A jaundice community project

Neonatal hyperbilirubinaemia is a common condition that leads to a significant number of term and near term infants being referred to hospital in the first few weeks of life. A visual examination is unreliable in estimating the severity of jaundice. National guidelines in many countries have recommended the transcutaneous bilirubinometer (TcB) as an effective screening tool in the community to aid clinical examination. This article reports on the impact of introducing the TcB to community midwives in Abertawe Bro Morgannwg University Health Board in south Wales.

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Keywords

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Key points

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1. The TcB is an effective screening tool for community midwives to triage neonates with jaundice in the first two weeks of life.
2. Effective access to a TcB by midwives will reduce unnecessary hospital referrals and waiting times.
3. The TcB enables midwives to reassure parents quickly and reduces cost and inconvenience to families as care is delivered at home.
4. Early detection with a TcB appears to limit maximum serum bilirubin levels attained in infants requiring treatment.

Background

Neonatal jaundice affects 60% of term and 80% of preterm infants, most of whom do not require any treatment. Some require interventions such as feeding support, phototherapy or exchange transfusion. A survey undertaken by the British Paediatric Surveillance Unit (BPSU) in the UK and Republic of Ireland estimated the incidence of bilirubin encephalopathy at 0.9/100,000 live births.[1] The condition is known to cause severe disability. The incidence of other potential risks due to bilirubin toxicity (eg dental dysplasia, high frequency hearing loss and visual abnormalities) remains unknown. In the first few weeks of life, the risk of bilirubin crossing the blood-brain-barrier increases when bilirubin levels exceed 340µmol/L and is extremely high with levels >510µmol/L.[1,2] Several countries including the USA and UK have published clinical guidelines to standardise management of neonatal jaundice.[2,3]

Current evidence shows that visual estimation of neonatal jaundice, while effective at detecting jaundice, is not reliable for estimating its severity even when undertaken by experienced clinicians.[2] The National Institute for Health and Care Excellence (NICE)[2] recommends using a TcB (when appropriate) or a laboratory estimation of total

Unit cost of bilirubin test					
	TSB (blood sample)			TcB (without calibration tips)	
Unit cost per test*	£19.23			£1.30	
Potential minimum cost savings based on two tests per patient for 18.18% of births					
Number of births in ABMU**	Infants needing testing	Cost for TSB	Cost for TcB test	Potential cost saving per year	Potential cost saving in seven years
5,760	1,047	£40,267	£2,772	£37,545	£262,815
Potential cost of organising referrals to the hospital by a midwife in the absence of TcB					
Number of births in ABMU	Hospital referrals for TSB	Estimated time for a midwife to organise a hospital referral	Cost of midwife at band 6/7 organising the hospital referral (@ £73 per hour)	Saving per year on cost of midwife time by avoiding referrals	Potential cost saving in seven years
5,760	1,047	15 minutes	£18.25	£19,107	£133,749

TABLE 1 Estimates of the total cost savings to ABMUHB by introducing TcBs.
Key: TSB = total serum bilirubin, TcB = transcutaneous bilirubinometer, ABMU = Abertawe Bro Morgannwg University, ABMUHB = ABMU Health Board. *Data source: NICE.[2]
**Data source: Office for National Statistics Annual District Birth Extract 2007.

serum bilirubin (TSB) to reliably assess severity of jaundice. Most hospitals in the UK have now implemented these guidelines but adoption is patchy in the community setting. When neonatal jaundice is noted in term infants of less than two weeks of age, the options available to the community midwife are:

1. refer to hospital for paediatric assessment and a blood test
2. take a blood sample from the baby and take it to the hospital for laboratory testing, or
3. use a TcB.

Options 1 and 2 significantly increase staff workload, cost and painful blood testing for infants.[4] The use of a TcB delivers care at home, reassures parents and reduces unnecessary referrals. Unfortunately most TcB devices currently available are expensive, costing between £2,500 and £5,000 per device. High device cost and controversies regarding evidence of benefit from community screening have limited widespread adoption of TcB devices in the community.

Developing a business case for introducing TcB testing in a community setting

Abertawe Bro Morgannwg University Health Board (ABMUHB) in south Wales provides health care to the city of Swansea and the nearby towns of Bridgend, Port Talbot and Neath. Dräger JM103 TcB devices were introduced in Singleton and Princess of Wales hospitals in 2010/11 as per NICE guidelines.[2] A pre- and post-implementation audit in the postnatal wards showed that the device was well accepted and reduced invasive blood sampling five fold.[5]

A pilot project was undertaken from March to August 2013 to assess the impact of limited introduction of TcB testing in the community. A care bundle including the NICE guidance-based protocol for TcB, community-to-hospital referral pathways, parent information leaflet, and quality and data monitoring systems were developed.

JM103 bilirubinometers were obtained on loan from the manufacturer for the project. A training programme was

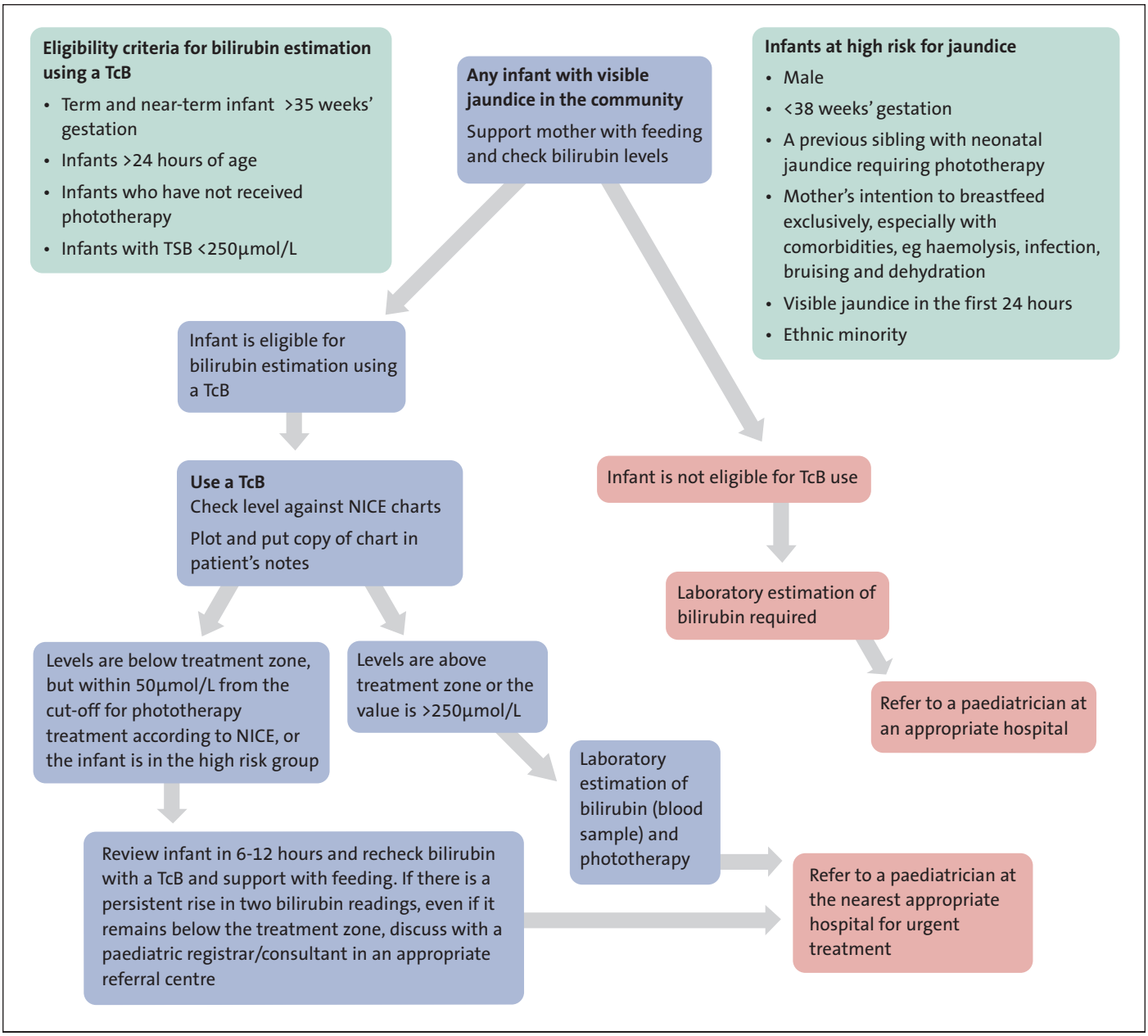

FIGURE 1 The referral pathway for neonatal jaundice for infants less than two weeks of age in ABMUHB. Key: TcB = transcutaneous bilirubinometer, TSB = total serum bilirubin. Adapted from Ramachandran (2016).[9]

developed for the three community midwives involved with the pilot. The project team reviewed 184 infants in Swansea and 264 infants in Bridgend, Neath and Port Talbot. With the aid of TcBs, project midwives appropriately triaged infants and 100% of infants referred to hospital required admission and treatment. Only 40% of referrals from non-project midwives with no access to a TcB required admission; 60% of their referrals needed no intervention and hence were potentially avoidable. The use of a TcB was found to have a high specificity and positive predictive value in identifying infants requiring treatment for jaundice. Patient satisfaction was very high. User feedback was provided to the manufacturer.

Armed with this data, a business case was developed for the Health Technology Fund (HTF) of the Welsh Government, which supports the introduction of innovative technologies to the NHS. From the pilot project it was known that 18.18% of term infants would require TcB testing for visible jaundice and only 1% of infants were likely to need hospital referral. Based on Abertawe Bro Morgannwg University (ABMU) birth rates it was postulated that over 1,000 potential hospital referrals could be avoided annually if TcBs were used.

It was estimated that the total cost savings to ABMUHB over a seven-year period would be £396,564 (**TABLE 1**). Significant additional savings could arise from a reduction in litigation from kernicterus. The manufacturer granted free service for seven years for any TcB purchased and offered regular staff training as part of the project.

It was calculated that for ABMUHB (area = 1,071km^2) it would be cost-effective to provide one TcB per midwife plus 10% for emergency backup (ie 80 devices for 72 whole-time equivalent midwives) at a cost of £384,000. The business justification case was reviewed and approved by ABMUHB finance department. The sum of £384,000 was awarded in a successful bid for financial support from HTF in 2013. JM103 devices were purchased via the ABMUHB procurement process. This device was selected because of its confirmed clinical reliability[2,6,7] and lack of disposables. ABMUHB agreed to fund any repairs that might be required to the devices over time in excess of the routine maintenance covered by the manufacturer.

	Estimated in business case	Actual values during project evaluation
Total live births	2,880 infants	3,028 infants
Infants with visible jaundice	18.18%	26.7%
Number of TcB tests undertaken	1,047 tests	950 tests (in 809 infants)
Number of infants referred to hospital	29 (1% of births)	76 (2.5% of births)
Total cost savings with TcBs compared to hospital referral and blood sampling	£28,326	£26,516
Number of infants who avoided hospital referral	500	733

TABLE 2 Important points arising from six months of project evaluation.

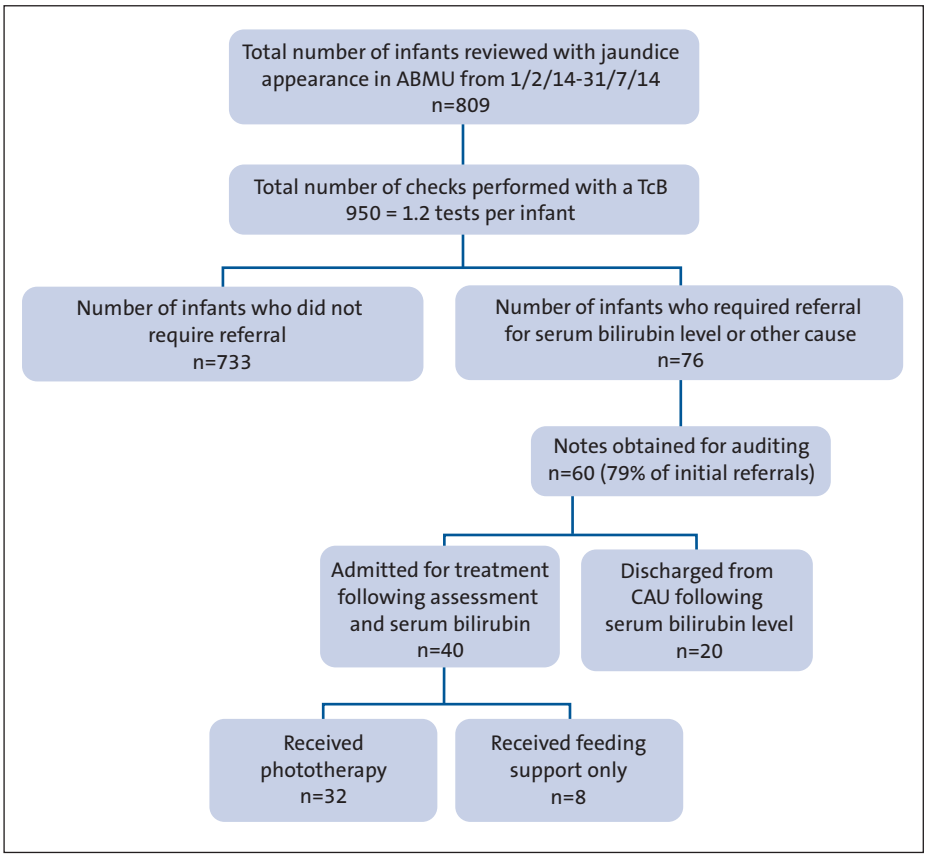

FIGURE 2 The jaundice community project evaluation (1 February 2014 to 31 July 2014). Key: ABMU = Abertawe Bro Morgannwg University, CAU = children's assessment unit.

Implementation of the jaundice community project

A project team was set up for implementation and evaluation, which included a consultant neonatologist, lead midwife, paediatric trainee, medical physics representatives, TcB trainer (from the manufacturer) and administrative staff. All hospital referrals were based on agreed pathways as noted in **FIGURE 1**. A training programme was set up for all the community midwives in ABMUHB with yearly updates. Training included: current management strategies for neonatal jaundice; appropriate feeding advice and support for parents; assessment of thresholds for hospital referral using NICE bilirubin nomograms; and treatment charts, agreed referral pathways and appropriate use of the TcB devices. The system for yearly maintenance of the devices in association with the manufacturer was established.

Results

All midwives in ABMUHB started using TcBs from January 2014. Data were collected and analysed for 5,657 midwife home visits for infants born between 1 February 2014 and 31 July 2014. There

were 3,028 live births in six months. The main outcomes were (**TABLE 2**):

- 950 TcB tests were undertaken in 809 infants (1.2 per infant) for suspected jaundice
- 76 infants (2.5% of total live births) were referred to hospital
- 60 case notes of infants referred to hospital were obtainable for detailed audit
- Of the 40 infants who required admission, 32 infants received phototherapy (**FIGURE 2**)
- Maximum serum bilirubin levels attained in 38 of the 40 infants admitted were ≤340µmol/L. None had levels >500µmol/L or developed kernicterus (**FIGURE 3**).

With the use of TcBs, avoidable hospital referrals were halved from 60% (noted for Swansea pre-implementation) to 33% (in ABMUHB post-implementation). In the 2013 pilot study parents waited an average time of four hours in the paediatric admission unit (PAU) to be assessed. With the new referral pathway, waiting times for an infant with neonatal jaundice dropped to an average time of 58 minutes.

The project achieved high patient satisfaction scores. All parents were asked to score the care they received on a scale of 1 to 5, with 5 being the highest. Seven hundred and thirty parents (90%) scored 5; only 24 parents (2.9%) scored 2 or lower (**FIGURE 4**). TcBs were also highly recommended by the midwives for ease of use. TcB testing was noted to have 100% specificity for predicting a requirement for phototherapy and the need for hospital admission.

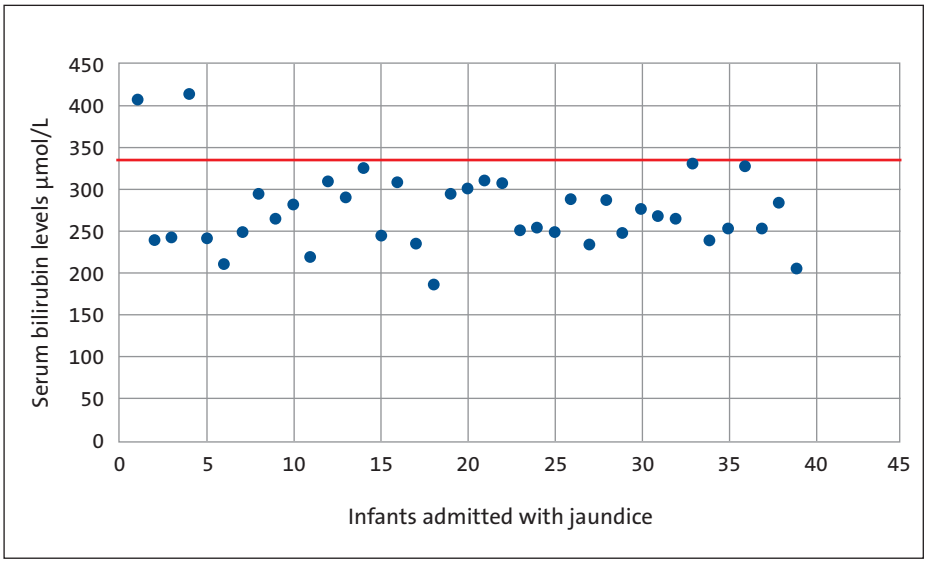

FIGURE 3 The maximum serum bilirubin levels attained in infants admitted to hospital. The red line indicates a value of 340µmol/L, over which there is a higher risk of kernicterus developing.

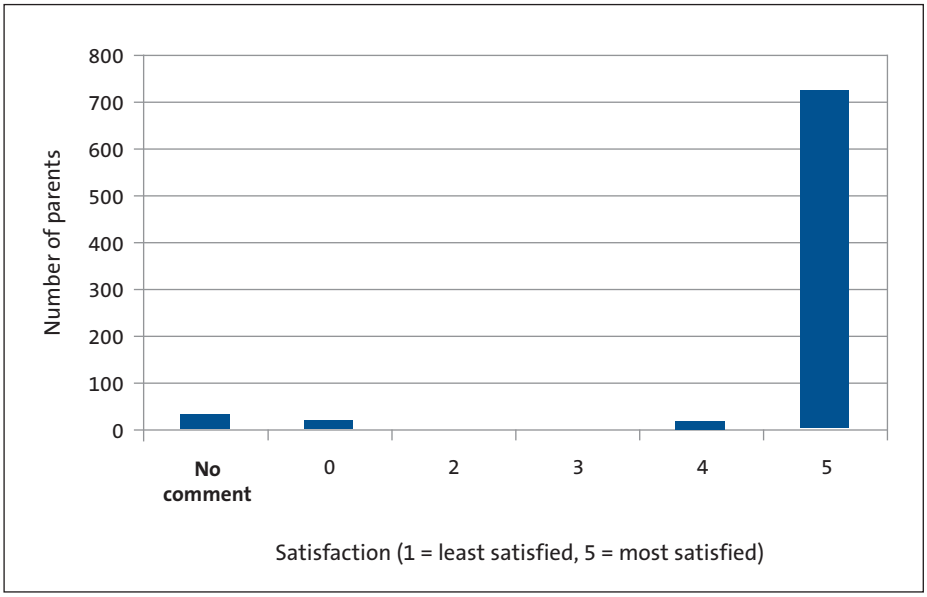

FIGURE 4 Parent satisfaction scores regarding the use of TcBs.

Discussion

The jaundice community project has established that the TcB is an effective screening tool for community midwives to triage newborn infants with jaundice in the first two weeks of life for specialist paediatric assessment, hospital admission and definitive treatment. Effective access to TcBs by midwives will reduce unnecessary hospital referrals and waiting times in PAUs. The high specificity in predicting the need for phototherapy and hospital admission is reassuring for staff. The observation that maximum serum bilirubin levels attained by most of the infants requiring admission remained below 340µmol/L indicates early detection of hyperbilirubinaemia and safety of the device when used in a community setting.

The TcB is a proven device for estimating bilirubin and reducing the need for blood tests in infants with visible jaundice when used within recommended parameters.[2,4,7] If TcBs are not used in the community around 27% of infants will need blood tests and/or a trip to the hospital. TcBs are likely to limit hospital referrals for neonatal jaundice to around 2.5% of total births. Term hospital admissions from neonatal jaundice are likely to be between 1-2% of the total births.

The TcB is not recommended for assessing prolonged jaundice beyond two weeks nor conjugated hyperbilirubinaemia. The significant reduction in waiting times noted in PAU can be attributed to the use of appropriate referral pathways.

The inability of the TcB to accurately measure bilirubin values above 250µmol/L limits its use in some infants.[2] Term infants who are more than four days old require phototherapy only when bilirubin levels exceed 350µmol/L. Efforts should be made to make the TcB reliable up to 350µmol/L.

Currently the TcB is not recommended in infants who have received phototherapy at any time due to lack of evidence of effectiveness. This limits its use for monitoring infants who were treated in hospital prior to discharge or receiving home phototherapy. Further research is required regarding the effectiveness of TcBs in infants who have received phototherapy.

In ABMUHB, 950 TcB tests were carried out for 3,028 live births over 181 days. This

equates to 5.25 tests per day. ABMUHB obtained 80 devices for 72 midwives (one TcB device per midwife plus 10% spare capacity). Hospital trusts with a smaller geographical area to cover may prefer to share devices. Bear in mind that devices need to be stored and charged at a common station for collection when needed. Hospitals that share should allow for greater travel cost claims from community midwives.

Significant cost savings with TcB use are related to community midwife time due to enhanced efficiency. Individual teams will need to review effective utilisation of these savings. Limited understanding of the spectrum of bilirubin-induced neurological dysfunction and toxicity enhances the relevance of community screening.[8]

Conclusion

The TcB is an effective tool for community midwives to screen newborn infants for hyperbilirubinaemia in the first two weeks of life. This article reports on the impact of introducing the TcB to community midwives in ABMUHB: hospital referrals were halved; waiting times in PAUs were reduced to a quarter; parents and staff reported high satisfaction levels with the device. The TcB enables midwives to reassure parents quickly and reduces the cost and inconvenience to families as care is delivered at home. By early detection, the use of a TcB was effective in limiting maximum serum bilirubin levels attained by the majority of infants who required treatment. Manufacturer-offered training and service packages will assist implementation.

Conflict of interest

The authors were given a few JM103 TcB devices free of charge by the manufacturer Dräger for undertaking a pilot quality improvement project in ABMUHB. The company did not have any influence on the design of the study, or the evaluation or reporting of results.

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