

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

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**Author Contributions:**

Shalini Ojha conceptualised the study, wrote the study protocol, designed the data collection proforma, co-ordinated the project and wrote the initial manuscript.

Laura Sand analysed the data and wrote the initial manuscript.

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Helen Budge analysed the data and contributed to the writing on the initial manuscript.

Andrew Leslie 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.

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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, determine the frequency of surgical diagnoses, with the purpose to inform the consequent inclusion of these referrals in the national 'time critical' dataset.

**Method:** A prospective, multi-centre UK-wide audit was conducted (01 August 2015 to 31 October 2015). Term infants,  $\leq 7$  days of age, referred for transfer due to bilious vomiting were included. Data at the time of transport and outcomes at seven 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 of this study 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 treatment of symptomatic malrotation and/or volvulus [1]. The increasing adoption of this approach has led to a large number 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 [2].

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 a four year period, 15% of transfers involving full-term infants  $\leq 7$  days of age were for bilious vomiting [3]. There are differences in policy between neonatal transport services regarding the urgency of response for such referrals. Although bile-stained vomiting is not included in the UK National Transport Group (NTG) time-critical conditions dataset, some teams classify these cases as time critical warranting that the transfer team dispatches within one 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, determine the frequency of surgical diagnoses and to analyse the regional variations in response. Results of this study will inform the consequent inclusion or exclusion of these babies in the national 'time critical' dataset.

## **Methods**

A prospective, multi-centre study was conducted by Neonatal Transport teams across the UK between 01 August 2015 and 31 October 2015. All 19 neonatal transport teams in the UK were invited to participate, of these, 16 contributed to this study (Figure legend:

Figure 1). All newborn infants, born at 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 abnormalities were excluded. Demographic, clinical, and radiological data were collected from the individual transport teams via a pre-designed, anonymised, data collection proforma. Outcome data were collected by local transport teams at seven days after the transfer via a telephone discussion with the paediatric surgical centre. The audit was approved by the UK Neonatal Transport Group, co-ordinated by the 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 standard deviation (SD) for normally distributed variables, median and interquartile range (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, Chicago, USA) software and Microsoft Excel (Microsoft, Baltimore, USA).

The outcome were dichotomised into surgical diagnosis (conditions where the 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 01 August 2015 and 31 October 2015. Two infants were excluded because of antenatal diagnoses of gastrointestinal 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 the time of transfer of 28 (21-46) hours.

The clinical features at the time of presentation are summarised in Table 1. The respiratory status at referral were: 154/165 (93%) no respiratory support; 8/165 (4%) were oxygen via nasal cannula; three (2%) infants, ventilated. Following assessment, the transport team ventilated 2 infants. The blood gas analyses at the time of referral were available in 129 cases. Two infants had acidosis (pH <7.35 with

BE <-5 mmol/L) while two others had a 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 2 had BE <-5mmol/L.

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

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

\*8 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 5 of these, further vomiting was witnessed and the colour reported as yellow.

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 9 teams when compared to the transfers performed by the 7 teams that do not classify bilious vomiting as a time critical condition (Table 2). However, there was no difference in the stabilising time (time from arrival of transport team at the referring centre to the team 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**

<b>Time in minutes (mean (SD))</b>	<b>Cases of bilious vomiting considered time critical</b>	<b>Cases of bilious vomiting <u>not</u> considered time critical</b>	<b>p value*</b>
<b>Dispatch time</b>	51.8 (58.6)	141.6 (307.5)	0.03

<b>Response time</b>	92.0 (71.9)	160.4 (221.9)	0.01
<b>Stabilising time</b>	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*

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.

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

<b>Diagnosis</b>	<b>Number (percentage) n = 152</b>
<b>Surgical conditions (n=34 (22%))</b>	
Symptomatic malrotation*	7 (5)
Malrotation with volvulus*	3 (2)
Ileal atresia	3 (2)
Hirschprung's Disease	8 (5)
Suspected Hirschprung'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)
<b>Non-surgical conditions (n=118 (78%))</b>	
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)

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\*diagnoses considered as “time critical”

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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, non-tender by both the teams.

All GI contrast studies were performed at the surgical center after the transfer. Results of this investigation were available in 135 cases. Of these, 28 were reported as 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; 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  $\pm$  SD): infants without any surgical pathology,  $2.75 \pm 1.15$ ; infants with any surgical pathology,  $2.66 \pm 1.04$ ).

**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**

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

## **Discussion**

This is the first U.K. 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 high quality sustainable services are imperative [4].

We found that among those transport services that consider a referral for bilious vomiting time critical, teams were dispatched within one hour, and arrived at the infant’s cot-side significantly quicker than the teams that do not consider bilious vomiting as a 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 minutes. 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. There may be several sick and unstable infants referred around the same time, and the transport service has to prioritise. An apparently well infant with bilious vomiting may be triaged against critical congenital heart disease or extreme prematurity, for example. Secondly,

emergency driving with blue lights is significantly more likely to result in a road traffic incident than driving as normal. The decision to transfer infants in a time-critical manner, therefore, requires careful consideration.

Although there is a general awareness that bilious vomiting is worrying, there appears to be a 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 general practitioners, a quarter of neonatal nurses, and a third of midwives choose yellow as the best match for bile [5]. In this study, in 8 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 infants were stable with normal blood gas and serum lactate levels. Serum lactate is a marker of severity of illness in sick neonates [6]. 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 ischemic 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. who found that 46% had a surgical pathology [3]. This may be because we excluded cases of antenatally detected abdominal 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. [2] who also found an increase in referrals to their centre without an increase in detection of malrotation.

We did not collect information to estimate the size of the baseline population of term births in the referring centres and similar to the data presented by Mohinuddin et al. [3], 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 [7]. These unknown variations may have introduced a bias in the data presented.

Nevertheless, this study provides an overview of infants who are referred for bilious vomiting across the UK. Previous studies have reported that the combination of abnormal clinical findings and an abnormal abdominal X-ray significantly increases the likelihood of a surgical diagnosis [3]. 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”. Decision should be made by clinical collaboration between teams and where appropriate swift transfer provided.

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## Figure legend:

### 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); 15, South Wales Neonatal Transport team (n=2).

### **What is already know on this topic**

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

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