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Research paper

A retrospective explanatory case study of the implementation of a bleeding management quality initiative, in an Australian cardiac surgery unit

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ABSTRACT

Background: Bleeding management in cardiac surgery is challenging. Many guidelines exist to support bleeding management; however, literature demonstrates wide variation in practice. In 2012, a quality initiative was undertaken at The Prince Charles Hospital, Australia to improve bleeding management for cardiac surgery patients. The implementation of the quality initiative resulted in significant reductions in the incidence of blood transfusion, re-exploration for bleeding; superficial leg and chest wound infections; length of hospital stay, and cost. Given the success of the initiative, we sought to answer the question; "How and why was the process of implementing a bleeding management quality initiative in the cardiac surgery unit successful, and sustainable?"

Methods: A retrospective explanatory case study design was chosen to explore the quality initiative. Analysis of the evidence was reviewed through phases of the 'Knowledgeto Action' planned change model. Data was derived from: (1) document analysis, (2) direct observation of the local environment, (3) clinical narratives from interviews, and analysed with a triangulation approach. The study period extended from 10/2011 to 6/2013.

Results: Results demonstrated the complexity of changing practice, as well as the significant amount of dedicated time and effort required to support individual, department and system wide change. Results suggest that while many clinicians were aware of the potential to apply improved practice, numerous barriers and challenges needed to be overcome to implement change across multiple disciplines and departments.

Conclusions: The key successful components of the QI were revealed through the case study analysis as: (1) an appropriately skilled project manager to facilitate the implementation process; (2) tools to support changes in workflow and decision making including a bleeding management treatment algorithm with POCCTs; (3) strong clinical leadership from the multidisciplinary team and; (4) the evolution of the project manager position into a perpetual clinical position to support sustainability.

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1. Introduction

Bleeding management in cardiac surgery faces challenges with an ageing population, complex procedures, augmented comorbidities, and increased use of anticoagulants and antiplatelet agents.[1,2] Risk of bleeding is high, and blood transfusion is a commonly relied-on treatment option. Accumulating evidence questioning the efficacy of blood transfusion and association with adverse events remain a concern.[1,3–5] Moreover, a reduction in transfusion of *all* blood products with appropriate bleeding management strategies has been associated with reduced morbidity, mortality, and cost.[1,6–8] In 2012, The Prince Charles Hospital ([TPCH], 560 bed, tertiary referral centre), in Brisbane, Australia, implemented a quality initiative (QI) to improve the management of bleeding for cardiac surgery patients. The QI was supported by the cardiac, anaesthesia, perfusion, and intensive care unit (ICU) departments at TPCH, where approximately 1200 primary cardiac surgery procedures are performed annually. Eight cardiac surgeons, 12 anaesthetists, 10 ICU consultants, seven perfusionists, 20 anaesthetic technicians, and 228 nurses were directly involved in providing patient care.

The implementation of a bundle of evidence-based bleeding management strategies as a part of the QI resulted in statistically significant reductions in the incidence of allogeneic blood transfusion, re-exploration for bleeding, superficial leg and chest wound infections, length of hospital stay, and cost.[1] Given the success of the bleeding management QI, we sought to answer the question: "How and why was the process of implementing a bleeding management QI in the TPCH adult cardiac surgery unit during the financial year of 2012–2013, successful and sustainable?" The purpose of this article was to describe the results of the case study undertaken to understand and explain the implementation process used to support the change in practice and factors that influenced that process.

2. Methods

2.1. Design

A retrospective, single, explanatory case study design was chosen to explore the QI.[9] The case study was approved by the institutional Human Research Ethics Committee (HREC/16/QPCH/103) and Griffith University HREC (2016/598).

2.2. Data analysis

In line with Yin's methods, data for this study were derived from: (1) document analysis; (2) direct observation of the local implementation environment; and (3) clinical narratives from interviews.[9] Multiple data were collated in a study database to maintain a chain of evidence forming the development of a comprehensive and chronological synopsis of the case. All three data sources were considered (triangulation approach), and the knowledge to action (KTA) action cycle was used to identify themes and guide data analysis (Appendix 1).[10] The KTA framework is somewhat unique and valuable in that it not only acknowledges and conceptualises the "creation" and "synthesis" of knowledge but also supports "actions" for guiding the implementation and translation of knowledge into practice.[11] The KTA "action cycle" was chosen as a framework because (1) it provides a model for analysing the progression of knowledge into clinical practice and (2) it can be used as a practical guide to apply knowledge in a real-world way. The QI time-period analysed by the case study extended from October 2011 to July 2013.

2.2.1. Document analysis

Primary goals of document analysis were to: (1) reconstruct of the evolution of the QI; (2) provide background and context; (3) uncover meaning; and (4) develop insight into the underlying motivation, mindset, and the vision of the core group of clinicians who pioneered the project, as well as those who were subsequently involved.[9,12] To achieve this, the following documents were collated: project reports, meeting minutes, group/*ad hoc* emails, diary entries, e-calendar appointments, in-service records, questionnaire responses, and morbidity/mortality meeting data. Analysis of these documents included (1) skimming, the initial preliminary examination to identify which documents required more in-depth review; (2) reading, a thorough revision of selected documents; and (3) interpretation, including thematic analysis for identification of emerging themes.[12] Documents were then categorised for analysis according to the phases of the KTA action cycle.

2.2.2. Direct observation

Direct observation of the QI context comprised of: (1) structural inputs, including infrastructure, the availability of educational resources and process tools to support bleeding management and (2) process inputs including requests for consultation, in-service, viscoelastic haemostatic assays and platelet function testing. These data were used to inform context and were further validated during the interview phase.

2.2.3. Interviews

A study specific interview guide was developed with questions grouped according to the action phases of the KTA cycle. Interview questions were pilot-tested for face and content validity with clinicians identified as key stakeholders (cardiac surgeons, anaesthetists, perfusionists, blood management nurses, and nurse unit managers/directors). Modifications were made based on feedback. After informed consent, nine face-to-face, semistructured individual interviews lasting approximately 30 min were conducted by the lead investigator, with the stakeholders matching the purposive sample above. Interviews were taped, transcribed, and analysed using thematic analysis: (1) verbatim transcription; (2) meaningful words; phrases and patterns elucidated, and codes generated; (3) codes combined into themes; (4) interview data reviewed in relation to themes ; and (5) themes defined and named.[13,14] This process was performed independently by two researchers (BP/YLF) and compared. Where disagreement with codes/themes occurred, explanation and clarification supported reaching a consensus. Member checking validation was achieved whereby a summary of themes were provided to participants, who confirmed these reflected their experience.

3. Results, discussion, and reflection

The results, including tables of representative samples of interview data, discussion, and reflection are presented below and have been themed by phases of the KTA cycle.[10]

3.1. KTA phase 1: identifying a problem; identifying, reviewing, and selecting knowledge

Typically, "Knowledge to Action" cycles commence with either recognition of a problem, then identification and critical appraisal of knowledge that may solve it, or by an initial awareness of new knowledge that triggers investigation into whether a knowledge-practice gap exists.[10,15] Our experience followed the former path. A bleeding management problem was identified through monthly cardiac surgery morbidity and mortality meeting data and *ad hoc* data queries, which revealed a 50% incidence of packed red blood

Table 1
Themes identified from initial motivation to change bleeding management practice.

Theme	Excerpts (verbatim) to interview questions
Identification of the problem	*"I think the whole evolution was seeing a clinical problem, getting some local data, and getting some grants for the next stage,"* (P5) and *"all of the evidence emerging that blood, not just red cells, but all the products were probably bad for you and that it was worthwhile to try and remove those from your practice if you could,"* (P6). *"I think there were individuals who recognised there was a problem with transfusion but I don't think that was recognised as a team"* (P7). *"The blood management nurse said to me 'do you know how much blood we are using and why we are using it, I think we should look why and what we can do about it?"* (P9). *"It's about having the insight to say we have a problem, there is no consistency in our approach, we should be looking at this differently…… is there a better way?"*(P8).
Variability in practice	*"It was very variable the way it was managed"* (P1). *"To be blunt….it was ad hoc, individual clinicians had different practice"* (P3). *"Really, it wasn't managed at all, it was on an individual basis, not following any sort of protocol, and based individual consultant preference"* (P6).
Anecdotal practice	*"…. best guess approach, which was based more on tradition than hard evidence,* (P2)" and *"…. when patients were actively bleeding, often we would have to act on instinct or guess work",* (P1). *"I was one of the people who used more blood products early to ensure we didn't run into problems"* and *"some of us actually believed that the early delivery of blood products, to correct coagulopathy or anticipated coagulopathy, was the best way to go"* (P3). *"There was no structured approach to the problem at all"* (P6).
Lack of control	*"Prior to the implementation, it was just throwing everything at the patient until they stopped bleeding"* (P8). *"I think anaesthetists were interested in improving the way they managed bleeding, but not really empowered"* (P2). *"..delivering unsatisfactory care… rather than giving the patient what they needed, we just gave them what we thought they might be short of without any evidence of the problem"* (P2). *"Before you'd send off coags but you would have treated the bleeding by the time the results were back, so I am not even sure why we did them…..lack of any other options I guess."* (P6).

P = Participant.

cell transfusion and > 5% incidence of unplanned reoperation for bleeding.[16] This was the motivation to seek ways to improve bleeding management, leading to several informal meetings where stakeholder clinicians concluded sufficient evidence existed to address the local bleeding management problem.[17] Data from the initial phase to change bleeding management practice revealed four distinct themes: identification of the problem; variability in practice; anecdotal practice; and lack of control (Table 1).

3.1.1. Reflections from phase 1

Clinical working environments risk stagnating by not keeping up with evidence-based practice or moving away from best practice. This may be manifest with clinicians tolerating or adapting to variations in delivery of care that do not support quality patient outcomes. Lack of attention to evidence may lead to practice "rules," with little or no evidence-base, and if no-one questions the "rules," the existing state becomes legitimised. To avoid this situation, audit of routine and *ad hoc* data is needed to highlight changing trends or allow comparisons against published evidence. Problems identified by "local data" have an increased likelihood of acceptance by clinicians, management, and finance decision-makers. It must also be considered that clinical practice problems may reflect institutional or system issues.[18,19]

3.2. KTA phase 2: adapting knowledge to the local context

Relevant evidence was compiled relating to "bleeding management" in cardiac surgery in late 2011 and included (1) local data; (2) published scientific literature; and (3) clinical practice guidelines.[20,21] Stakeholders attended a meeting to discuss (1) concerns with bleeding management within the local environment/patient cohort and (2) compliance with evidence-based practice.[10,15] A non-anonymous, printed questionnaire, consisting of 20 open-ended questions was developed from the compiled evidence and distributed to 43 clinicians at the end of the meeting. The aim was to determine: (1) what bleeding management strategies clinicians felt would be locally appropriate; (2) how those strategies might be incorporated into existing workflow; (3) identification of individual stakeholders or groups needed to change practice; and (4) how a bleeding management program might be described and function in the local context. The questionnaire revealed respondents (response rate 39.5%) had a good understanding of bleeding management strategies but recognised gaps in local practice (direct quotes provided). Some felt "*the most crucial improvement would be implementation of a transfusion protocol,*" to support "*identification of 'at risk' patients with a plan for treatment if high risk for transfusion.*" Anaesthetists considered minimising crystalloid dilution and appropriate use of tranexamic acid (TXA) important, as well as "*analysis of haemostatic potential, rotational thromboelastometry (ROTEM), platelet function.*" Respondents felt not all strategies were always necessary for all patients, rather an individual patient-focused combination of strategies, "*aimed at avoiding patient's reaching a transfusion trigger value.*"

Respondents supported a more collaborative approach, "*improved communication between perfusionist, anaesthetist, and surgeon,*" "*issues are communicated but not resolved,*" and "*improve documentation regarding transfusion from main operating theatre (MOT) to ICU.*" Frustration was evident, "*when a patient is treated by a range of clinicians from anaesthetists, surgeons, intensivists, nurse, etc, with an ad hoc approach, transfusion is set by the clinician with the highest transfusion trigger, regardless of the approach of the rest of the team….*"

Data from the questionnaire were reviewed by the hospital Blood Management Steering Committee (BMSC) and were used in a grant submission to fund a QI project manager (PM) in early 2012.

3.2.1. Reflections from phase 2

While clinicians can identify evidence-based best practice, this does not inevitably translate to the clinical practice environment. For the translation of knowledge into practice, evidence often needs "tailoring to fit," to become embedded in the existing system.[22,23] Front-line stakeholders participating in analysing their "local" bleeding management practice in relation to guidelines, and assessing potential "local" solutions, increased acceptance, ownership, and drive for change.

Responses to the questionnaire demonstrated (1) the clinical awareness of the need for change; (2) appropriate evidence-based bleeding management strategies considered relevant to the local patient cohort; (3) barriers to implementation of new bleeding management practice; and (4) potential clinical leads.

3.3. KTA phase 3: assessing barriers to knowledge use

Documentary analysis of data from early 2012 revealed some developing tension at organisation level regarding an *ad hoc* approach to proposed changes in bleeding management practice. Nursing management and finance raised concerns regarding (1) organisational commitment; (2) the need to employ a PM to ensure the change was implemented in a valid, comprehensive, and sustainable way; (3) financial support for point-of-care

Table 2
Themes identified as barriers to using evidence-based bleeding management knowledge.

Themes	Excerpts (verbatim) to interview questions
Lack of resources	*"There were also financial barriers with equipment, consumables, financing someone to do the work, the education, follow up with data etc"* (P1) and *"….we got funding for our bleeding management program, but it wasn't enough"* (P5). *"Getting the equipment and consumables…… we didn't have the equipment to do the analysing, we didn't have enough money for testing"* (P9). *"We needed to have someone to drive it through…..to be there, to do the work, because at the beginning, its extra to normal process"* (P3). *"Other barriers were the outdated protocols…did we have any? (*P1).
Lack of knowledge/acceptance of evidenced-based bleeding management	*"There is a big difference between what people know, what they think they know, and what they practice"*, and *"without local data your opinion can be enormously skewed to fit your own belief system"* (P7). *"…people not being aware of the evidence"* (P1). *"There were a whole lot of paradigms around bleeding that I was taught historically that meant nothing"* (P6). *"I think there was a variety of belief in the ROTEMs ability to pick out coagulopathy, detect it"*, and *"the surgeons didn't necessarily believe that when the ROTEM was normal, that the coagulation was normal, so there was a variability in belief of the tools"* (P2), and *"Prior to where we are,I was nihilistic, I wasn't sure about how we would go"* (P3).
Professional identity and roles	*"There are always barriers, the medical workforce has a lot of inertia, the ability to change is very difficult* (P5)," and the *"barriers were the ingrained habits, the hubris or ego that makes you persist with bad habits, that makes you think your anecdotal approach is eminence based medicine"* (P4). *"One of the biggest barriers was getting the surgeons to support our planned change and having the confidence to allow us to essentially manage coagulopathy independently, not to make their own specific requests for what they 'thought' was needed and as they gained confidence that has changed massively"*(P1).
Organisational support	*"…we were fortunate that we had a supportive manager in the hospital at the time"*, and *"management were exceptional with their support based on the data they were presented with……"* (P5). *"Providing regular data to the managers and business managers, kept them on side"* (P9). Contrasting comments were noted*; "Management at the hospital didn't know there was a problem"* (P6) and *"the program was dragged past management, rather than them facilitating it"* (P1).

P = Participant.

coagulation instruments and consumables; and (4) perpetuity. Whilst the majority of clinicians believed that the QI would provide improved patient outcomes, there could be no guarantee of delivering benefits in excess of their costs. This was an often-documented hurdle and frustration. Interview data corroborated these findings and highlighted additional perceived barriers (Table 2).

3.3.1. Reflections from phase 3

Numerous local, contextual barriers created the gap between evidence-based recommendations and the delivery of best practice.[24,25] In our context, lack of knowledge and acceptance of evidence, as well as the confidence to embrace change featured strongly as barriers. Ultimately, however, these obstacles appeared to act as a "call to arms" uniting clinical groups with a common goal, fostering relationships, encouraging ownership, and building enthusiasm for change. Finance and management also became more supportive, recognising, and accepting accountability for ensuring bleeding management healthcare delivery aligns with clinical practice guidelines. Involving them early on may introduce obstacles; however, all relationships including those that involve hurdles were addressed.

3.4. KTA phase 4: selecting, tailoring, and implementing interventions

Considerable proactive effort is required to adapt bleeding management strategies to the local environment/patient cohort and amalgamate with existing resources and workflow.[26] The stakeholder group initially defined three priority strategies for implementation of the QI: (1) establishment of a dedicated PM position; (2) development of a treatment algorithm, as a bleeding management decision support tool (Appendix 2.); and (3) development of an implementation plan. These priority strategies are explored in more detail:

(1) Dedicated project manager: A health service grant was secured to support a full-time clinical nurse consultant as a PM for 15 months (01/04/2012–31/06/2013). Documentary evidence revealed a rapid advancement of the QI with the commencement of this position. There was an increase in project-related emails, reports, meetings, stakeholder communication, and the development of the project plan. The PM secured a further grant to purchase (1) consumables for point of care coagulation tests (POCCTs); (2) a medical fridge; and (3) −20 degree organised (1) work unit guidelines; (2) training documents and tools; (3) physical infrastructure for the POCCTs; (4) approval/packaging of ROTEM software by hospital information technology department; and (5) uploading of the software onto clinical computers for live remote viewing.

Education commenced for nurses, anaesthetic technicians, and medical staff (total of 153 sessions) was held by the PM on (1) project aims; (2) bleeding management strategies; (3) the bleeding management algorithm; (4) interpreting assays; and (5) training ROTEM and Multiplate (platelet function) operators. Important challenges were (1) the number of clinicians requiring education; (2) "difficulty getting groups together"; (3) clinical workload of staff requiring education; (4) workflow of staff; and (5) different levels of engagement. Consequently, education, evaluation, and sharing of information were often conducted with individual clinicians or small groups. Training occurred over 24 h, 7 days a week, multiple times daily, to weekly. Diary entries show this was time consuming and not particularly efficient.

A new data set, specifically relating to the QI was negotiated and developed with the cardiac surgery data managers who routinely collect data for service management, monitoring, and evaluation. Additional data included (1) transfusion location (e.g. MOT/ICU/ward); (2) blood loss; (3) blood loss on return to MOT; (4) ROTEM/multiplate assays; (5) anticoagulant/antiplatelet medication and time ceased; (6) intraoperative TXA dose; and (7) temperature and haemoglobin (Hb), on return to ICU. Blood product stock levels were reconfigured in anticipation of the change in requirements as a result of the newly developed bleeding management treatment algorithm.

(2) Creation of a treatment algorithm: A one-page treatment algorithm was developed based on evidence and feedback from stakeholders.[1]

The algorithm included (1) identification of patients at high risk of bleeding; (2) appropriate use of TXA and cell salvage; (3) optimising temperature, Hb, pH, and calcium; (4) early diagnosis haemostatic deficits with POCCT; and (5) targeted therapy. Documentation from emails, reports, and diary entries describes suggestions from clinicians from all streams on modifications to the algorithm and educational tools.

(3) Development of an implementation plan: A project plan documenting the QI included (1) project scope; (2) aims; (3) roles/

Table 3
Themes demonstrating the requirements to select/apply bleeding management strategies.

Theme	Excerpts (verbatim) to interview questions
Dedicated blood management role	*"The most important thing, having a person on the ground, a champion, guided by the guidelines", "having someone who took an active interest and walked the walk, not just talked the talk, being a presence in the clinical environment, that was the most important thing" (P4). "…. the driving champion had to be the right person, they have to be educated, supported, passionate, and they had to understand that they are changing habits and that doesn't happen overnight",(P9), and "then we had you (project manager), the boss of the whole program and your personality allowed you to deal with the vast, and shall we say more difficult personalities" (P6). "In fact, the driver to make process change, if you left it without a champion, would not work at this sort of level" (P3).*
Education	*"….having 'the project manager" to educate people, sit down and talk to people, to teach people, has been a cornerstone of that success" (P1). "..the educational component and having someone to own it, someone that had the time and the diligence, and the drive to educate and bring people across the line was a key aspect to the program",(P4), and "when you spend enough time educating people and getting rid of the dogmas and re-educating and re-educating and re-educating, sometimes it's just being dogged and not letting go, or giving in, and that's really what happened" (P5). "So without making it sound too person dependent, you can have a protocol but without someone to educate and drive the change……it was actually necessary to have that driving body" (P8).*
Adapting knowledge	*"Combining all of things together in an algorithm was very useful, having them on the walls, having education sessions, staff available to advise and feedback about what the POCCT results meant for this patient etc. was also very useful and much easier for people to integrate into their practice" (P2). "Developing educational material (posters, online resources, procedures etc), that's important, and having access to doctor's orientation week and things like that"(P4). "We actually developed the locally relevant protocols, process and tools that came from those probing questions of things we didn't know"(P9). "You can have a guideline but it doesn't necessarily mean much unless you can make it locally relevant, so the project saw a shift in perception to say 'well yes', there are elements of these guidelines we can take and use"(P8).*
Clinical champions	*"We had a core group of supporters who fostered the process, and then the rest of the group, as a consequence, followed suit," (P3), and "you needed a driver otherwise it would have stayed a good idea on paper and that's all it would have been" (P9). "The reason the program got up at Prince Charles was that clinicians from multiple areas pushed the barrow along" (P6). "It had to be backed up by senior clinical champions" (P4). "….engaging with the entire team, rather than just going it alone," (P5) and "the multidisciplinary approach was important, support was required from a variety of directions" (P2).*
Use of diagnostic point of care coagulation testing	*"The point of care testing meant we could be very directed in correcting what we now knew what was wrong, as opposed to a shot gun approach using multiple products when we really didn't know what the problem was" (P5). "Before I come off bypass, someone's done a ROTEM, it's as easy as asking for a blood gas, it's not even thought about, its asked for, it's done, the process has been made so easy" (P6), and "there was always someone around who could do a ROTEM and Multiplate, and they could do it properly because they had been properly trained and you had confidence in the quality assurance of the instruments and results" (P2). "The surgeons see the ROTEM results up on the computer screen and they're not looking at the numbers, more the visual but anaesthesia are… and they're been very methodical about looking at the physiology behind the ROTEM and what it all means, and then looking over the drapes and trying to put it together with the surgeons, so it's been pretty good for that" (P6). "….and I was nihilistic about how good the quality of data would get from the ROTEM was going to be, and how accurate it was going to be to allow the end-point. It's proven to be successful" (P3). "I think getting the ROTEM data visual in theatre was crucial to this management program being sustainable", and "surgeons are able to look up and say….ok that's what's they're talking about, that's what the problem is,…..having that information provides a targeted approach to bleeding rather than laying blame" (P7).*

P = Participant.

responsibilities of stakeholders; (4) sponsors; (5) identification of barriers/potential risks; (6) milestones; (7) budget; (8) data collection; (9) data analysis; (10) communication/reporting plan; and (11) timeline. The plan was approved by the grant funding body, the hospital Chief Executive Officer, the directors of cardiac surgery, ICU, anaesthetics, and the BMSC. Mandatory monthly reporting to the grant funding body documented progress, achievements, barriers, and learnings.

Support from multidisciplinary clinical leads featured strongly in emails, diary entries, "file notes," and documented attendance at the BMSC meetings. Numerous stakeholders were involved in ongoing tailoring of strategies, confirming local relevance, and establishing/maintaining support and enthusiasm for the QI. Documentation between the PM, executive, and finance records positive rhetoric for the improvement in clinical outcomes and reduced transfusion. However, there was no documented commitment to support ongoing sustainability, despite the subject being frequently raised. Responses from interviews corroborate these findings (Table 3).

3.4.1. Reflections from phase 4

The existence of knowledge does not guarantee that knowledge is appropriately applied.[25,27] The PM acted as a "knowledge broker" through education and facilitating interactions between stakeholders, clinicians, and decision-makers. This allowed the entire group to recognise each other's aims and objectives, work collaboratively, engage across clinical/management/finance streams, and promote common goals.[22,28,29] The PM sought to understand and meet the needs of all groups by (1) responding to anticipated and unexpected challenges in a timely way; (2) managing opposition/indifference with literature and education; and (3) promoting support with outcome data. The requirement to dedicate significant time to recognising and overcoming barriers and ensuring momentum was validated by interview data. Clinical champions supporting both the QI and the PM were critical to engagement and collaboration.

Furthermore, involving clinicians in adapting and customising strategies increased the likelihood of acceptance and adherence to change.[24–26] Ensuring processes for embedding the strategies were made simple, routine, and fit within existing workflow is also key. Individuals are efficient processors of routine tasks, but new, complicated information is challenging especially in busy, complex, and dynamic environments.[30,31] Importantly, use of an algorithmic decision support tool ensured that bleeding was identified early, allowing haemostasis to be achieved more quickly and appropriately.

3.5. KTA phase 5: monitoring knowledge use and phase 6: evaluating outcomes

Data for the QI were analysed monthly and provided to the BMSC, hospital executive, finance, nursing, and medical management. Reporting to clinicians was provided through morbidity and mortality meetings, consultant meetings, clinical in-service, ad hoc emails, and individual meetings with the directors of the involved units. Data included (1) structural indicators (e.g. progress of infrastructure installation, POCCT trained operators, computers

Table 4
Themes identified regarding "Monitoring Implementation Strategies" and "Evaluating Clinical Outcomes".

Theme	Excerpts (verbatim) to interview questions
Communicating with data	*"With ongoing audit and review of the program we really feel that we are improving outcomes for the patients"* (P1). *"You need data……you convince clinicians by demonstrating better outcomes, you convince managers with appropriate resource utilisation and you convince administrators with numbers"* (P4). *"It's important to have feedback loops because you become accustomed to what you are doing whether its adequate or inadequate"*(P7). *"It was about having clear performance indicators at the start, the data set that was developed was important"* (P4). *"It was truly about data, you provided the evidence throughout the project…..there were clear indicators that the implementation process was working and it was good for patients"*(P9). *"this feeds our knowledge and that feeds into audit data and that in turn feeds back into proving efficiencies and effectiveness of what we've done" (P5).*
Economic proof	*"I mean that first 12 months we saved hundreds of thousands of dollars"* (P9). *The graphs speak for themselves, we showed that our blood product use came down by about $1,000,000 over 15 months, data is important, and regular real time reporting"* (P4).

P = Participant.

available for live streaming of ROTEM); (2) process indicators (e.g. number/type of POCCTs performed, in-service, TXA use); and (3) outcome measures (e.g. incidence of reoperation for bleeding, infection).

3.5.1. KTA phase 5: monitoring knowledge use

Monitoring the use of knowledge during the QI was important to determine the extent to which knowledge was integrated into practice.[1,32] Understanding change in knowledge and attitude were significant, as these directly influence behaviour and clinical practice. Education attendance, the uptake of POCCTs, requests for copies of the algorithm, repeat in-service, and educational tools were surrogate measures for the uptake of the QI and featured strongly in documentation and interview data.

3.5.2. KTA phase 6: evaluating outcomes

Clinical outcomes comparing 15 months before and after the QI were published showing statistically significant decreases in the incidence of transfusion, re-exploration for bleeding, superficial chest wound/leg wound infection, a 12% reduction in mean length of stay from operation to discharge, and a decrease in the acquisition cost of blood products by AUD 1,029,11.[1] There was an increase in the percentage of patients who received TXA.[1] Interview responses regarding "Monitoring Implementation Strategies" and "Evaluating Clinical Outcomes" are combined in Table 4.

3.5.3. Reflections from phases: 5 and 6. Monitoring knowledge use and clinical outcomes provide information on the appropriateness of the use of evidence, clinical decisions, tools, and patient outcomes.[33] For example, monitoring the uptake of POCCTs established that the clinicians were embracing the real-time diagnostic technology. Monitoring incidence of transfusion in MOT and ICU demonstrated the impact of change in practice. Document analysis and interview data revealed the ongoing provision of data during the QI served to motivate and empower clinicians to embrace the change in practice.

3.6. KTA phase 7: sustaining knowledge use

Ensuring change became embedded in routine practice was a critical consideration identified early in the QI, (quotes from interviews): (1) Governance structures, "*….blood management steering committee supporting change was important"* (P8); (2) Reporting structures, *"data came out quite early, right away we seem to have an impact on transfusion rate"* (P6); (3) Organisational structures through early planning for a permanent CNC (Blood Management) position, "*planning to sell to the sustainability early to the administrators is important"* (P4); and (4) Compliance with national standards, "*Accreditation was useful, we got a Met with Merit for the work with bleeding*" (P4). Themes identified from interviews regarding bleeding management sustainability are found in Table 5.

3.6.1. Reflections from phase 7

Sustaining practice change revolved around three core fundamentals: (1) a facilitating role; (2) engaged, supportive stakeholders; and (3) effective process.[34] Effective process included ongoing monitoring to: (1) inform outcomes; (2) monitor improvements; (3) ensure clinicians do not "go off message"; and (4) confirm processes remain locally relevant and aligned with

Table 5
Themes identified regarding bleeding management sustainability.

Theme	Excerpts (verbatim) to interview questions
Sustainability	*"The most difficult thing which we have in front of us is maintenance of outcomes, just because process has worked, doesn't mean it will always work"* (P3). *"The reason it's worked, and the reason its continued to work is all the ongoing issues are addressed, the ongoing education of new staff, of which there are a lot……all the time"* (P6). *"You need to keep your champion because people go 'off message"* (P8). *"I said, we need a business case to make this position sustainable, we had a feeling we were doing something obvious, it was going to be successful, but in order to be sustained, we needed perpetuity"* (P4).
Changing culture	*"Everyone was on a steep learning curve, it really challenged a lot of the history of bleeding management at the hospital"* (P6). *"This has been a great learning experience, because although I knew something was wrong, I didn't know what was really wrong and I didn't know if we could fix it."* (P6). *"I initially thought that the ROTEM was going to be the key to reducing transfusion but incorporating it into a holistic blood management program has been the key", and "ROTEM is important, essential, but it's not all of it. I couldn't even conceptualise what we have now, the blood management program we have, and it's evolving all the time, it's been exactly what we needed. It's not just about the bleeding patient, its recognising the potential bleeder and optimising before we get to the bleeding point" (P7).* *"Listening to the rational conversations between the surgeons and anaesthetists in theatre…..for me that was when I thought this has a chance of working……of being sustainable"* (P7).
Evidence-based bleeding management	*"That's the advantage we have now, we talk about the evidence, what the deficits are, how to correct them, we are empowered to discuss the best fit for the patient"* (P2). *'Everyone recognises the importance of fibrinogen, I don't think anyone would have even talked about fibrinogen in the historical era at Prince Charles, they just would not"* (P6). *'Now we have discussions about what's best, based on evidence, not best guess"* (P1). *"We used buckets of FFP, I can't remember the last time I saw FFP"* (P6). *"Everyone has learned a great deal; we now have more sophisticated tools and a rational evidence based approach"* (P5). *"At Prince Charles hospital, at any time of the day, any day of the week, you get evidence based best practice when you have to manage a bleeding patient"* (P6).

P = Participant.

evidence. The development of an ongoing supporting blood management clinical nurse consultant role to continue education, monitoring, evaluation, and ongoing improvement reduced the risk of the practice "drifting" or stagnating.

4. Limitations

Multiple documentary sources were used to explore the evolution of the QI; however, as the lead investigator was also the PM, there was a risk of confirmation bias. We have confidence in the fidelity of our analysis for the following reasons: (1) reflexivity supported rigour; (2) data from the study were reported to critical internal and external colleagues for alternative propositions and explanations; (3) data from interviews corroborated documentary data; and (4) if contradictions were present, more data were sought. The study findings were specific to the hospital involved; however, the overall findings are likely to have broad relevance to other institutions implementing QI initiatives for blood management.

5. Conclusion

This case study provides a comprehensive and systematic analysis of the implementation of a bleeding management QI in a cardiac surgery program at a tertiary hospital. The KTA cycle was a useful framework for analysing and understanding the implementation process; however, it can also provide a framework for organising thinking, planning, and actions in "real world" practice. The key successful components of the QI were revealed through the case study analysis as: (1) an appropriately skilled project manager to facilitate the implementation process; (2) tools to support changes in workflow and decision-making including a bleeding management treatment algorithm with POCCTs; (3) strong clinical leadership from the multidisciplinary team; and (4) the evolution of the project manager position into a perpetual clinical position to support sustainability. These findings can inform future QI initiatives, particularly those requiring evidence uptake and practice change by multidisciplinary clinicians in the acute inpatient setting.

Authors' contributions

Bronwyn Pearse contributed to conception and design, acquisition, analysis, and interpretation of data, manuscript development and final approval, and agreement for accountability. Claire Rickard and Samantha Keogh contributed to study design, interpretation of data, revising manuscript/final approval, and agreement for accountability. Yoke Lin Fung contributed to study design, acquisition, analysis and interpretation of data, revising manuscript/final approval, and agreement for accountability.

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Supplementary information

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