

# Newborn infants with bilious vomiting: a national audit of neonatal transport services

Shalini Ojha,<sup>1,2</sup> Laura Sand,<sup>3</sup> Nandiran Ratnavel,<sup>4</sup> Stephen Terence Kempley,<sup>5</sup> Ajay Kumar Sinha,<sup>6,7</sup> Syed Mohinuddin,<sup>6</sup> Helen Budge,<sup>3</sup> Andrew Leslie<sup>8</sup>

<sup>1</sup>Division of Medical Sciences and Graduate Entry Medicine, School of Medicine, University of Nottingham, Derby, UK

<sup>2</sup>Neonatal Unit, Derby Teaching Hospitals NHS Foundation Trust, Derby, UK

<sup>3</sup>Division of Child Health, School of Medicine, University of Nottingham, Nottingham, UK

<sup>4</sup>London Neonatal Transfer Service, The Royal London Hospital, Barts Health NHS Trust, London, UK

<sup>5</sup>Blizard Institute, Queen Mary University of London, London, UK

<sup>6</sup>Paediatrics, Barts Health NHS Trust, London, UK

<sup>7</sup>Paediatrics, Barts and the London School of Medicine and Dentistry, London, UK

<sup>8</sup>Neonatal Transport, University Hospitals of Leicester, Leicester, UK

## Correspondence to

Dr Shalini Ojha, Division of Medical Sciences and Graduate Entry Medicine, School of Medicine, University of Nottingham; [shalini.ojha@nottingham.ac.uk](mailto:shalini.ojha@nottingham.ac.uk)

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## ABSTRACT

**Objective** The precautionary approach to urgently investigate infants with bilious vomiting has increased the numbers referred to transport teams and tertiary surgical centres. The aim of this national UK audit was to quantify referrals and determine the frequency of surgical diagnoses with the purpose to inform the consequent inclusion of these referrals in the national 'time-critical' data set.

**Methods** A prospective, multicentre UK-wide audit was conducted between 1 August, 2015 and 31 October, 2015. Term infants aged  $\leq 7$  days referred for transfer due to bilious vomiting were included. Data at the time of transport and outcomes at 7 days after transfer were collected by the local teams and transferred anonymously for analysis.

**Results** Sixteen teams contributed data on 165 cases. Teams that consider such transfers as 'time-critical' responded significantly faster than those that do not classify bilious vomiting as time-critical. There was a surgical diagnosis in 22% cases, and 7% had a condition where delayed treatment may have caused bowel loss. Most surgical problems could be predicted by clinical and/or X-ray findings, but two infants with normal X-ray features were found to have a surgical problem.

**Conclusion** The results support the need for infants with bilious vomiting to be investigated for potential surgical pathologies, but the data do not provide evidence for the default designation of such referrals as 'time-critical.' Decisions should be made by clinical collaboration between the teams and, where appropriate, swift transfer provided.

## INTRODUCTION

The standard surgical approach to bilious vomiting in a neonate is to investigate urgently for an underlying surgical pathology with an aim to avoid the consequences of delay in the treatment of symptomatic malrotation and/or volvulus.<sup>1</sup> The increasing adoption of this approach has led to large numbers of referrals for investigations and surgical assessment. A large surgical centre in the UK recently reported that the number of infants investigated in their centre has doubled over the past 4 years despite no significant change in the birth rate in their catchment area or any significant increase in number of surgical conditions detected.<sup>2</sup>

Most infants who present in this way are born at hospitals without paediatric surgical or radiological facilities and so require transfer. The London Neonatal Transport Service reported that over 4 years, 15% of transfers involving full-term infants

## What is already known on this topic?

- ▶ Infants with bilious vomiting must be managed urgently.
- ▶ They must be rapidly transferred to surgical centres.
- ▶ The number of such referrals has increased recently.

## What this study adds?

Infants with bilious vomiting should be considered for urgent transfer but the decision to transport classify all cases as time-critical may not be necessary.

$\leq 7$  days of age were for bilious vomiting.<sup>3</sup> There are differences in policy between the UK neonatal transport services regarding the urgency of response for such referrals. Although bile-stained vomiting is not included in the UK National Transport Group time-critical conditions data set, some teams classify these cases as time-critical, warranting that the transfer team dispatches within 1 hour from the start of the referring call. Other teams choose to respond on a case-by-case basis.

The aim of this national UK audit was to quantify referrals for transfer of newborn infants with bilious vomiting, to determine the frequency of surgical diagnoses and to analyse clinical findings and outcomes with a view to review the national time-critical data set.

## METHODS

A prospective, multicentre study was conducted by Neonatal Transport teams across the UK between 1 August 2015 and 31 October 2015. All 19 Neonatal transport teams in the UK were invited to participate, of these, 16 contributed (figure 1). All term gestation ( $\geq 37$  weeks) newborn infants, referred for transfer due to bilious vomiting at  $\leq 7$  days of age, were included. Infants with antenatal diagnosis of gastrointestinal (GI) abnormalities were excluded. Demographic, clinical and radiological data were collected via predesigned, anonymised, data collection proforma. Outcome data were collected by local transport teams at 7 days after the transfer via telephone discussion with the paediatric surgical centre. The audit was approved by the UK Neonatal Transport Group, co-ordinated by the



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**Figure 1** Participants of the National Survey of Newborn Infants transferred for bilious vomiting. The numbers indicate the name of the Transport Team, and the size of the dot is proportional to the number of cases contributed to the audit: 1, Acute Neonatal Transport Service (n=11); 2, CenTre Neonatal Transport (n=15); 3, Embrace Transport Service (n=15); 4, Greater Manchester Neonatal Transport Team (n=6); 5, KIDS and West Midlands Neonatal Transport Service (n=15); 6, Kent, Surrey and Sussex Newborn Transport Team (n=12); 7, London Neonatal Transport Service (n=26); 8, Newborn Emergency Stabilisation and Transfer Team (n=2); 9, Newcastle Newborn Transport Team (n=4); 10, Northern Ireland Specialist Transport and Retrieval Service (n=3); 11, Peninsula Neonatal Transport Service (n=13); 12, Scottish Neonatal Transport Service (n=27); 13, Southampton Oxford Neonatal Transfer (Oxford) Team (n=5); 14, Southampton Oxford Neonatal Transfer (Southampton) Team (n=9) and 15, South Wales Neonatal Transport team (n=2).

CenTre Transport team and registered at the University Hospitals of Leicester NHS Trust. Each participating transport team obtained approval from their local Caldicott Guardian.

Data are described as mean and SD for normally distributed variables and median and IQR for others. Sensitivity and specificity of radiological features for surgical diagnoses were calculated. All statistical analyses were performed using PASW (or SPSS: v21, IBM) and Microsoft Excel (Microsoft, Baltimore, Maryland, USA).

The outcomes were dichotomised into surgical diagnosis (conditions where management required further involvement of the paediatric surgical team) and no surgical diagnosis. The surgical diagnoses were further categorised as 'time-critical surgical diagnosis' if the condition could be a risk to viability of gut such as symptomatic malrotation or malrotation with volvulus or intestinal perforation.

## RESULTS

Sixteen Transport Teams across the UK participated ([figure 1](#)) and contributed data on 169 cases transferred between 1 August

**Table 1** Clinical feature in infants transferred for bilious vomiting

Clinical feature	Clinical examination at presentation (observations of the referring team), n (%)	Clinical examination prior to transfer (observations of the transport team), n (%)
Green vomit witnessed*	155 (95)	84 (51)
Abdominal distension present	48 (29)	47 (29)
Abdominal tenderness present	20 (12)	21 (13)
Firm abdomen	19 (12)	15 (9)

\*Eight infants were reported as having green vomit by parent or attending midwife, but the vomitus was not available for inspection by the referring team. In five of these, further vomiting was witnessed and the colour reported as yellow.

2015 and 31 October 2015. Two infants were excluded because of antenatal diagnoses of GI anomalies and two others because they were preterm. The final analysis was performed with 165 infants including 69 (42%) boys. The median (IQR) gestation age was 40 (39–41) weeks, birth weight was 3.46 (0.50) kg and age at transfer was 28 (21–46) hours.

The clinical features at presentation are summarised in [table 1](#). The respiratory status at referral were 154/165 (93%), no respiratory support; 8/165 (4%), oxygen via nasal cannula and 3 (2%), ventilated. Following assessment, the transport team ventilated two infants. The blood gas analyses at referral were available in 129 cases. Two infants had acidosis (pH<7.35) with BE<-5 mmol/L while two others had BE<-5 mmol/L, but no acidosis (pH of 7.38 and 7.41, respectively). The transport team performed blood gas analyses while on the referring unit in 81 cases. At this point, four infants had acidosis, of which two had BE<-5 mmol/L.

Of the 16 participating transport teams, 9 classify referrals for bilious vomiting as time-critical. The dispatch time (time from start of the referring call to the transport team departing their base) and response time (time from start of referring call to transport team arriving with patient) were significantly shorter for transfers carried out by these nine teams when compared with the transfers performed by the seven teams that do not classify bilious vomiting as time-critical ([table 2](#)). However, there was no difference in the stabilising time (time from the arrival of transport team at the referring centre to departing site; [table 2](#)). Most infants were transferred to the Paediatric or Neonatal Intensive Care Unit at the receiving centre, although 45/165 (27%) were taken directly for investigation.

**Table 2** Time taken for transfer of infants referred for bilious vomiting

Time in minutes (mean (SD))	Cases of bilious vomiting considered as time-critical	Cases of bilious vomiting not considered as time-critical	p-value*
Dispatch time	51.8 (58.6)	141.6 (307.5)	0.03
Response time	92.0 (71.9)	160.4 (221.9)	0.01
Stabilising time	52.5 (36.7)	54.4 (20.7)	0.18

Dispatch time, time from start of the referring call to the transport team departing their base; response time, time from start of referring call to transport team arriving with patient; stabilising time, time from arrival of transport team at the referring centre to the team departing site.

\*Mann-Whitney test.

**Table 3** List of diagnoses in newborn infants transferred for bilious vomiting

Diagnosis	Number (%) n=152
Surgical conditions (n=34 (22%))	
Symptomatic malrotation*	7 (5)
Malrotation with volvulus*	3 (2)
Ileal atresia	3 (2)
Hirschsprung's disease	8 (5)
Suspected Hirschsprung's disease	3 (2)
Anal stenosis	2 (1)
Colonic atresia	1 (1)
Duodenal obstruction	1 (1)
Ischaemic colitis? NEC	1 (1)
Meconium ileus	1 (1)
Meconium plug	1 (1)
NEC	3 (2)
Non-surgical conditions (n=118 (78%))	
Normal	98 (65)
Suspected sepsis	11 (7)
Sepsis	1 (1)
Enteroviral meningitis	1 (1)
Gallstones	1 (1)
Gastro-oesophageal reflux	5 (3)
Meconium aspiration syndrome	1 (1)

\*Diagnoses considered as 'time-critical'.

The diagnosis (at 7 days after the transfer) was available in 152 (92%) cases (table 3). One participating centre was unable to obtain permission to share this information from their Caldicott Guardian. Thirty-four infants (22%) had any surgical diagnosis of which 10 (7%) had a time-critical condition. None died in the follow-up period.

The referring team's opinion of the abdominal X-ray was available in 69 (42%) of which 31 (45%) were thought to be abnormal. The transport team's opinion was available in 108 (65%) of which 55 (51%) were considered abnormal. In 57/165 (35%), where impression of both teams were available, there was good correlation between the two (kappa coefficient (95% CI) 0.77 (0.60–0.94)). In four cases, including two infants with symptomatic malrotation, both teams found the X-ray to be normal, but the infant was subsequently diagnosed with a surgical pathology. Of these four, two had firm, distended abdomen while the other two were reported to have a distended abdomen which was soft and non-tender by both the teams.

All GI contrast studies were performed at the surgical centre after the transfer. Results of this investigation were available in 135 cases. Of these, 28 were reported abnormal including two with gastro-oesophageal reflux only. One had features of possible obstruction but the subsequent laparotomy ruled out any surgical pathology. Of the 10 infants who did not have GI contrast study performed, 9 had surgical pathology identified on the abdominal X-ray (necrotising enterocolitis, 3; suspected Hirschsprung's disease, 3, anal stenosis, 2 and malrotation with volvulus, 1).

The sensitivity and specificity of the radiological investigations are described in table 4. Serum lactate levels were a poor indicator of surgical problems (serum lactate at referral (mean±SD): infants without any surgical pathology, 2.75±1.15; infants with surgical pathology, 2.66±1.04).

**Table 4** Diagnostic accuracy tests for predicting the presence of any surgical pathology among infants who are referred for transfer for presentation with bilious vomiting

Test	Sensitivity (%)	Specificity (%)
Abdominal X-ray (referring team)	77 (50–93)	58 (44–71)
Abdominal X-ray (transport team)	85 (65–96)	55 (44–66)
Gastrointestinal contrast study report	96 (80–100)	97 (92–99)

## DISCUSSION

This is the first UK nation-wide study to analyse the activity of neonatal transport services across the country focusing on a single clinical problem. We have demonstrated that such collaborative work is feasible and can produce valuable data for service evaluation and research. Over the past decade, neonatal transport services across the UK have evolved at different rates and continued efforts to optimise the use of available resources and develop benchmarking data to ensure that high-quality sustainable services are imperative.<sup>4</sup>

We found that among those transport services that consider a referral for bilious vomiting time-critical, teams were dispatched within 1 hour, and arrived at the infant's cot-side significantly quicker than the teams that do not consider bilious vomiting as time-critical. The findings suggest that classifying a condition as time-critical can hasten the response of the transport teams and shorten the duration of transfer by 60–90 min. Geographical and logistical factors such as distance and traffic density are likely to be other strong determinants in individual transfers.

For neonatal transport services, the dilemma in treating cases as time-critical is twofold. First, there may be a triage decision; several sick and unstable infants are often referred around the same time, and the service has to prioritise. Second, emergency driving with blue lights significantly increase the risk of road traffic incidents. The decision to transfer infants in a time-critical manner, therefore, requires careful consideration.

Although there is general awareness that bilious vomiting is worrying, there appears to be lack of clarity about the colour of bile. Walker *et al* found, in a survey, that more than half of the participating parents did not identify green as the colour representing bile, while nearly half of the general practitioners, a quarter of neonatal nurses, and one-third of midwives choose yellow as the best match for bile.<sup>5</sup> In this study, in eight cases, the referring team did not see the green vomitus; bilious vomiting was reported by the parent or the midwife and it is possible that these cases may not have had true bilious vomits.

The majority of referred infants were stable with normal blood gas and serum lactate levels. Serum lactate is a marker of severity of illness.<sup>6</sup> It is possible that bilious vomiting is an early marker of surgical pathology and infants included in this study were commenced on appropriate management before any significant deterioration occurred and, hence, had low lactate levels. However, it is also well recognised that serum lactate can be misleadingly normal in infants with critically ischaemic gut when the venous drainage from the ischaemic segment is completely cut-off from the systemic circulation.

Seven days after transfer, 22% of the infants had a diagnosis that required surgical input including 7% whose condition may have resulted in bowel loss if not treated promptly. These figures are lower than those reported by Mohinuddin *et al*<sup>3</sup> who found that 46% had a surgical pathology. This may be because we excluded the cases of antenatally detected pathologies but could also be an indication of an increasing likelihood of paediatricians/neonatologists referring cases of bilious vomiting due to

the increased awareness of the risks. This is supported by the report from Drewett *et al*<sup>2</sup> who also found an increase in referrals to their centre without an increase in the detection of malrotation.

We did not collect information to estimate the size of the baseline population of term births at the referring centres and, similar to Mohinuddin *et al*,<sup>3</sup> this cohort does not include those born in the surgical centres who do not require transfer. In addition, we have no information regarding infants who may have presented with bilious vomiting but were not referred. A survey of neonatologists revealed variations in management and demonstrated that many infants with bilious vomiting may not be referred.<sup>7</sup> These unknown variations may have introduced a bias in the data presented.

Nevertheless, this study provides an overview of infants referred for bilious vomiting across the UK. Previous studies have reported that the combination of abnormal clinical findings and abnormal abdominal X-ray significantly increases the likelihood of a surgical diagnosis.<sup>3</sup> We also found that most infants with surgical pathology had abnormal clinical and/or radiological signs, although cases may present without classical features and confound the clinician.

## CONCLUSION

Approximately one-fifth of term gestation infants transferred for bilious vomiting in the first week of life have a surgical pathology. There is a need for infants with bilious vomiting to be investigated for potential surgical pathologies, but the data presented here do not support the default designation of such referrals as 'time-critical.' Decisions should be made by clinical collaboration between teams and, where appropriate, swift transfer provided.

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**Contributors** SO conceptualised the study, wrote the study protocol, designed the data collection proforma, co-ordinated the project and wrote the initial manuscript. LS analysed the data and wrote the initial manuscript. NR conceptualised the study and reviewed the manuscript. SK conceptualised the study and reviewed the manuscript. AS and SM conceptualised the study and reviewed the statistical analysis and the manuscript. HB analysed the data and contributed to the writing on the initial manuscript. AL conceptualised the study, organised the national collaboration, obtained regulatory approvals, and reviewed the manuscript. UK Neonatal Transport Group members commissioned the study, organised local regulatory approvals, data collection, and commented on the discussions and conclusion.

**Competing interests** None declared.

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