ORIGINAL ARTICLE

The Effect of a User-Guided Request Form for Chest Radiographs in a Neonatal Intensive Care Unit

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Summary

The objectives of this prospective, observational study were to determine the current indications of requesting chest radiograph in sick infants in a neonatal intensive care unit (NICU) and the effect of a user-guided request form for chest radiographs of sick infants. During the three-month study period, a total of 423 chest radiographs were requested on 159 sick newborn infants in the intensive area of this NICU. A majority (55.6%) of these chest radiographs were performed to verify positions tips of either central catheters (27.4%) or endotracheal tubes (28.1%). The number of chest radiographs done during the period when the user-guided request forms were utilised was significantly lower (1.24 per patient) than before (1.37 per patient) or after (1.58 per patients) the period when these forms were in use (p=0.01). The rate of radiological abnormalities detected in radiographs requested to verify position of tips of endotracheal tubes were significantly greater during the period when user-guided forms were used than when they were not (p=0.01). A significantly higher proportion of changes in management were instituted when the user-guided forms were in use than during the period when they were not used (p=0.03). We conclude that a user-guided radiographic request form helps doctors in NICU to carry out their management more effectively.

Key Words: Neonatal intensive care unit, Chest radiographs, User-guided request form

Introduction

Radiographs, especially of the chest, are commonly performed in the neonatal intensive care unit (NICU). They are used to assist daily patient care and management. However, if they are used indiscriminately, they may cause unnecessary irradiation to sick neonates.

There are only four studies which have dealt with the assessment of chest radiographs for pulmonary diseases in neonates in the NICU. All four studies had different objectives and conclusions making it difficult to appreciate the precise role of chest radiographs in the neonates[1, 2, 3, 4]. We therefore designed a user-guided form attached to the standard radiograph request form in an NICU with the aim of obtaining information on the common indications for chest radiographs in sick newborn infants and to assess the effect of this form on the chest radiograph request practice among doctors caring for these infants.

Materials and Methods

This was a prospective observational study conducted over a three-month period, from 11th April 2001 to 13th July 2001, in the NICU of Maternity Hospital, Kuala Lumpur. During this period, all neonates admitted to the intensive area in the NICU who had chest

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radiographs done were recruited into the study. The attending doctors were unchanged throughout the entire study period.

The study was divided into three phases; Phase I (pre-intervention), Phase II (intervention) and Phase III (post-intervention). Each phase was conducted over a period of one month. The pre-intervention phase was regarded as a pilot study and a baseline prior to the interventional phase. During phases I and III, a standard request form for radiographs was used. During phase II (intervention period), a questionnaire was attached by stapling it onto the standard request form thus converting it into a user-guided request form (appendix 1). During the entire study period, the doctors working in the NICU were not briefed about the existence of the study and were kept blinded to the study objectives.

Demographic data, indications, interpretation of radiographs, clinical interventions and subsequent management decisions were recorded in a standard proforma during all three phases. Interpretation of radiographs and decisions regarding the need of interventions were left to the attending clinicians.

A radiological abnormality was defined as the presence of radiological evidence of the suspected diagnosis or malposition of endotracheal tubes and central catheters. A further change in management was defined to have taken place when it was carried out following a review of radiographs; this did not include treatment commenced prior to or upon request of chest radiograph.

All data were coded and entered into a pre-programmed database created using Microsoft Access version 2000. Statistical analysis was carried out using the statistical package SPSS version 10.1 for Windows (SPSS Inc, Chicago, Illinois, USA).

The chi-square test (or Fisher's exact test for expected value of less than 5) was used for analysis of categorical variables. A p value of less than 0.05 was considered statistically significant.

Results

There were 165 admissions to the intensive area of the NICU during the study period. The case records of 6 infants could not be traced after discharge or death and were not included in the final analysis. Of the remaining 159 infants, a total of 423 requests were for chest radiographs (105 in phase I, 158 in phase II and 160 in phase III).

A majority of the infants were male and of Malay ethnic origin in all three phases of the study. However, there were no significant differences in the gender and ethnic distribution during the three phases of the study. There was also no statistical difference in the proportion of infants with different birth weight groups during the three phases of the study (Table I).

In all three phases of the study, a majority of the infants had only one radiograph performed per patient. Very few patients had more than three chest radiographs performed during their stay in the intensive area of the NICU. In phase II when the user-guided form was in use, there were more patients with only one radiograph done (81.8%). In contrast, more patients had three or more radiographs done in phase III. However, this difference was not statistically significant. The mean number of radiographs done per patient during the whole study was 1.58, which was significantly more than the mean number of chest radiographs (at 1.24 per patient) done during phase II (p=0.01). The mean number of chest radiographs done was 1.37 per patient during phase I, and 1.58 during phase III.

Table II compares the distribution of clinical conditions for which chest radiographs were requested during the three phases of the study. The commonest indication for doing a chest radiograph was to verify position of tips of either endotracheal tubes or central catheters; the next common indication was for confirmation of diagnosis of respiratory distress syndrome (RDS). However, the user-guided form did not make any significant difference to the request-practice for these indications during the study. The only indication to which the user guided form seemed to have made a significant difference was in the assessment of progress of lung pathology; significantly less chest radiographs were requested during phase II than phase III when the user-guided forms were no more in use (p=0.01).

Table III compares the frequency distribution of radiological abnormalities detected by chest radiographs during the different phases of the study. There was no significant difference in the proportions of various types of radiological abnormalities detected during all three phases of the study (phase I: 42%, phase II: 41.8%, phase III: 45.6%, p=0.36). However, with the utilisation of a user-guided form, a significantly

greater proportion of abnormalities were detected in radiographs done to assess endotracheal tube position during phase II than during phase III when the forms were no more in use (p=0.01).

Table IV summarises the relationship between the need for a further change in management after review of chest radiographs and the introduction of a user-guided request form. Although there was no significant difference in the overall proportions of chest radiographs which resulted in a further change in management in all three phases of the study, there were significantly more changes in the management instituted following radiographs requested to verify endotracheal tubes position in phase II than phase III (p=0.03).

Table I: Demographic data of infants

Parameters	No. of infants during phases: I n=43 (%)	II n=66 (%)	III n=50 (%)	p value
Sex				
Male	26 (60.5)	43 (65.2)	34 (68)	0.7
Female	17 (39.5)	23 (34.8)	16 (32)	
Ethnic group				
Chinese	9 (20.9)	10 (15.2)	4 (8)	0.1
Malay	24 (55.8)	35 (53)	37 (74)	
Others*	10 (23.3)	21 (31.8)	9 (18)	
Birth weight group				
<1500g	18 (41.9)	15 (22.8)	21 (42)	0.1
>1500g	25 (58.1)	51 (77.2)	29 (58)	
No. of radiographs per patient**				
1	32 (72.1)	54 (81.8)	30 (60)	0.3
2	8 (18.6)	8 (12.1)	11 (21.6)	
>3	4 (9.3)	4 (6.1)	8 (11.3)	

Note: * includes Indians and other ethnic groups
** maximum number of radiographs per patient was 7

Table II: Indications of Requesting Radiographs

Indications	No. of radiographs requested according I n=105 (%)	II n=158 (%)	III n=160 (%)	p value
Pneumonia	8 (7.6)	12 (7.6)	10 (6.3)	0.9
RDS	19 (18.1)	26 (16.5)	26 (16.3)	1.0
Other lung pathology*	4 (3.8)	11 (7)	8 (5)	0.5
Post intubation	34 (32.4)	45 (28.5)	39 (24.4)	0.4
Verification of position of UAC/ UVC/long line	29 (27.6)	45 (29)	42 (26)	0.8
Assessment of progress of lung pathology	9 (8.6)	8 (5.1)	22 (13.8)	0.01
Others**	2 (2.4)	11 (7.9)	13 (8.1)	0.2

* denotes meconium aspiration syndrome, pneumothorax, congenital lung anomaly
** denotes cardiomegaly, transient tachypnoea of newborn, chronic lung disease
RDS=respiratory distress syndrome, UAC=umbilical arterial catheters, UVC=umbilical venous catheters.

Table III: Relationship between radiological abnormalities detected and indications for radiography

Indications for radiography	No. of radiographs with abnormalities detected during phases:			p value
	I (%)	II (%)	III (%)	
Pneumonia	n=8 5 (62.5)	n=12 9 (75)	n=10 8 (80)	NS
RDS	n=19 14 (73.7)	n=26 12 (46.2)	n=26 17 (65.4)	NS
Other lung pathology	n=4 2 (50)	n=11 6 (54.5)	n=8 3 (37.5)	NS
Post intubation	n=34 6 (17.6)	n=45 16 (35.6)	n=39 5 (12.8)	0.01*
Verification of catheter position	n=29 11 (37.9)	n=45 11 (24.4)	n=42 13 (40)	NS
Assessment of progress of lung pathology	n=9 7 (77.8)	n=8 6 (75)	n=22 18 (81.8)	NS
Others	n=2 0	n=11 6 (54.5)	n=13 9 (69.2)	0.01

* denotes statistical significance between phases II and I and between phases II and III;
RDS=respiratory distress syndrome, NS=not statistically significant

Table IV: Relationship between further changes in management and indications for radiography

Indications for radiography	No. of radiographs resulting in further changes in management during phases:			p value
	I (%)	II (%)	III (%)	
Pneumonia	n=8 2 (25)	n=12 4 (33.3)	n=10 6 (60)	NS
RDS	n=19 4 (21.1)	n=26 4 (15.4)	n=26 2 (7.7)	NS
Other lung pathology	n=4 1 (25)	n=11 2 (18.2)	n=8 1 (12.5)	NS
Post intubation	n=34 5 (14.7)	n=45 15 (33.3)	n=39 5 (12.8)	0.03*
Verification of catheter position	n=29 11 (37.9)	n=45 14 (31.1)	n=42 14 (33.3)	NS
Assessment of progress of lung pathology	n=9 2 (22.2)	n=8 6 (75)	n=22 8 (36.4)	0.03**
Others	n=2 0	n=11 4 (36.4)	n=13 5 (38.5)	NS

*denotes statistical significance between phases II and III; **denotes statistical significance between phases I and II; RDS=respiratory distress syndrome

Discussion

Infants admitted to the intensive area of the NICU frequently require some form of respiratory support and close monitoring. It is therefore essential to know when, why and how chest radiographs could help in the management of these patients. There is no published data from any Malaysian NICUs on this subject.

In the present study, approximately more than half of the radiographs requested were for detection of position of tips of central catheter or endotracheal tubes. There was no significant change in the proportions of chest radiographs requested for these two purposes with the introduction of the user-guided form. However, when analysed for the yield of these radiographs, only a third of these radiographs showed any malposition of tips of either central catheters or endotracheal tubes. There were significantly more endotracheal tubes detected not to be at optimal level during phase II (intervention phase) when the use-guided form was utilised than during the other two phases. This could be attributed to the "reminder" provided by the user-guided form during phase II that helped to raise the doctors' alertness to look for malposition of tips of the catheters or endotracheal tubes shown on the radiographs. However, one other possible explanation for the lower detection rate of abnormally placed catheters or endotracheal tubes during phase III was the improved skill in intubation and placement of the endotracheal tubes by the doctors during the last month of their three-month posting when they became more skilful in insertion of catheters or endotracheal tubes. Generally, the percentage of abnormally placed endotracheal tubes in our study (15.3%) was lower than that reported by Quansey et al (20%) in a paediatric intensive care unit[5]. We are unable to compare our results directly to another study as there is no published data from other NICUs. Although the number of radiographs that demonstrated abnormally positioned endotracheal tubes was relatively low, it was not possible from this study alone to suggest that radiographs do not play a role in verifying central catheter and endotracheal tube positions in babies in NICU. However, in order to reduce irradiation to these small babies, other modes of imaging should be considered. Ultrasonography is a convenient bedside tool which can be used for confirming the position of the tips of central catheters[6]. Bronchoscopy during intubation may be used as an alternative to radiographs in confirming position of tip of endotracheal tubes. However, both of these techniques require some level of expertise to ensure accurate diagnosis. Meanwhile, we recommend that once an infant is intubated and the position of the tip of endotracheal tube has been confirmed to be at the optimal level by a chest radiograph, the marking of the endotracheal tube at the level of the infant's lip should be noted for subsequent repeat intubations, thus reducing the number of repeated chest radiographs and irradiation.

We found that the presence of a radiological abnormality did not necessarily mean that a further change in management was mandatory. Overall a third of the radiographs with radiological abnormalities did not require any further action to be taken. Interventions may have been performed even before the radiographs had returned as the doctors have other clinical parameters to guide them in NICU. Similar to the data for presence of radiological abnormalities, there was a significant reduction in the percentage of cases requiring a further change in management during phase II than phase III after intubations ($p=0.03$). In the post intervention phase III where the doctors are more experienced, they may have been more skilled in intubations and therefore needing fewer adjustments of endotracheal tube positions. In contrast, the increased the number of radiographs requiring a further change in management in phase II could have been due to the promptness to look for changes prompted by the user-guided form.

There were some limitations of this study. Although we tried not to disclose the purpose of the study to the doctors working in the NICU, the presence of the user-guided form may have affected the request practice of these doctors. The doctors' skills in the procedures also differed. The other problem was the small sample size and the short duration of this study. More convincing results would have been obtained if the study had been carried on for a longer period.

In conclusion, we found that a majority of chest radiographs requested in sick infants in the NICU were used for confirmation of position of catheters and endotracheal tubes. During the period when user-guided request forms were utilised, less chest radiographs were requested per infant yet more abnormalities were detected and there was a greater rate of change of management instituted by the doctors upon availability of the chest radiographs requested for confirmation of position of endotracheal tubes, than

when this type of forms ceased to be in use. A user guided request form may therefore help doctors to manage their sick infants more effectively. However, further studies over a longer period of time and involving a larger number of doctors should be carried out to confirm these findings.

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