

Institution: Cranfield University		
Unit of Assessment: 17		
Title of case study: Saving Lives: Improving Efficiency and Reducing Wastage in the Blood Supply Chain		
Period when the underpinning research was undertaken: 2005-present		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Richard Wilding OBE	Professor of Supply Chain Strategy	1998-present
Nicky Yates	Senior Lecturer in Logistics and Supply Chain Management	2008-present
Emel Aktas	Professor of Supply Chain Analytics	2014-present
Period when the claimed impact occurred: 2013-present		
Is this case study continued from a case study submitted in 2014? Y/N No		
1. Summary of the impact (indicative maximum 100 words)		
<p>Ensuring the supply of blood to health services is critical to saving lives. Cranfield's innovative blood supply chain inventory management and logistics modelling research has had significant impact at both national and international levels. Notably, within the UK, Cranfield has enabled National Health Service Blood and Transplant (NHSBT) to appreciably improve efficiency and decrease wastage. Exemplified by a 33% reduction in national bloodstocks held at any one time (2016 cf. 2013), less wastage of a perishable and critical resource which cannot be manufactured synthetically, whilst ensuring stocks are available to meet the average annual NHS need of 1.4 million units of blood (2019).</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>To maintain the health and wellbeing of the population, blood products are required for a large range of patient treatments throughout the NHS. The consequences of a unit not being available in the right place at the right time can, in the worst case, lead to the death of a patient. Blood components will always be a limited and precious, perishable resource as they cannot be manufactured artificially. Ensuring sufficient supply of blood products in the right place at the right time, whilst minimising wastage of a precious resource, in the context that shortage may have lethal consequences, is one of NHSBT's most demanding challenges.</p> <p>Since the mid-2000s, drawing on Cranfield Supply Chain Research Centre's strong background of research in supply chain management; we have applied supply chain management theory to improve the efficiency of blood supply chains. This research has had impact both within the UK and Australia.</p> <p>Red Cell Demand Planning As part of a two-year funded Innovate UK, Knowledge Transfer Partnership, Cranfield developed a novel model for predicting national demand for red blood cells, by establishing the critical factors that influenced the use of blood in the supply of blood products to hospitals. Thus, applying the theoretical principles of statistical forecasting to a novel context [R1&R2]. (2008 to 2010).</p>		

Perishable Inventory Management

Theoretical perishable inventory management literature suggests that sophisticated and complex inventory models will drive performance. However, Cranfield's qualitative research with hospital inventory managers found that, in practice, a combination of basic well-grounded inventory theory with simple management procedures, carried out by experienced staff, leads to better performance (2008 to 2010) [R3&R4].

Bloodstock Levels and Wastage

By 2013, overall demand for red blood cells in the UK had decreased by 5%, but the stock levels in blood centres and hospitals remained the same. Grounded in the theory of supply chain segmentation, this research analysed the relationship between red blood cell demand, stock levels and time expiry wastage using descriptive statistics and linear regression to determine data patterns and produce a predictive model to determine ideal stock levels for red blood cells across NHSBT [R4&R5]. (2013)

Logistics Service Provision

In 2016 NHSBT's hospital logistics operation was experiencing an increasing problem of reducing revenue and increasing cost to provide the service, reducing money available to provide services to patients. To help find solutions to this problem, Cranfield employed the Discrete Event Simulation methodology to model four blood centres and their associated hospitals. Extensive scenario analysis investigated novel charging mechanisms and delivery strategies in a risk-free environment, leading to the development of a new charging mechanism framework and hospital delivery strategies. (2016)

Platelet Distribution Model

Platelets, with their exceptionally short shelf life (7 days in 2017), need particularly careful and active management to maximise their usefulness and minimise wastage. Cranfield developed an innovative analytical model to allow for planning distribution and allocation of this precious resource, incorporating perishability, substitution, and transport costs. The model incorporated a novel substitution logic, including a range of clinical factors not considered previously [R6]. (2018).

3. References to the research (indicative maximum of six references)

- [R1] Dobbin J., Wilding R., Cotton S., (2009), True Blood: Challenges of the Blood Supply Chain in England, *Focus Magazine*, Chartered Institute of Logistics and Transport, November, 32-36.
- [R2] Blood Stock Management Scheme Annual Report (2008 to 2009) p.17.
- [R3] Stanger S., Wilding R., Yates N., & Cotton S., (2012), What drives perishable inventory management performance? Lessons learnt from the UK blood supply chain, *Supply Chain Management: An International Journal*, 17 (2) 107-123.
<https://doi.org/10.1108/13598541211212861>
- [R4] Yates N., Stanger S., Wilding R., & Cotton S., (2017) Approaches to assessing and minimizing blood wastage in the hospital and blood supply chain, *ISBT Science Series*, 12 (1) 91-98. <https://doi.org/10.1111/voxs.12330>
- [R5] Lusiantoro L., & Yates N., (2015), Identifying the ideal blood stock level: a statistical analysis of blood inventory levels in the UK. In: The 20th Annual Conference of The Chartered Institute of Logistics & Transport, *Logistics Research Network (LRN)*, University of Derby, 9-11 September.
- [R6] Aktas E., Roberts M., Yates N., & Saghiri S., (2019), An Integrated Decision Support System for Platelet Distribution. In: *European Conference on Operational Research 2019*, Dublin, 23-26 June.

4. Details of the impact (indicative maximum 750 words)

Cranfield's world-renowned supply chain expertise has enabled the NHSBT service, staff, hospitals, and millions of patients to benefit from the implementation of service improvements. The collaborative relationship between Cranfield and NHSBT commenced in 2005. Impact since 2013 can be seen in enhanced demand planning, stock management, logistics provision and reduction in blood wastage, as detailed below. The findings from Cranfield inventory management research were also adopted by the National Blood Authority in Australia, as below.

Red Cell Demand Planning

The novel red cell demand planning model, devised and implemented by Cranfield, was embedded in NHSBT, achieving significant forecasting accuracy improvements compared to previous methods. The model changed demand planning practices within NHSBT, enabling more accurate prediction and better management of national blood stocks across the service.

"Our collaboration with Cranfield meant that fresher blood was being delivered to our hospitals with longer expiry times, therefore reducing costs and ultimately increasing customer satisfaction" [S1].

The model, which was used for several years, became the catalyst for a web-based demand planning system with enhanced visibility of 'actual' demand data (rather than just what was issued) and a Department of Health planning tool. This impact began in 2010 and these practices continue to reap benefits to the present day [S1&S2].

Perishable Inventory Management

The research carried out with hospital inventory managers identified six key drivers of good inventory management performance to inform good inventory management practice and performance. In addition to demonstrably improving practice in the NHS [S2], these were taken up by the National Blood Authority, Australia who adopted the six good inventory performance recommendations to inform their '10 tips to Help Manage your Blood Product Inventory' communications campaign started in 2016. In addition, an active link has been included on their national service website to enable access to the original Cranfield research [S3&S4]. The poster has been instrumental in reducing red blood cell wastage across the Australian service by 2.2% (2016 to 2018).

Bloodstock Levels and Wastage

The research on bloodstock levels proposed a segmented supply chain strategy for managing different blood groups, based on a novel blood group classification system. Research findings indicated that the less predictable the demand, the higher the wastage, particularly at hospital level. Applying the segmented strategy enabled NHSBT to focus management attention on those blood groups with the largest impact on overall wastage and potential for cost saving, while maintaining the alert level of three days stock cover for other groups. This work led directly to a 33% reduction in quantities held nationally, from approximately 60,000 units in 2013 to 40,000 in 2016. The application of the research also contributed to a reduction in wastage, the expiry rate reduced from 0.75% in 2013 to 2014 to 0.32% in 2015 to 2016. Consequently, less donations were required, and overall costs were reduced. This then led to a change in NHSBT national policy for bloodstock inventory levels [S1].

Logistics Service Provision

The simulation model developed of the logistics operation provided insights into the way in which the transport operation is run and made recommendations for improvements to charging mechanisms, fleet management, customer engagement and balancing in-house and third-party logistics providers. The work led directly to the introduction of a click and collect charge for non-routine deliveries in 2017. The introduction of the charge has focused customers (hospitals) on making better use of their routine deliveries, with a consequent reduction in the use of the self-collect service, reducing disruption for hospital services staff in blood centres who prepare

products for despatch. The delivery model has been refocussed, allowing a reduction in the size of the vehicle fleet, benefiting sustainability objectives [S5].

“The introduction of the charge has helped to redress the balance of decreasing revenue against an increasing cost to provide.” [S5]

Platelet Distribution Model

The model developed by Cranfield was implemented in 2018 for the daily planning of platelets. It provides an integrated decision support system for planning transportation and redistribution of platelets, considering perishability, substitution and transportation costs and is utilised daily by NHSBT. Implementing the tool, NHSBT been able to reduce costs of ad hoc transportation to rectify problems with stock distribution by 37%. The tool led directly to a reduction in wastage, due to time expiry, of 1% and has been an enabler in a further reduction of 40%. Shortages in blood centres at 7am following distribution have reduced by 10% [S6].

5. Sources to corroborate the impact (indicative maximum of 10 references)

- [S1] Chief Executive, Health Research Authority, formerly Associate Director Customer Services, NHSBT testimonial
- [S2] Blood Stocks Management Scheme (BSMS) testimonial
- [S3] The National Blood Authority, ‘10 Tips to Help Manage your Blood Product Inventory’, <https://www.blood.gov.au/10-tips-help-manage-your-blood-product-inventory>
- [S4] Acting Deputy Chief Executive, Fresh Blood Products & Business Systems, National Blood Authority, Lyneham ACT, Australia testimonial
- [S5] Assistant Director Logistics testimonial
- [S6] Regional Hospital Services Manager – North, NHS Blood and Transplant Service, Manchester