Australian and New Zealand Society of Blood Transfusion
BEST Collaborative	Biomedical Excellence for Safer Transfusion Collaborative
CPOE	Computerised physician order entry
EHR	Electronic health record
EIS	Electronic identification system
EMR	Electronic medical record
HIT	Health information technology
ID	Identification
IT	Information technology
LIS	Laboratory information system
MTP	Massive transfusion protocol
N/A	Not applicable
PBM	Patient blood management
PPID	Positive patient identification
QI	Quality indicators
QR	Quick response
RFID	Radiofrequency identification
SHOT	Serious Hazards of Transfusion
STIR	Serious Transfusion Incident Reporting
VHIMS	Victorian Health Incident Management System
WBIT	Wrong blood in tube
WCT	Wrong component transfused
WHO	World Health Organisation

Appendix 4: Summary of Australian and New Zealand Society of Blood Transfusion practical guidelines

Source: Crispin 2022, Table 1

Transfusion process	Summary of guidance
Decision to transfuse	Prescription of blood products through an EMR is an opportunity to offer decision support. Decision support, standardised prescription protocols and product information need to be regularly reviewed and updated by transfusion professionals.
Consent	EMRs must have a process for documenting informed consent or refusal in line with institutional policies.
Blood product prescription	Prescriptions must be in accordance with national guidelines. The EMR must have a complete and up-to-date list of blood products, to be prescribed by the product form (e.g., units of red cells) or weight-based dosing. EMRs should alert prescribers to special transfusion requirements. Special transfusion requirements should be communicated between clinical and laboratory systems. EMRs may use standardized prescriptions for rates of administration but need to maintain flexibility for individual patient needs.
Electronic requests	Requests may include requests for blood sample collection and testing, requests for blood products to be prepared or requests for blood to be delivered. Sample collection requires positive patient identification and labelling at the bedside immediately after collection. Where EMRs assist with patient identification, they must be identified by a barcode or radio frequency identification chip specific to the patient and distinguishing them from the patient record.
Storage and collection	Where blood is issued to a refrigerator external to the laboratory, processes for blood product tracking, identification and collection are required.
Blood product administration	Positive patient identification is required prior to administration of blood products. Independent confirmation of patient and product identification needs to be performed by a second practitioner or the EMR. If performed by the EMR, it must be able to identify the patient, confirm the blood product and group and that it has been specifically issued to the patient.
Special circumstances	Processes must be in place for issuing un-crossmatched emergency blood for critical bleeding and massive transfusion.
Adverse events	Adverse events should be recorded in the EMR and warnings provided to clinicians where a patient has special transfusion risks. Decision support for adverse transfusion reactions should be considered. The role of EMRs in adverse events should be captured and evaluated to determine whether systemic improvements are required.

Appendix 5: Summary of clinical governance recommendations for EMRs

Source: Crispin 2022, Table 2

User roles	User roles must be defined and limited to functions for which users are qualified and authorized. EMRs must record the fate of blood products and maintain traceability of each unit.
Common functions and processes	Sample and product labels must always have written identification in addition to machine-readable identification. Each process should be indelibly recorded. Where a process has more than one operator, all should be recorded.
Overrides	Overrides should be recorded when they are needed. All overrides should be evaluated to determine whether systemic improvements are required. Wherever possible, overrides should not create a process that is easier for the electronic process to avoid shortcuts that may affect safety.
Implementation	Implementation must include integration into human healthcare systems, including the following: • Clear policies and standard operating procedures; • Directions within the EMR to guide correct performance of processes; • Involvement of users in design and implementation; • Maintaining downtime procedures. Systems must be designed for safety, mandating best practice where possible. Appropriate education and training should be provided, but critical safety features should be designed and not dependent on EMR-specific training to maintain safety. Integration between electronic systems should be bidirectional to minimize the chance of error.
Validation and maintenance	Validation is required for all transfusion processes. Interfaces between electronic systems must be specifically validated. Validation needs to consider software, hardware and integration into the healthcare setting, workflow and culture. Validation should ensure that forcing functions operate within a clinical workflow to achieve the intended aims. Validation should include override and partial system failure procedures. Maintenance and review of policies and procedures should occur regularly and involve staff in all stages of the transfusion process.