Blood sampling volume audit 2019

Blood Matters program

Blood Matters

Australian Red Cross Lifeblood

VICTORIA State Government

This page has been left blank for the purpose of double-sided printing.

Blood sampling volume audit 2019

Blood Matters program

To receive this publication in an accessible format phone 03 9694 0102, using the National Relay Service 13 36 77 if required, or email Blood Matters bloodmatters@redcrossblood.org.au

Authorised and published by the Victorian Government, 1 Treasury Place, Melbourne.

ISBN 978-1-76069-389-3 (pdf/online/MS word)

Available on the Blood Matters webpage https://www2.health.vic.gov.au/hospitals-and-health-services/patient-care/speciality-diagnostics-therapeutics/blood-matters/reports-audits-journal-articles

(2004700)

Contents

Abbreviations

Term	Explanation
AIHW	Australian Institute of Health and Welfare
CVAD	central venous access devices
Group 1	AIHW – principal referral health services
Group 2	AIHW – public acute A and B and private acute A and B health services
Group 3	all other health services
Group 4	health services reporting on NICU units
Haem/onc	haematology/oncology
Hb	haemoglobin
HDU	high dependency unit
ICU	intensive care unit
LOS	length of stay
mL	millilitres
NBA	National Blood Authority
NICU	neonatal intensive care unit
PBM	patient blood management

Executive summary

The 2014, the National Blood Authority (NBA) *Patient blood management (PBM) guidelines* identified iatrogenic anaemia as an important element of the second pillar of PBM: minimise blood loss.

Iatrogenic anaemia can be caused by blood loss from repetitive blood sampling for laboratory testing.

Patients in high-acuity services require frequent blood draws for diagnostic purposes. The estimated phlebotomy volume ranges from 13 mL to 60 mL per day, depending on the study. High cumulative blood loss can be associated with a greater decrease in haemoglobin and increased transfusion requirements.

In 2017, Blood Matters conducted a snapshot audit to measure the practices that were currently in place to reduce iatrogenic blood loss in Victoria, Northern Territory, Australian Capital Territory and Tasmania. The audit found that most health services did not have policies to support minimal blood sampling as a PBM approach. For the most part, blood conservation strategies had not been considered, although some strategies were used for reasons other than prevention of iatrogenic anaemia. Blood Matters identified a number of recommendations for health services to consider and for Blood Matters to implement.

As recommended, the health services were reaudited for policy compliance, as well as practice in 2019.

Overall, there was no apparent improvement in policy promoting minimal blood sampling practices. It should be noted that the response rate was low (32 per cent), and different health services responded compared with the previous 2017 audit. Table 6 shows the initial recommendations from the 2017 audit, progress made, and the new recommendations based on the 2019 audit.

Unfortunately, the cumulative blood-loss audit had an extremely low response rate of 20 per cent. This was due to the perception by clinical units that the audit was a complex, burdensome task. Nonetheless, nearly 4,000 samples from 550 patients from medical wards (n = 7), haematology/oncology units (n = 5), ICU/HDU (n = 15), and NICU (n = 2) are included in the analysis of this report.

Not surprisingly, there is significant variation in the cumulative volume of blood samples according to clinical unit.

The largest proportion of patients audited were in the clinical area of ICU (46 per cent), and this group also had the highest number of blood draws per day. Blood discard (clearance) rates were highest in the haematology/oncology (haem/onc) clinical group, followed closely by ICU.

From the data reported in this audit, there is potential concern for iatrogenic anaemia developing in patients in ICU and haem/onc, based on cumulative blood sampling volumes over the study LOS. The large volumes were due to a combination of longer length of stay, more frequent testing and higher rates of line clearance.

Table 15 provides practice recommendations from the 2017 audit and the new recommendations based on the 2019 audit.

Background

The 2014 National Blood Authority (NBA) *Patient blood management (PBM) guidelines* identified iatrogenic anaemia as an important element of the second pillar of PBM: minimise blood loss.

PBM guidelines: companion 17 specifically addresses iatrogenic blood loss and provides potential strategies to reduce such blood loss, including:

- using small-volume blood collection sampling tubes
- introducing point-of-care testing
- reinfusing blood drawn from closed blood-sampling systems
- altering test ordering behaviour.

Implementing these strategies requires strategic planning and communication with relevant stakeholders including medical staff, laboratory scientists and nursing staff.

Iatrogenic anaemia in high-acuity services

Iatrogenic anaemia can be caused by blood loss from repetitive blood sampling for laboratory testing.

Patients who develop anaemia have increased transfusion requirements, length of stay, rates of readmission and mortality (Ullman et al. 2015).

Patients in high-acuity services, such as intensive care units (ICU), require frequent blood draws for diagnostic purposes.

The estimated phlebotomy volume ranges from 13 mL to 60 mL per day. Quinn et al. (2019) reported 27 mL per day of blood drawn from patients in ICU, which was more than any other ward within the health service.

The high cumulative blood loss was associated with a greater decrease in haemoglobin and increased transfusion requirements.

Similarly, Ullman et al. (2015) reported local experience with 38 mL per day of blood drawn in adult ICU patients. This was significantly more than in paediatric and neonatal ICUs, suggesting that adult ICU practitioners may be less conscious of frequent blood sampling and may underestimate the risk of iatrogenic anaemia.

Literature review

Whitehead et al. (2019) reviewed the literature on several strategies employed to reduce iatrogenic anaemia.

Small-volume and paediatric tubes have been reported to reduce blood loss without compromising sample integrity or diagnostic validity.

Point-of-care testing had a similar effect in reducing blood loss for biochemistry testing, with some reports of an association with reduced transfusion requirements.

A significant proportion of blood drawn for laboratory testing is discarded when drawing from in-dwelling devices. Use of closed blood sampling devices can reduce the amount of discarded blood by up to 25 per cent (Whitehead et al. 2019).

Bundled interventions aim to incorporate the above strategies together with education and policy changes. Whitehead et al. (2019) reviewed three studies on adult ICU patients and found that blood loss in patients with bundled interventions was 65 per cent less compared with control patients. This led to an absolute reduction of 10 to 29 mL per day.

In another study, Jones et al. (2018) developed a quality improvement project that increased nursing knowledge regarding iatrogenic anaemia, phlebotomy blood loss and blood conservation strategies. This resulted in an increased use of blood conservation devices.

2017 Blood Matters audit

In 2017, Blood Matters conducted a snapshot audit to measure current practices to reduce iatrogenic blood loss in Victoria, Northern Territory, Australian Capital Territory and Tasmania.

It found that most health services did not have policies to support minimal blood sampling as a PBM approach.

Blood conservation strategies had largely not been considered, although some strategies were used for reasons other than prevention of iatrogenic anaemia.

Recommendations following the audit are shown in Table 1.

Table 1: Recommendations following 2017 Blood Matters audit

Blood Matters
• Develop a guideline addressing iatrogenic anaemia that could be used by health services for policy development • Develop and promote educational strategies to increase awareness of iatrogenic anaemia and potential benefits of strategies to reduce this • Develop an audit tool to determine the cumulative daily phlebotomy loss per patient to highlight the need for practice change • Promote or develop (if not currently available) pictorial tables, including test and sample tube required and volume • Re-audit policy and practice in 2018

At the health service level
• Health services should develop and implement policies to promote minimal sampling strategies that address patient blood management issues (iatrogenic anaemia) • Health services should consider including audits of cumulative daily phlebotomy loss per patient as a Blood Management/Hospital Transfusion Committee agenda item to review and make recommendations around practice to address potential iatrogenic anaemia • Health services should explore the potential to use small volume tubes compatible with current laboratory analysers

The re-audit recommended for 2018 was delayed until 2019 due to other work priorities.

All other recommendations for Blood Matters have been addressed and information can be found on the Blood Matters webpage <https://www2.health.vic.gov.au/blood-matters>.

2019 audit overview

Objectives

- Identify policy and practice changes that have occurred since the 2017 audit
- Assess total blood volume taken from patients for samples (testing and discard) in a designated clinical area for seven consecutive days

Method

We invited public and private health services in rural, regional and metropolitan areas (n = 136) in four jurisdictions (Victoria, Northern Territory, Australian Capital Territory and Tasmania) to respond to an online audit (LimeSurvey) of policies and strategies that support reduction of iatrogenic blood loss.

Strategies included in the audit were those recommended in recent peer-reviewed literature, namely:

- small-volume phlebotomy tubes
- closed-system sampling
- frequent evaluation of routine blood sampling orders
- bundled scheduling of blood sampling
- point-of-care testing
- non-invasive monitoring
- charting of cumulative daily phlebotomy loss.

In addition, a bedside prospective audit of practice was completed.

This involved the health service selecting one clinical area, such as ICU, haematology/oncology (haem/onc) or other area for auditing. The selected clinical area was to record all blood-sampling events for all patients during a nominated seven-day period.

The audit collected information about volume used for blood samples, line clearance and whether blood was discarded or returned, including type of collection method. No patient identifiers besides age and gender were submitted.

On submission of the bedside audit, individualised preliminary reports with peer benchmarking were provided back to each health service, so data submitted could be reviewed for potential errors.

The audit was open from 1 August 2019, with data entry to be completed by 20 September 2019.

Limitations

There are limitations to the audit conducted.

The response rate was low for 'Part 2: practice' (n = 43, 20 per cent), barriers cited were mainly due to the burden of measuring each blood sample drawn and consequently gaining cooperation from clinical wards.

However, it was considered important to record actual blood drawn, rather than an estimate based on pathology orders, in order to determine the impact of discards due to line clearance.

Some auditors submitting data anecdotally expressed concern that not all blood draws were documented for each patient. Not documenting all blood draws for a patient would underestimate the actual volume of blood being taken.

Although we collected and measured how much blood was drawn from a patient, we did not collect the actual impact of that blood loss through reporting patient haemoglobin and/or need for transfusion.

Part 1: Policy – results

Forty-three health services completed the online audit (response rate 32 per cent). In 2017, 78 health services completed the online audit (response rate 52 per cent).

Only one health service reported having a policy to minimise the volume and frequency of blood sample collection to reduce iatrogenic anaemia. This is in contrast to the 2017 audit, where six health services responded yes (four health services did not re-participate in 2019, and two responded no in 2019).

Although most health services did not have a specific iatrogenic anaemia policy, 79 per cent (n = 34) (86 per cent, n = 67 in 2017) reported that minimal blood sampling strategies occur to some degree (either through practice in a clinical area or as formal policies).

It is most common in paediatrics, followed by general wards and intensive care units (Table 2). Not all health services that reported minimal volume strategies stated the specific clinical area.

Table 2: Clinical areas[1] within a health service practising minimal blood sampling, whether a formal guideline exists or not

Audit year	ICU Number (%)	Paediatric Number (%)	General wards Number (%)	Emergency Number (%)	Haem/onc Number (%)	Other Number (%)
2017 (n = 78)	12 (15%)	20 (26%)	13 (17%)	4 (5%)	4 (5%)	Renal unit (n = 1) Neonate (n = 6) High risk patients (n = 2)
2019 (n = 43)	6 (14%)	11 (26%)	4 (9%)	5 (12%)	1 (2%)	Neonate (n = 2)

The most frequently reported strategies are point-of-care testing (n = 25), small-volume phlebotomy tubes (n = 24), frequent evaluation of routine sampling orders (n = 16) and closed-system sampling (n = 6).

Table 3 shows a comparison between 2017 and 2019 results.

Where health services report using these strategies, they predominantly occur for purposes other than to minimise iatrogenic anaemia, and most frequently for convenience, time efficiencies or improved patient comfort.

Only two health services report charting of cumulative daily phlebotomy loss specifically in neonatal special care units.

1 A health service could select more than one clinical area.

Table 3: Minimal blood sampling strategies used within a health service[2] (in at least one clinical area), whether a formal guideline exists or not

Strategy	2017: no. health services reporting minimal sampling to minimise iatrogenic anaemia (n = 78) Number (%)	2019: no. health services reporting minimal sampling to minimise iatrogenic anaemia 2019 (n = 43) Number (%)	2017: no. health services reporting minimal sampling for other reasons (n=78) Number (%)	2019: no. health services reporting minimal sampling for other reasons 2019 (n=43) Number (%)
Small-volume phlebotomy tubes	13 (17%)	8 (19%)	23 (29%)	16 (37%)
Closed-system sampling	10 (13%)	5 (12%)	9 (12%)	1 (2%)
Frequent evaluation of routine blood sampling orders	9 (12%)	5 (12%)	18 (23%)	11 (26%)
Bundled scheduling of blood sampling	10 (13%)	6 (14%)	23 (29%)	13 (30%)
Point-of-care testing	4 (5%)	1 (2%)	41 (53%)	24 (56%)
Non-invasive monitoring	6 (8%)	–	18 (23%)	12 (28%)
Charting of cumulative daily phlebotomy loss	1 (1%)	1 (2%)	1 (1%)	–

Only 30 per cent of health services (n = 13) reported using minimal blood sampling practices for the purpose of minimising iatrogenic anaemia, in at least one clinical area or patient group. In addition, some health services reported practices that may potentially promote unnecessary blood tests, such as ordering specified test sets (n = 18, 42 per cent) and routine blood sampling orders (n = 19, 44 per cent), without adequately evaluating the clinical condition of the individual patient.

Nine health services reported having electronic medical records. Of these, two had order sets prescribed with the option to remove individual specific tests. The remaining seven health services stated there were no order sets prescribed.

Table 4 shows the perceived barriers to implementing minimal blood sampling for both 2017 and 2019. The most frequent (n = 23) explanation for a lack of policy or practice of minimal sampling was, 'Practice has not been considered'. In addition, eight health services stated that small tubes are discouraged due to increased manual handling, decreasing efficiency and increasing risk of errors.

2 A health service could select more than one strategy.

Table 4: Perceived barriers to implementing minimal blood sampling

Barriers[3] (multiple responses allowed)	2017 Number (%)	2019 Number (%)
Small-volume tubes are not available	6 (8%)	4 (9%)
Small-volume tubes are not suitable for our pathology provider's analysers	8 (10%)	11 (26%)
Practice is not supported by pathology/laboratory	8 (10%)	3 (7%)
Practice is not supported by management	1 (1%)	–
Practice of returning blood from central lines is not supported	13 (17%)	11 (26%)
Resources to instigate and sustain change are not available	5 (6%)	2 (5%)
Practice has not been considered	39 (50%)	23 (53%)
No known barriers	26 (33%)	9 (21%)

A number (n = 6) of the smaller rural health services also reported that they do not need minimal blood sampling strategies due to the low level of acuity of their patients.

Of the 33 health services that reported having a laboratory on site, nine (39 per cent) had no analysers with the ability to take small volume sample tubes for any test type (Table 5).

Table 5: Analyser ability to accommodate small volume sample tubes

Analyser type accommodating small volume sample tubes[4] (multiple responses allowed)	2019 Number (%)
No laboratory onsite	10 (23%)
Laboratory onsite but no analyser type accommodating small volume sample tubes	9 (21%)
Analyser type – full blood examination	23 (53%)
Analyser type – group and save	15 (35%)
Analyser type – biochemistry	21 (49%)
Analyser type – routine coagulation testing	18 (42%)
Onsite laboratory with analysers for all tests above accommodating small volume sample tubes	13 (30%)

3 Based on auditors interpretation and reliance on clarifications with health service and laboratory.
4 Reliance on auditor knowledge/clarification with the laboratory staff.

The handling and processing of small-sample volume tubes may pose issues within some laboratories where automated analysers are primarily designed to handle standard adult tubes. It should be noted there is a difference between small-volume tubes and paediatric tubes. However, this may cause an issue due to an the inability to add on further tests. Depending on the tests required, smaller volumes within a standard tube may be sufficient.

Five health services reported when tendering for new analysers that the tender documents included specification for these to have the ability to use small volumes/ small-volume tubes. Twenty respondents were unsure.

Only two health services reported providing specific education regarding iatrogenic anaemia.

Part 1: Policy – summary and conclusions

The response rate for the policy component of the audit in 2019 was lower than when the audit was completed in 2017 (32 per cent versus 52 per cent). Despite previous recommendations published in 2017, it appears little has been done to work towards reducing blood loss through phlebotomy (Table 6).

Table 6a: Progress made on previous recommendations – Blood Matters

Blood Matters recommendations 2017	Progress 2018	Recommendations 2019
Develop a guideline addressing iatrogenic anaemia that could be used by health services for policy development	Publication of: *Reducing iatrogenic blood loss: clinical practice guideline template* (Jan 2018, available on Blood Matters webpage)	Promote clinical practice guideline template to health services. Include information with individual health service reports
Develop an audit tool to determine the cumulative daily phlebotomy loss per patient to highlight the need for practice change	Development and promotion of cumulative daily phlebotomy loss (available on Blood Matters webpage)	Promote audit tools
Promote or develop (if not currently available) pictorial tables, including test and sample tube required and volume	This was deemed not necessary due to availability of information at the local level	Reinforce the use of pictorial tables for sample tube requirements and volumes
Re-audit policy and practice in 2018	Re-audited policy in 2019, with the addition of practice	Provide individual health service results. Provide audit tools on webpage for health services to reaudit

Table 6b: Progress made on previous recommendations – health services

Health service recommendations 2017	Progress 2018	Recommendations 2019
Health services should develop and implement policies to promote minimal sampling strategies that address patient blood management issues (iatrogenic anaemia)	There was no reported increase in health services having policies in place to promote minimal sampling strategies	Reinforce that health services should develop and implement policies to promote minimal sampling strategies that address patient blood management issues (iatrogenic anaemia)
Health services should consider including audit of cumulative daily phlebotomy loss per patient as a Blood Management / Hospital Transfusion Committee agenda item to review and make recommendations around practice to address potential iatrogenic anaemia	One health service has conducted such audits	Add the audit tool to those available on the Blood Matters webpage. Provide a 'Practical tips for auditing' fact sheet to be disseminated with the results and available on the webpage
Health services should explore the potential to use small volume tubes compatible with current laboratory analysers.		Encourage discussion with laboratories to determine barriers and promote change Develop an ideal fill volume guide along with the sample tube requirements.

Part 2: Practice – results

Twenty-seven (20 per cent) health services submitted data for the cumulative blood sampling section. A total of 3984 samples from 550 patients were included in the analysis. Clinical units audited included medical wards (n = 7), haematology/oncology units (n = 5), ICU/HDU (n = 15), NICU (n = 2). Two health services chose to audit two different clinical units.

For the purposes of this report, health services were allocated a group primarily based on the Australian Institute of Health and Welfare (AIHW) hospital peer group (2015).

All principal referral health services were allocated to Group 1 (n = 6); public acute A and B and private acute A and B health services were allocated to Group 2 (n = 12); health services reporting on NICU units were allocated Group 4 (n = 2); all other health services were allocated into Group 3 (n = 7).

Table 7 summarises the demographics of the 550 patients audited during the reporting period. The largest percentage of patients were audited whilst in ICU (46 per cent).

Table 7: Demographics of patients (n = 550)

Clinical unit (peer group) (no. health services)	Number of patients	Male Number (%)	Age (years) Average (range)	Study LOS (days) Average (range)
ICU – Group 1 (n = 4)	128	86 (67%)	62.3 (13.0–89.0)	3.4 (1.0–8.0)
ICU – Group 2 (n = 9)	124	73 (59%)	61.7 (9.0–90.0)	3.9 (1.0–9.0)
HDU – Group 3 (n = 2)	35	18 (51%)	61.7 (22.0–90.0)	2.4 (1.0–5.0)
NICU – Group 4 (n = 2)	22	8 (36%)	0.1 (0.0–0.8)	6.3 (3.0–11.0)
Haem/onc – Group 1 (n = 2)	71	44 (62%)	58.0 (16.0–85.0)	4.8 (1.0–7.0)
Haem/onc – Group 2 (n = 3)	74	42 (57%)	68.4 (35.0–92.0)	3.5 (1.0–10.0)
Medical ward – Group 2 (n = 2)	67	26 (39%)	68.8 (25.0–92.0)	4.7 (1.0–8.0)
Medical ward – Group 3 (n = 5)	29	16 (55%)	71.9 (27.0–98.0)	4.3 (1.0–8.0)

Blood sampling volume

Patients located in group 1 ICUs had the highest number of blood draws per patient per day (average 3.6).

This resulted in an average of 33 mL/day of blood loss, with a cumulative loss of 121 mL over the study length of stay (LOS) (Table 8).

Table 8: Blood sampling volumes by clinical unit and peer group

Clinical unit (peer group)	Number of samples	Number of draws/day/ patient Average (range)	Volume (mL/day/ patient) Average (range)	Study LOS/ patient (days) Average (range)	Cumulative phlebotomy volume (mL)/ patient Average (range)
ICU – Group 1	1,718	3.6 (0.1–10.0)	33 (2–111)	3.4 (1–8)	121 (4–720)
ICU – Group 2	1,299	2.3 (0.1–9.8)	20 (1–61)	3.9 (1–9)	87 (4–491)
HDU – Group 3	102	1.2 (0.3–5.0)	1 (3–44)	2.4 (1–5)	33 (9–107)
NICU – Group 4	115	0.9 (0.1–2.2)	1 (0.1–5)	6.3 (3–11)	7 (0.3–27)
Haem/onc – Group 1	381	1.1 (0.2–4.0)	19 (0.5–66)	4.8 (1–7)	100 (2.7–463)
Haem/onc – Group 2	153	0.8 (0.1–1.4)	8 (1–40)	3.5 (1–10)	28 (5–152)
Medical ward –Group 2	169	0.6 (0.1–1.3)	5 (0.8–15)	4.7 (1–8)	20 (3–82)
Medical ward– Group 3	47	0.5 (0.1–1.3)	6 (0.8–40)	4.3 (1–8)	22 (3–160)

Blood sampling access

Depending on the type of access used to collect blood samples, some line clearance discard is unavoidable.

Patients in the ICU are frequently sampled via an indwelling device (such as CVAD, IV peripheral or arterial) that requires a volume of blood to be discarded to remove contaminated components (referred to as line clearance). Some blood sampling systems can be set up as 'closed', which allows reinfusion of the line clearance.

At other times, blood may be discarded due to drawing more blood than required. Table 9 describes the discard rate by type of access device used.

Table 9: Discard rate by access type

Access type[5]	No line clearance Number (%)	Line clearance returned Number (%)	Line clearance discarded Number (%)	Average volume discarded/day/ patient (mL) – when discarded Average (range)
CVAD	48 (7%)	17 (2%)	648 (91%)	6.0 (0.25–43)
IV – peripheral	22 (9%)	3 (1%)[6]	212 (89%)	3.0 (0.06–23)
Stab – peripheral	422 (90%)	3 (1%)[7]	43 (9%)	0.4 (0.05–9.5)
Arterial	25 (1%)	360 (14%)	2,104 (85%)	12.7 (0.6–68)
Prick - finger/heel	73 (100%)	0 (0%)	0 (0%)	

Of interest is the 9 per cent of discarded blood from a peripheral stab access, which may indicate the collection of a volume greater than required, or not using systems such as Vacutainers, where blood is collected directly into the tubes without waste.

Table 10 shows the high discard rates in haem/onc wards and ICUs.

In clinical settings where frequent blood sampling occurs over a longer length of stay, line clearance discards can have a significant impact on patient haemoglobin (Hb) and, consequently, outcome (and need for transfusion).

Table 10: Impact of line clearance on blood volume discarded

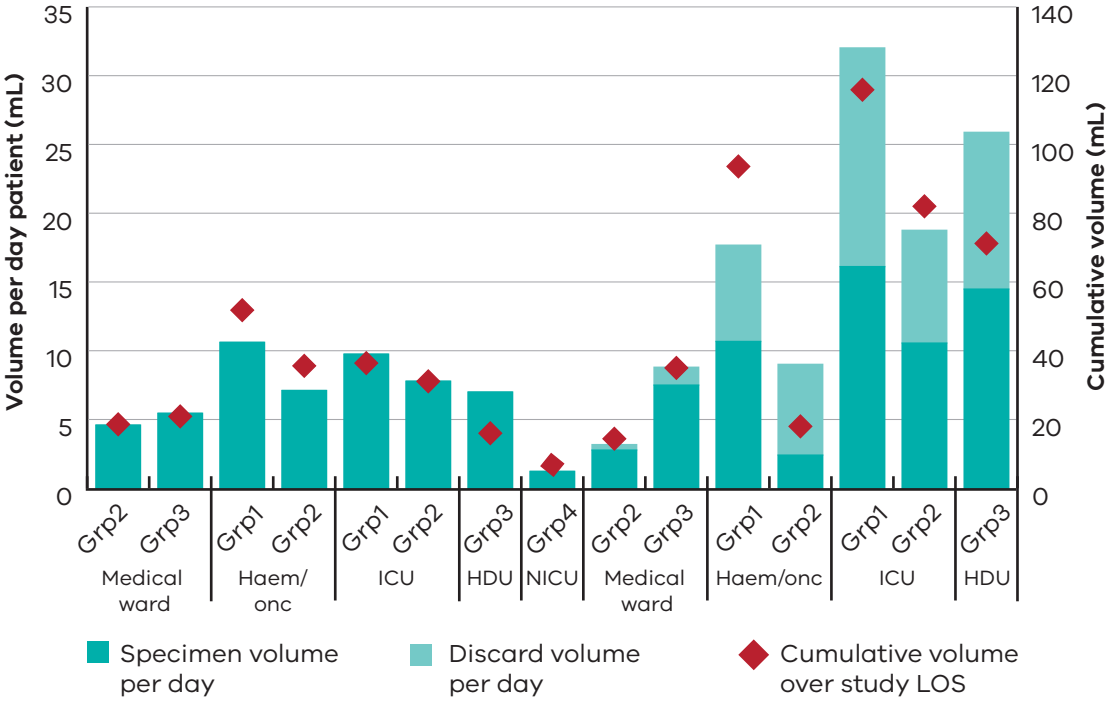
Clinical unit (peer group)	No line clearance Number (%)	Line clearance returned Number (%)	Line clearance discarded Number (%)	Average volume discarded/day/ patient (mL) – Average (range)
ICU Group 1	39 (2%)	148 (9%)	1,531 (89%)	15.9 (0.4–68.0)
ICU Group 2	74 (5%)	179 (14%)	1,045 (81%)	8.2 (0.2–31.6)
HDU Group 3	51 (50%)	0 (0%)	51 (50%)	11.4 (3.7–23.7)
NICU Group 4	60 (52%)	55 (48%)	0 (0%)	–
Haem/onc Group 1	30 (8%)	1 (0%)	350 (92%)	7.0 (0.9–16.1)
Haem/onc Group 2	97 (63%)	0 (0%)	56 (37%)	6.6 (1.4–10.0)
Medical ward Group 2	135 (80%)	0 (0%)	34 (20%)	0.4 (0.1–2.9)
Medical ward Group 3	46 (98%)	0 (0%)	1 (2%)	1.3 (1.3–1.3)

5 Access type not reported for four blood collections.
6 Likely data entry error, as blood would not be expected to be returned via this route of collection.
7 Likely data entry error, as blood would not be expected to be returned via this route of collection.

Where line clearance is occurring, ICU patients have the greatest discard volume on average, at 50 per cent of the total blood drawn (16 mL/day). This results in an average cumulative volume of 116 mL over the study LOS (Figure 1).

Haem/onc and HDU patients also reported a large percentage of blood volume discarded. However, with lower LOS and lower frequency of blood sampling, the overall impact is smaller.

Figure 1: Average blood volume for sample and discard per patient per day by clinical unit and peer group



Blood volume drawn by patient age

Volume drawn for patients aged under ten are significantly lower than for older patients (Table 11).

Due to these patients having a lower total blood volume, it is important to ensure minimal blood is drawn for blood samples.

This is achieved principally by having no discard due to no clearance (heel or finger prick) or returning the line clearance.

In addition, low volume tubes are used, further reducing blood loss due to blood sampling.

Table 11: Impact of age on blood volume drawn (specimen and discard) by clinical unit[8]

Clinical unit (peer group)	Ave. vol. drawn/ day/patient (mL) (average, range) < 1 year (n = 22)	Ave. vol. drawn/ day/patient (mL) (average, range) 1 to < 10 (n = 1)	Ave. vol. drawn/ day/patient (mL) (average, range) 10 to < 20 (n = 6)	Ave. vol. drawn/ day/patient (mL) (average, range) 20 to < 80 (n = 433)	Ave. vol. drawn/ day/patient (mL) (average, range) equal to or > 80 (n = 86)
ICU Group 1	–	–	28 .2 (19.3–37.3)	34.5 (2.2–111.2)	23.3 (9.0–52.0)
ICU Group 2	–	1.7	33.6 (28.3–37.4)	20.8 (1.1–61.4)	14.7 (3–34.8)
HDU Group 3	–	–	–	12.1 (3.0–43)	17.8 (5.9–44)
NICU Group 4	1.2 (0.04–4.6)	–	–	–	–
Haem/ onc Group 1	–	–	31	19.2 (0.5–66.1)	21 .5 (14.5–28.5)
Haem/ onc Group 2	–	–	–	8.9 (1.6–40)	7.1 (1.2–15)
Medical ward Group 2	–	–	–	7.8 (3.0–15.0)	4.6 (0.8–11.7)
Medical ward Group 3	–	–	–	4.6 (0.8–14.2)	6.9 (1.1–40)

8 Two missing ages.

Reason for blood sampling

The majority of blood sampling (69 per cent) occurs due to routine blood orders, rather than by clinical review and subsequent medical request (26 per cent).

Avoidable additional samples due to a laboratory request for re-bleed (due to errors in labelling or inadequate sample) contributed to only 1 per cent of blood samples (Table 12).

Table 12: Average (range) volume drawn (mL) per blood specimen taken by reason for testing by clinical unit[9]

Clinical unit (peer group)	Reason for testing: routine (n = 2750)	Reason for testing: medical request (n = 1,036)	Reason for testing: lab request (n = 40)	Other (n = 155)
ICU Group 1	7.8 (0.5–109)	13.3 (1.0–83)	12.7 (2–22)	7.3 (1–26)
ICU Group 2	7.0 (0.05–32)	11.7 (0.2–41.4)	14.4 (3.5–28)	7.5 (1–102.5)
HDU Group 3	13.1 (1–28.7)	7.5 (1.0–40)	12 (9–15)	–
NICU Group 4	1.1 (0.2–3.3)	1.5 (0.1–7.7)	0.2	0.6 (0.2–1.7)
Haem/onc Group 1	18.0 (2.7–90)	20.6 (2.0–86)	–	16.9 (5–30)
Haem/onc Group 2	13.0 (4–38)	15.8 (2–40)	8.0	–
Medical ward Group 2	8.1 (3.0–20)	7.6 (2–20)	–	–
Medical word Group 3	–	13.6 (1–80)	–	–

9 Reason for testing not reported in three blood collections.

Weight / volume / estimated haemoglobin drop

Blood volume can be estimated as approximately 70 mL/kg for adults, 80 mL/kg in children and 100 mL/kg in neonates <https://transfusion.com.au/disease_therapeutics/haemorrhage>.

As such repeated or large volume blood sampling will effect Hb.

Patient weight was included in the data collection form four days after the initial circulation, and as a result, only 314 of the 550 (57 per cent) recorded weight.

Table 13 outlines the estimated percentage blood loss related to blood sampling based on recorded patient weight.

Table 13: Estimated percentage blood loss related to blood sampling calculated on body weight

Weight range	Count	Weight (kg) Average (range)	Estimated blood volume mL of average patient	Cumulative blood loss (mL) Average (range)	Percentage blood loss by weight Average (range)
Less than 5 kg	14	3 (1–4)	300	7.7 (0.3–27.4)	2.5% (0.1–9.1)
5 – less than 30 kg	0	–	–	–	–
30 – less than 50 kg	9	41.2 (30–49)	2,884	58.7 (5–191)	2.0% (0.2–6.6)
50 – less than 80 kg	151	66.7 (50–79)	4,669	60.0 (3–463)	1.3% (0.6–9.9)
80 kg plus	140	95.8 (80–178)	6,706	81.2 (3–720)	1.2% (0.4–10.3)

Potential effect of blood sampling on haemoglobin

The scope of this audit did not record the patient's haemoglobin. However, based on the findings of Thavendiranathan et al. (2005) that for every 1 mL of phlebotomy in adults, there is a mean decrease in haemoglobin of 0.07 g/L, haemoglobin changes can be extrapolated.

While small changes in haemoglobin may be clinically unimportant, a clinically significant change has been reported to be between 6.6 and 10 g/L.

In this audit, the greatest estimated Hb decreases were seen in Group 1 ICU and haem/onc (already at risk of anaemia due to their disease), and Group 2 ICU patients (Table 14), 8.5 g/L, 7.0 g/L and 6.1 g/L respectively over the study period LOS.

Table 14: Extrapolated Hb loss over study length of stay for each group

Clinical unit (peer group)	Cumulative phlebotomy volume (mL)/patient during study LOS Average (range)	Estimated drop in haemoglobin over study LOS/patient (g/L) Average (range)
ICU Group 1	121 (4–720)	8.5 (0.3–50.4)
ICU Group 2	87 (4–491)	6.1 (0.3–34.4)
HDU Group 3	33 (9–107)	2.3 (0.6–7.5)
Haem/onc Group 1	100 (2.7–463)	7.0 (0.2–32.4)
Haem/onc Group 2	28 (5–152)	1.9 (0.4–10.6)
Medical ward Group 2	20 (3–82)	1.4 (0.2–5.7)
Medical ward Group 3	22 (3–160)	1.5 (0.2–11.2)

The estimated drop in Hb associated with the blood volumes drawn for testing and discard could contribute to a patient's transfusion needs, some of which would depend on the starting Hb of the patient and disease process.

Part 2: Practice – summary and conclusions

There is significant variation in the cumulative volume of blood samples according to clinical unit.

The largest proportion of patients audited were in the clinical area of ICU (46 per cent), and this group also had the highest number of blood draws per day.

Blood discard rates were highest in the haem/onc clinical group, followed closely by ICU.

From the data reported, there is potential concern for iatrogenic anaemia developing in patients in Group 1 ICU and haem/onc, and Group 2 ICU patients based on cumulative blood sampling volumes over the study LOS. The large volumes were due to a combination of longer length of stay, more frequent testing and higher rates of line clearance.

Blood sample volume was significantly lower in patients aged under 10 years of age.

The majority of blood sampling related to routine orders rather than medical request.

Tables 15a and 15b outline recommendations for both Blood Matters and health services related to sampling practice.

Table 15a: Practice recommendations for Blood Matters

Recommendations for Blood Matters
• Collate and circulate combined report and individual data to health services for action by the Blood Management/Hospital transfusion committee. • Publish report to Blood Matters webpage and circulate to interested parties. • Develop information with strategies and tips that could be used in health services to reduce cumulative phlebotomy loss • Communicate report findings to scientific staff through newsletters and at meetings particularly in relation to the capacity to use small volume sampling.

Table 15b: Practice recommendations for health services

Recommendations for health services – 2017	Recommendations for health services – 2019
Health services should consider including audits of cumulative daily phlebotomy loss per patient as a Blood Management / Hospital Transfusion Committee agenda item to review and make recommendations around practice to address potential iatrogenic anaemia.	Participating health services to report their individual and comparative data to their Blood Management / Hospital transfusion committee for review and action to address potential iatrogenic anaemia. Non-participating health services should consider including audit of cumulative daily phlebotomy loss per patient as a Blood Management/Hospital Transfusion Committee agenda item to review and make recommendations around practice to address potential iatrogenic anaemia. All health services should review current line clearance volumes to explore if these can be reduced, or alternate strategies such as closed systems can be used, especially for clinical groups at high risk of cumulative phlebotomy loss.
Health services should explore the potential to use small volume tubes compatible with current laboratory analysers.	Health services/laboratories should explore the potential to use small volume tubes compatible with current laboratory analysers and include this requirement when replacing equipment.
	Health services/laboratories should review current sample volume requirements to consider if these can be reduced if the use of small volume sample tubes is not feasible.
	Health services are encouraged to review routine orders for blood sampling as a strategy to potentially reduce cumulative phlebotomy loss.

References

ANZSBT 2016, Guidelines for transfusion and immunohaematology laboratory practice, <www.anzsbt.org.au/data/GuidelinesforTransfusionandImmunohaematology LaboratoryPractice_1ed_Nov20_.pdf>, accessed 1 April 2017, now revised January 2020 <https://anzsbt.org.au/wp-content/uploads/2020/03/Guideline_-for_Transfusion_and_Immunohaematology_Laboratory_Practice_20200326_FINAL_Published_SecurePW-1.pdf>

Australian Institute of Health and Welfare (AIHW) 2015, *Australian hospital peer groups*, <https://www.aihw.gov.au/reports/hospitals/australian-hospital-peer-groups/contents/table-of-contents>, accessed January 2020.

Bielby L, Moss R, Mo A, McQuilten Z, Wood EM 2019, 'The role of the transfusion practitioner in the management of anaemia', *ISBT Science Series*, vol. 0, no. 1–9 DOI: 10.1111/voxs.12523.

Jones S, Spangler P, Keiser M, Turkelson C 2019, 'Impact of nursing education on phlebotomy blood loss and hospital-acquired anemia: a quality improvement project', *Dimensions of Critical Care Nursing*, vol. 38, pp. 13–19.

National Blood Authority 2014, *Patient blood management guidelines – companions*, <www.blood.gov.au/system/files/documents/patient_blood__management_guidelines_companions.pdf>, accessed 1 April 2017.

Quinn, JG et al. 2019, 'A contemporary description of patients' estimated blood losses from diagnostic phlebotomy in a census of hospital episodes from a Canadian tertiary care center', *Transfusion*, vol. 59, pp. 2849–2856.

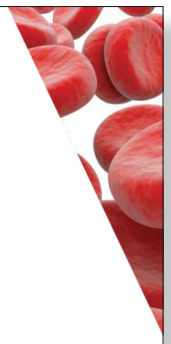
Thavendiranathan P, Bagai A, Ebidia A, Detsky AS, Choudhry NK 2005, 'Do blood tests cause anemia in hospitalized patients? The effect of diagnostic phlebotomy on hemoglobin and hematocrit levels', *J Gen Intern Med*., vol. 20, pp. 520–4.

Ullman AJ, Keogh S, Coyer F, Long D, New K, Rickard C 2015, '"True blood": The critical care story: an audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings', *Australian Critical Care*, vol. 29, no. 2, pp. 90–95.

Whitehead NS, Williams L, Meleth S, Kennedy S, Ubaka-Blackmoore N, Geaghan SM, Nichols JH, Carroll P, McEvoy MT, Gayken J, Ernst DJ, Litwin C, Epner P, Taylor J and Graber ML 2019, 'Interventions to prevent iatrogenic anemia: a Laboratory Medicine Best Practices systematic review', *Critical Care*, vol. 23, p. 278.

Appendix 1: Audit instructions

Blood sampling volume audit 2019



Introduction
Iatrogenic anaemia is a term applied to the anaemia that results from blood loss due to repeated blood sampling to obtain specimens for laboratory testing. Strategies to reduce iatrogenic blood loss include altering of test ordering behaviour (limiting the number of tests ordered), micro-sampling, reinfusion of blood drawn from indwelling devices and point of care microanalysis (National Blood Authority (NBA) 2014).
For every 100 mL of blood withdrawn, there is a decrease of 7 g/L in haemoglobin.) A reduction in iatrogenic blood loss reduces the risk of anaemia and potentially the need for blood transfusion (NBA 2018). The use of micro-sampling has been shown to significantly reduce the volume of blood loss and has been associated with a significant reduction in blood transfusion (Tinmouth 2008). Implementing strategies to reduce iatrogenic blood loss in an organisation requires strategic planning, communication and implementation with relevant stakeholders such as medical staff, laboratory scientist and nursing staff.

In 2017 Blood Matters undertook a snapshot audit of health service practices that could minimise iatrogenic anaemia associated with blood sampling.

This audit (2019):
Aims

- To identify policy and practice changes that have occurred since 2017 audit.
- To assess total blood volume taken from patients for samples (testing & discard) in a designated clinical area for seven consecutive days.

Method
This audit comprises of two parts:

Part A: Desktop audit of policy and procedures
Part B: Bedside prospective audit of practice – of all patients in one selected clinical area for one week (7 days).

Audit open from 1 August 2019, with data entry to be completed by 20 September 2019.

Please complete all health service data entry by Friday 20 September 2019

Links to audit tools:
Part A: https://dhhsvic.limequery.com/318161?newtest=Y&lang=en

Part B: bedside data collection sheets
Data entry submission to Blood Matters
These tools can be found https://www2.health.vic.gov.au/hospitals-and-health-services/patient-care/speciality-diagnostics-therapeutics/blood-matters/transfusion-audits

blood matters

Australian Red Cross BLOOD SERVICE

VICTORIA State Government | Health and Human Services

Instructions

Part A: Desktop audit of policy and procedures
This part of the audit is to be completed by Blood Management, Transfusion, Laboratory or appropriate Risk management staff.
The audit is submitted online via LimeSurvey
https://dhhsvic.limequery.com/318161?newtest=Y&lang=en

Part B: Bedside prospective audit of practice
This part of the audit is to assess health services current blood sampling practices, and will record the volume of blood taken from patients for testing and discard. Clinical staff will be required to record volumes at the time of blood sample collection.

The health service is requested to select one clinical area, e.g. ICU, haematology, or other clinical area for auditing. All patients in the selected clinical area to have a record of all blood sampling events documented for a 7-day period (within the audit timeframe 1 August to 6 September – Complete data entry by 20 September).

Print out the attached audit tool for bedside documentation of blood sampling. Include only one patient's information per sheet, however one patient may need multiple sheets.

Patient details for health service use only, are entered at the top. Do not include patient identifiers, other than gender and age, when submitting data to Blood Matters.

For clinical staff at the bedside:
A separate row needs to be completed for each sample draw. For example, if blood cultures are taken from a central line and other samples are taken from a peripheral IV at the same time, two separate rows would need to be completed.

- Total volume withdrawn = the total volume of any blood taken for samples, to clear lines and discard
- Volume line clearance = any blood withdrawn to clear the line of other fluids before taking specimens for testing, whether discarded or returned
- Reason for blood sampling
    - Routine – any routine testing that would regularly occur for that patient e.g. daily U&E, FBE
    - Medical request – any sampling that is in addition to usual routine testing requirements e.g. patient has melena and a FBE is requested to check Hb
    - Laboratory request (zero tolerance) – where specimens have been rejected by the laboratory, for any reason, and a new specimen requested, or additional bloods required by the laboratory to complete testing.
    - Other – any other reason blood testing is taken
- Sample collection method:
    - Vacutainer - where specimens are collected directly into the sample tubes.
    - Syringe - collection using a syringe to collect blood either from a line or for a peripheral stab
    -

Please ensure that if pathology collectors or medical staff are collecting blood samples from the patient, the required information is entered on the data collection tool.

For the data entry to Blood Matters:
On completion of the audit, data is to be entered into an excel file and emailed to bloodmatters@redcrossblood.org.au

The Excel file contains multiple tabs. The first tab provides a summary page allowing entry of basic information about your health service. It also provides a summary of the data as it is entered into the individual patient tabs.
The summary section cannot be directly edited, but allows easy navigating to patient data entry tabs and provides a quick overview of all data entered to check for accuracy.
The Excel file allows data submission of up to 50 blood collections per patient, for up to 50 patients. For sites with more than 50 patients a second Excel file will be needed. Use one tab per patient for data entry. All blood collections for the patient, during the audit period go into the one tab.

References:
Tinmouth, A, McIntyre, L, Fowler, R. Blood conservation strategies to reduce the need for red cell transfusion in critically ill patients, CMAJ 2008178:49-57.

National Blood Authority Patient Blood Management Guidelines Companions No 17 Reduce iatrogenic blood loss (2014) https://www.blood.gov.au/patient-blood-management-guidelines-companions

National Blood Authority 'Use of small volume tubes to reduce blood loss case study: Flinders Medical Centre.' (2018) https://www.blood.gov.au/system/files/SVTs-at-FMC-case-study-v2-with-endnote-references.pdf

'True Blood' The Critical Care Story: An audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings, Australian Critical Care 29 (2016) 90-95.

Appendix 2: Part 1 – policy audit questions

Blood sampling volume - Policy

Blood Matters audit: 2019

Sample only - submit online

Iatrogenic anaemia is a term applied to the anaemia that results from blood loss due to repeated blood sampling to obtain specimens for laboratory testing. Strategies to reduce iatrogenic blood loss include altering of test ordering behaviour (limiting the number of tests ordered), micro-sampling, reinfusion of blood drawn from indwelling devices and point of care microanalysis (NBA 2014). The use of micro-sampling has been shown to significantly reduce the volume of blood loss and has been associated with a significant reduction in blood transfusion (Tinmouth 2008). Implementing strategies to reduce iatrogenic blood loss in an organisation requires strategic planning, communication and implementation with relevant stakeholders such as medical staff, laboratory scientist and nursing staff.

References Tinmouth, A, McIntyre, L, Fowler, R. Blood conservation strategies to reduce the need for red cell transfusion in critically ill patients, CMAJ 2008178:49-57. National Blood Authority Patient Blood Management Guidelines Companions No 17 Reduce iatrogenic blood loss (2014) https://www.blood.gov.au/patient-blood-management-guidelines-companions 'True Blood' The Critical Care Story: An audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings, Australian Critical Care 29 (2016) 90-95.

Name of health service: *

Email address of person completing the survey: *

Policy

Does your health service have a policy to minimise the volume and frequency of blood sample collection to prevent iatrogenic anaemia? *

- Yes
- No
- Unsure

If you have a policy:

What was the date of last review for your policy: *

Which clinical areas within your health service does the policy cover *

- ICU
- Paeditarics
- General wards
- Emergency department
- Haematology/oncology ward
- None of the above
- Other:

Blood Matters

Australian Red Cross BLOOD SERVICE

VICTORIA State Government | Health and Human Services

Which strategies are stipulated in the policy to support minimal blood sampling: * (Please choose **all** that apply)

- small volume phlebotomy tubes (e.g., using paediatric sample tubes or sample tubes with thick walls)
- closed system sampling (where samples are taken from central lines (Hickman's) reinfusing initial blood taken or using the initial draw for blood cultures)
- frequent evaluation of routine blood sampling orders (Reducing the number of samples taken from the patient, such as not doing a daily cross match specimen)
- bundled scheduling of blood sampling
- point of care testing (e.g. hemoCue)
- non-invasive monitoring
- charting of cumulative daily phlebotomy loss
- none of the above

Strategies

Whether formal guidelines exist or not, do any of the below areas within your health service practice minimal blood sampling? *
(Please choose **all** that apply)

- ICU
- Paeditarics
- General wards
- Emergency department
- Haematology/oncology ward
- None of the above
- Other:

Whether formal guidelines exist or not, are any of the following strategies (which support minimal sampling) currently in place: *

	Yes - to minimise iatrogenic anaemia	Yes - other reasons	No
Small volume phlebotomy tubes (e.g., using paediatric sample tubes or sample tubes with thick walls)			
Closed system sampling (where samples are taken from central lines [Hickman's] reinfusing initial blood taken or using the initial draw for blood cultures)			
Frequent evaluation of routine blood sampling orders (Reducing the number of samples taken from the patient, such as not collecting a cross match specimen daily)			
Bundled scheduling of blood sampling			
Point of care testing			
Non-invasive monitoring			
Charting of cumulative daily phlebotomy loss			

If any of the above answers include “yes – for other reasons”, please comment on what the reasons may be, e.g., Point of care testing is used in some areas for convenience rather than for the purpose of minimal sampling.

Whether formal guidelines exist or not, is specific education regarding iatrogenic anaemia provided? *

- Yes
- No
- Unsure

Sample only - submit online

Do any of the following practices occur within your health service that may potentially increase the number of samples taken? *
(Select **all** that apply)

- Specified test set – (i.e. where a specific patient group have specified tests taken at stipulated time points regardless)
- Routine blood sampling orders (i.e. daily FBE regardless of clinical condition of the patient)
- None of the above

If your health service has an electronic medical record (EMR), are blood tests managed as order sets? *

- Order sets prescribed – cannot be modified
- Order sets prescribed – but can remove specific tests if not needed
- No order sets prescribed
- Not applicable

If no policy is in place or where minimal sampling is not practised, please indicate why?* (Select all that apply and provide a comment, where applicable)

- Small volume tubes are not available
- Small volume tubes are not suitable for our pathology provider's analysers
- Practice is not supported by pathology/laboratory- (other than equipment restrictions)
- Practice not supported by management
- Practice of returning blood from central lines not supported
- Resources to instigate and sustain change not available
- Practice has not been considered
- No known barriers
- Not applicable, health service actively supports and implements minimal sampling
- Other:

Please indicate if the current analysers at your health service have the ability to take small volume sample tubes. (Select all that apply)

- Full blood examination
- Group and Save
- Biochemistry
- Routine coagulation testing
- No lab onsite
- None of the above

When new tenders for analysers are raised, do they include the specification to allow for small volume testing? *

- Yes
- No
- Unknown
- No lab onsite

Blood Matters

Australian Red Cross BLOOD SERVICE

VICTORIA State Government | Health and Human Services

BLOOD SAMPLING AUDIT – Bedside

Audit start date:_____ **Audit end date:** _____

Patient clinical specialty: ☐ surgical ☐ medical ☐ haem/oncology (including BMT) ☐ trauma

Was the patient ADMITTED during the audit period: ☐ **Yes** ☐ **No** **If yes, admission date:** _____

Please complete every time you withdraw blood from your patient

(Please start a new row per access/draw, e.g. if completing peripheral draw and CVAD at one time, this MUST be entered on two lines)

Patient ID label

Sample draw	**Date** dd/mm/yy	**Time** (24 hour clock)	**Total volume Withdrawn** (mL)	**Volume line clearance** (mL)	**Line clearance:** (D)iscarded (R)eturned	**Reason for blood sampling** (R)outine (M)edical request (L)ab request - rebleed (O)ther	**Access type** (C)VAD (I)V - Peripheral (S)tab - Peripheral (A)rterial	**Collection method** (V)acutainer (S)yringe
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Was the patient DISCHARGED during the audit period: ☐ **Yes** ☐ **No** **If yes, discharge date:** _____

Please ensure patient details are included on each page; and use as many forms as your patient requires.