Changed ophthalmic workload following introduction of digital retinal photography for retinopathy of prematurity screening

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Keywords:	Retinopathy of prematurity, Screening, Photo-screening, Wide-field digital retinal imaging, Workload
Abstract:	Importance: This study reports an enduring reduction in ophthalmologist workload in screening for retinopathy of prematurity (ROP) following the introduction of nurse-led wide-field digital retinal imaging (WFDRI) in an Australian setting. Background: ROP screening is vital in care of premature infants but is considered burdensome, difficult and time consuming for ophthalmologists. This study assessed the reduction in workload following the introduction of nurse-led WFDRI to a large neonatal nursery. Design: Retrospective audit Participants: 628 infants screened for ROP in the years 2010, 2013 and 2019 at the Royal Women's Hospital, Victoria. Methods: The last complete year of screening for ROP using binocular indirect ophthalmoscopy (BIO) alone was compared with two subsequent years after the introduction of nurse-led WFDRI. Main Outcome Measures: Time taken to report and document WFDRI and the time taken to undertake BIO examination of a premature infant and document the results. Results: The ophthalmologist's time pertaken to conduct BIO, review images and document the results per 100 examinations patient examinations was reduced from 16.7 hours before introduction of WFDRI to 3.7 hours. Similarly, the weekly time spent on this component of ROP screening fell from 2.3 hours per week to 0.8 and 1.0 hours per week after introduction of WFDRI. Conclusions and Relevance: The introduction of nurse-led WFDRI has

	resulted in a dramatic and sustained reduction in ophthalmologist workload involved in ROP screening in a large Australian neonatal nursery. This may result in improved retention of the ophthalmic workforce required to undertake ROP screening.

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Changed ophthalmic workload following introduction of digital retinal photography for retinopathy of prematurity screening

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ABSTRACT

Background: ROP screening is vital in care of premature infants but is considered burdensome, difficult and time consuming for ophthalmologists. This study assessed the reduction in workload following the introduction of nurse-led WFDRI to a large neonatal nursery.

Methods: We report a retrospective audit of 628 infants screened for ROP in the years 2010, 2013 and 2019 at the Royal Women's Hospital, Victoria. The last complete year of screening for ROP using binocular indirect ophthalmoscopy (BIO) alone (2010) was compared with two subsequent years after the introduction of nurse-led WFDRI. The main outcome measures were the time taken to report and document WFDRI and the time taken to undertake BIO examination of a premature infant and document the results.

Results: The ophthalmologist's time taken to conduct BIO, review images and document the results per 100 patient examinations was reduced from 16.7 hours before introduction of WFDRI to 3.7 hours. Similarly, the weekly time spent on this component of ROP screening fell from 2.3 hours per week to 0.8 and 1.0 hours per week after introduction of WFDRI.

Conclusions: The introduction of nurse-led WFDRI has resulted in a dramatic and sustained reduction in ophthalmologist workload involved in ROP screening in a large Australian neonatal nursery. This may result in improved retention of the ophthalmic workforce required to undertake ROP screening.

Keywords: Retinopathy of prematurity, Screening, Photo-screening, Wide-field digital retinal imaging, Workload

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1. INTRODUCTION

Retinopathy of prematurity (ROP) is a vasoproliferative disease affecting the developing retinas of premature infants.[1, 2] It affects tens of thousands of children around the world each year and is one of the leading causes of avoidable blindness in children globally.[3] The improving neonatal survival rate over the past decades has resulted in an increased incidence of ROP, particularly in developing countries.[4, 5] As the treatment outcomes for ROP are highly favourable if provided in a timely manner, the early detection of ROP through effective screening protocols is of high importance.[2, 6] Currently, the gold standard for ROP diagnosis is binocular indirect ophthalmoscopy (BIO), which is a costly, logistically difficult and ophthalmologist time-intensive procedure.[7, 8] There is evidence that there may be a shortage of ophthalmologists willing to undertake ROP screening.[9]

Wide field digital retinal imaging (WFDRI) is an increasingly viable method used in the screening of ROP.[10, 11] By using WFDRI to capture retinal images, many of the logistical and workload difficulties associated with ROP screening can be lessened.[12, 13] Due to significant developments in this technology since its introduction, the diagnostic accuracy of WFDRI is highly comparable to BIO.[11, 12, 14]

In 2012 a nurse-led WFDRI program was commenced at The Royal Women's Hospital in Melbourne, Australia. Initially two experienced neonatal nurses were trained by the ophthalmologist undertaking ROP screening at this nursery. This training lasted approximately 12 weeks with each nurse taking WFDRI of approximately 80 infants before being able to practice independently of the ophthalmologist. Subsequently these nurses have trained three additional nurses in WFDRI with minimal input from the ophthalmologist.

The purpose of this report is to document the reduced workload for the ophthalmologist since the introduction of WFDRI as a part of ROP screening. A proportion of ROP screening examinations are still undertaken with a BIO

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examination. These include BIO examinations to confirm WFDRI findings when considering treatment, infants that are medically instable and limited assessment to document presence or absence of plus disease alone is required and for final or exit examinations are undertaken to determine if the retina is fully vascularised. The results of all ROP screening examinations were recorded in a prospectively-maintained electronic database.

2. METHODS

This is a retrospective study of the estimated workload for the ophthalmologist undertaking ROP screening at a tertiary neonatal unit. 2010 was chosen as this was the last full calendar year of ROP screening using the BIO examinations alone. The year 2013 was chosen for the initial comparison year as the WFDRI service had been in operation for 10 months and was thought to be "mature" and functioning well. 2019 was the last full calendar year prior to doing the study and was used to determine if any workload benefit was sustained.

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2.1 Subjects

The Royal Women's Hospital ROP database was searched to identify infants that had at least one ROP screening examination in the years 2010, 2013 and 2019.

This study met the National Health and Medical Research Council requirements for quality assurance/audit projects, and was approved by the RWH Research Committee and RWH Human and Research Ethics Committee.

2.2 Data collection and analysis

Gestational age, birthweight, the number of examinations, and the type of examinations (BIO or WFDRI) for each infant were available within The Royal Women's Hospital ROP database. All data was initially processed in Microsoft Excel 2010, before data analysis using R Version 4.0.0 (R Foundation for Statistical Computing, 2020).

Due to the non-parametric distribution of gestational age and birthweight, the Kruskal-Wallis statistical test was used to determine if there were statistically significant differences between the gestation age and birthweight variables for the 2010, 2013 and 2019 cohorts.

As no contemporaneous records were maintained for the duration of each examination, the following procedure was used to estimate the times for each type of examination. During a working ROP screening ward round in 2020 the average time taken to interpret WFDRI and document the results was determined. The time taken to perform a BIO examination and document the results was also determined. These times were used to estimate the time expended in the direct patient examination and documentation components of the ROP screening for the three different years.

3. RESULTS

There were 171 infants who received an average of 4.2 examinations in 2010, with a total of 716 examinations being performed. The median number of exams performed on an infant was 3 and the mode was 1. The median gestation age of this group was 27.0 weeks, with the population ranging from 23.0 weeks to 33.0 weeks. The median birthweight was 976 g, and ranged from 425 g to 1696 g. 51.5% of the population was female.

There were 213 infants who received an average of 3.0 examinations in 2013, with a total of 640 examinations being performed. The median number of exams performed on an infant was 2, with a mode of 1. Their median gestation age was 27.8 weeks, ranging from 23.7 weeks - 34.3 weeks. The median birthweight was 920 g, (range 448 g to 2050 g). 58% of the population was female.

There were 224 unique infants who received an average of 3.8 examinations in 2019, with 855 examinations being performed. The median number of exams performed per infant was 3 and the mode was 2. The median gestation age of this

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group was 27.4 weeks (range 23.9 weeks - 34.9 weeks). The median birthweight was 951 g (range 484 g to 1663 g). 51% of the population was female (Figure 1).

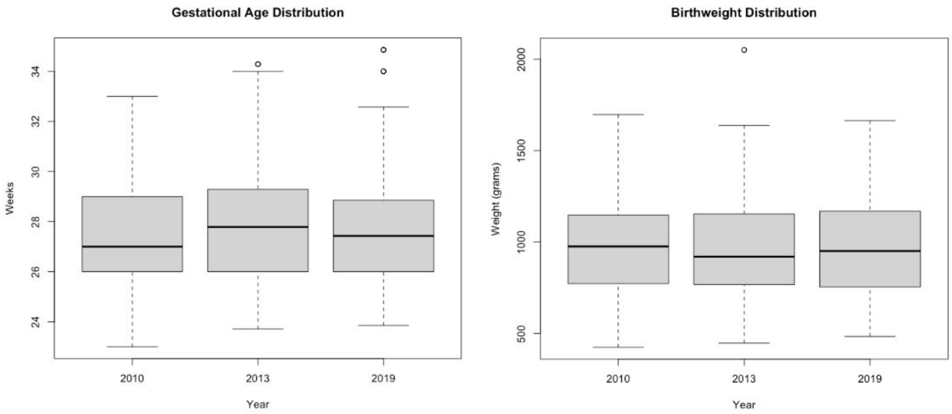

Figure 1: Demographic comparison for the 2010, 2013 and 2019 cohorts.

There was no significant difference between the three groups with respect to birthweight (p=0.99). However, there is a significant difference in the gestational ages across these three cohorts (p=0.029).

The estimated time required to interpret and document the results for WFDRI was determined to be two minutes per review, whereas the estimated time for a BIO examination and documentation was 10 minutes.

We calculated that the time per 100 examinations was reduced from 16.7 hours before to 3.7 hours after the introduction of WFDRI. Similarly, the weekly time spent on ROP screening fell from 2.3 hours per week to 0.8 and 1.0 hours per week after introduction of the nurse lead WFDRI into ophthalmologist workflow (Table 1).

	2010	2013	2019
Total Number of Infants	171	213	224
Total Number of Encounters	716	640	855
Number of BIO Examinations	716	137	181

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Number of WFDRI Examinations	0	503	674
Time per 100 Examinations (Hours)	16.7	3.7	3.7
Total Time per Year (Hours)	119.3	39.6	52.6
Total Time per Week (Hours)	2.3	0.8	1.0

Table 1: Summary of ROP Screening Workload for 2010, 2013 and 2019

4. DISCUSSION

This retrospective study shows a large reduction in ophthalmologist workload after introducing WFDRI into the ROP screening protocol. With a greater than 4-fold reduction in time spent per 100 examinations and a 2-fold reduction in absolute time each week, the benefits of having an ophthalmologist review retinal images in lieu of performing a BIO examination are clear. These findings are consistent with results from previous studies. [11, 15, 16]

There were some differences in the demographic distribution between the three cohorts studied. The 2013 cohort appears to have a higher median gestational age than in 2010 and 2019, even though the birthweight distribution between the three years are very similar. This variation in gestational age is not thought to have influenced the findings of this study although it is possible that overall, 2013 may have had fewer infants with ROP given the association between ROP severity and gestational age.

There are other components of ophthalmologist workload that are not explored in this study, such as time spent discussing results with families and other medical team members. It could be assumed that these components have not changed significantly with the introduction of WFDRI. While task-shifting of this nature significantly reduces ophthalmologist workload, it conversely increases the workload of the neonatal nurses undertaking WFDRI. The calculation of the time spent and costing changes resulting from this task-shifting was outside the scope of this study; however, there is evidence that such a change generally results in an overall cost

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decrease overall. [17-19] There is evidence that nursing staff view the increased responsibility of tasks such as taking WFDRI positively, as it provides a new pathway to advanced nursing practice. [20]

4.1 Conclusions

We have demonstrated that the introduction of WFDRI for inpatient ROP screening has significantly reduced ophthalmologist workload and reduced the overall time spent screening infants for ROP without reducing the number or frequency of examinations. This change has been sustained for at least 6 years despite an increased number of infants requiring ROP screening. We believe this may result in improved retention of the ophthalmic workforce required to undertake ROP screening.

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