Validation of an Acuity Measurement Tool for Maternity Services

Cherryl Lowe

Abstract—Background - The TrendCare Patient Dependency System is currently used by a large number of maternity Services across Australia, New Zealand and Singapore. In 2012, 2013 and 2014 validation studies were initiated in all three countries to validate the acuity tools used for women in labour, and postnatal mothers and babies. This paper will present the findings of the validation study.

Aim - The aim of this study was to; identify if the care hours provided by the TrendCare acuity system was an accurate reflection of the care required by women and babies; obtain evidence of changes required to acuity indicators and/or category timings to ensure the TrendCare acuity system remains reliable and valid across a range of maternity care models in three countries.

Method - A non-experimental action research methodology was used across maternity services in four District Health Boards in New Zealand, a large tertiary and a large secondary maternity service in Singapore and a large public maternity service in Australia. Standardised data collection forms and timing devices were used to collect midwife contact times, with women and babies included in the study. Rejection processes excluded samples when care was not completed/rationed, and contact timing forms were incomplete. The variances between actual timed midwife/mother/baby contact and the TrendCare acuity category times were identified and investigated.

Results - Thirty two (88.9%) of the 36 TrendCare acuity category timings, fell within the variance tolerance levels when compared to the actual timings recorded for midwifery care. Four (11.1%) TrendCare categories provided less minutes of care than the actual timings and exceeded the variance tolerance level. These were all night shift category timings. Nine postnatal categories were not able to be compared as the sample size for these categories was statistically insignificant. 100% of labour ward TrendCare categories matched actual timings for midwifery care, all falling within the variance tolerance levels.

The actual time provided by core midwifery staff to assist lead maternity carer (LMC) midwives in New Zealand labour wards showed a significant deviation to previous studies. The findings of the study demonstrated the need for additional time allocations in TrendCare to accommodate an increased level of assistance given to LMC midwives.

Conclusion - The results demonstrated the importance of regularly validating the TrendCare category timings with actual timings of the care hours provided. It was evident from the findings that variances to models of care and length of stay in maternity units have increased midwifery workloads on the night shift. The level of assistance provided by the core labour ward staff to the LMC midwife has increased substantially.

Outcomes - As a consequence of this study, changes were made to the night duty TrendCare maternity categories, additional acuity indicators were developed and times for assisting LMC midwives in labour ward increased. The updated TrendCare version was delivered to maternity services in 2014.

Cherryl Lowe is the CEO of Trend Care Systems Pty Ltd, Brisbane, Australia (phone: +617-3390-5399, e-mail: cherrie@trendcare.com.au).

I. INTRODUCTION

THE ultimate measure of success in healthcare is when a patient is provided with the appropriate resources, at the required moment, maximising the likelihood of the best possible patient outcome. The achievement of this 'Holy Grail' relies on good decision-making and includes decisions around how much physical capacity is provided, the type and mix of trained staff required, how much funding will be required, and how the funded resources are organised and distributed. Forecasting, budgeting and resource establishment processes must aim for a close match between the actual demand for services and the care resources provided if patient clinical outcomes and resource utilisation are to be efficiently maximised. Blegen et al. (1998, p.34 – 50) describes the measurement and control of patient acuity as the drivers of quality patient outcomes [1]. Parrinello (1987, p. 167 – 172) highlighted that nurses are responsible for providing competent care and in doing so can decrease the severity of illness and consequently decrease a patient's acuity level [2].

In maternity services, the labour component of resourcing forms a large part of the overall maternity services budget. The largest proportion of time spent with women and babies is provided by midwives in maternity services. The annual cost of provisioning a midwifery team for a moderate sized unit is millions of dollars. The cost of a single day for midwifery labour in a maternity service represents thousands of dollars of investment. Of even greater importance, the adequacy of midwifery staffing directly influences the outcomes for women and babies. Therefore, it is vital that the decisions made around the resourcing of the labour component of midwifery care are as accurate as possible.

The TrendCare Patient Dependency System is extensively utilised by the maternity services in Australia, New Zealand and Singapore hospitals that were included in this study. The validation study was conducted across these three countries in 2012, 2013 and 2014 to validate the TrendCare acuity tools used for women in labour, and postnatal mothers and babies. This paper will give a brief overview of the TrendCare System, describe the methodology of the study, present the findings of the validation study and provide an overview of changes made in response to the findings.

II. BACKGROUND AND LITERATURE REVIEW

The TrendCare system is a software solution that provides a scientific, evidence-based approach for establishing the

required level of staffing for a service. The acuity measurement tool within the system is a form of automated reasoning that is underpinned by algorithms and weighted clinical indicators that have been identified as having an impact on patient/midwife/nurse contact time and midwifery workloads.

The fundamental metrics generated by the TrendCare system for maternity services are the hours of care per patient per day (HPPD) and the hours of care per birth (HPB) in birth suite. The hours allocated to women and babies for care are divided into three 8 hour periods: morning; evening; and night, to cover the 24 hour period. The algorithms that support the HPPD and HPB calculations have been developed by timing actual care provided, direct and indirect, for a range of patient types for each of the three periods of the day. These data are obtained by undertaking contact timing studies on a large volume of women and babies in birth suites and postnatal wards.

A benchmark range has been generated for each patient type through the analysis of large samples of data from a large cross-section of maternity services. These data clearly demonstrate that the TrendCare acuity system is sensitive enough to accommodate large tertiary as well as small regional services. For example, the benchmark HPPD range for a postnatal caesarean section woman with a baby ranges from 4.3 to 5.4 HPPD. The shorter the length of stay and the higher the complexity of care, the higher the HPPD. International benchmarking studies have also demonstrated that the TrendCare acuity tool is sensitive enough to identify different staffing requirements for different models of care.

Staffing methodologies are not designed to provide a precise measure in terms of identifying the exact HPPD requirement for a particular shift. The goal is to identify a predicted range within which complete care could be expected to be delivered safely and effectively. However, if appropriate staffing is to be available on the day, it is necessary to come as close as possible to estimating the care requirements for each individual woman. Harper et al. (2007, p. 248 – 299) state, that patient classification systems and acuity tools allow managers and administrators to predict staffing needs and more accurately control nurse to patient ratios [3].

Plummer (2005) completed a four year comprehensive review of the TrendCare patient dependency/acuity system and compared its use to the nurse/patient ratio staffing methodology used in Victoria, Australia. This study included maternity services. In her conclusion, she stated:

"TrendCare can provide fairer and more equitable workloads and at a lower cost than the Victorian mandated nurse/patient ratios" [4].

Hovenga (1994) highlights the limitations of task timed methodologies where an industrial work measurement model is applied to midwifery and nursing without consideration of the complexities of the work where interventions can overlap and may be delivered simultaneously [5]. Thompson (1984, p.52) warns that task based staffing systems fail to account for indirect care, measuring only "the time to perform nursing tasks rather than the (time) devoted to the nursing process as a

whole" [6]. This view is also supported by Gault (1982) who insists that patient characteristics determine midwifery/nursing workloads [7].

The TrendCare system has not been developed using a task-based timing methodology. The timing studies are based on the total midwifery process and include the total midwifery contact time for both direct and indirect care.

A review of literature by Harper (2007) identified that a quality patient classification tool required four key concepts: the tool involves the nursing process, proves flexible and adaptable, and has creditability (reliability and validity) [3].

Hovenga (1994) concluded in her extensive literature review of patient classification systems, that factorial classification systems tend to be more reliable in terms of inter-rater reliability and that they are easily audited as all applicable indicators can be determined from patient documentation [5].

TrendCare is a factorial patient acuity classification system using clearly defined indicators of dependency. Patient characteristics and care elements are combined by automated algorithms which place patients into acuity categories, each with a specific allocation of time.

III. Purpose of This Study

1) To determine if the TrendCare patient acuity system provides a reasonable average time for maternity patient types for day, evening and night shifts.

Maternity patient types included in the study were:

- MVB – Maternity Postnatal Vaginal Delivery
- MCB – Maternity Postnatal Caesarean
- LAB – Labour
- LBA – Labour Assist to Independent Midwife

2) To identify any required adjustments to the TrendCare patient acuity system that will provide more accurate timings for maternity patient type categories across the day, evening and night shifts.

IV. Research Objectives

1) To collect the actual midwife/woman and baby contact time, direct and indirect, using digital stopwatches on the day, evening and night shifts for all women and babies included in the study.

2) To identify all midwifery activities included in the midwife/woman and baby contact timing for each patient shift in the study.

3) To compare the average actual timings for all women and babies in each category to the category timings allocated by the TrendCare acuity system.

4) To identify reasons for variances between actual timings and the TrendCare allocated times by examining the midwifery activities completed for each patient shift.

5) To confirm the level of accuracy of the category timings in the TrendCare system for each patient type.

6) To identify any areas for improvement to the TrendCare system in order to increase the accuracy of the acuity measurement in maternity patient types.

7) To provide feedback to the senior management in all participating maternity services regarding the outcome of the study.

V. HYPOTHESIS

1) The TrendCare patient dependency system provides an accurate measurement of midwifery workloads in postnatal units and labour wards.
2) The time provided by core midwives to assist lead maternity carer midwives (LMC) in the labour ward has increased in New Zealand maternity services.

VI. METHODOLOGY

A non-experimental action research methodology was used to review and evaluate maternity patient acuity category times in the TrendCare acuity measurement tool. The study was conducted across maternity services in four District Health Boards in New Zealand, a large public maternity service in Australia, a large tertiary maternity service and a secondary maternity service in Singapore. This research involved the measurement of the contact time midwives and midwifery support staff had with women, their babies and relatives in order to provide all direct and indirect care. The research sample included specific maternity patient types including: postnatal vaginal birth (mother and baby); postnatal caesarean birth (mother and baby); women in labour (including midwifery care for mother and baby pre and post birth) and; the assistance provided by core midwifery staff to lead maternity care midwives in New Zealand birth suites.

It is important to note that the timings recorded in this study by midwives and other midwifery support staff was not task-based and that the focus of the timings was on the midwifery care process as it translates to contact time. This included all aspects of care; (direct and indirect) for women, babies and their relatives.

The method used for conducting timing studies to test the accuracy of the TrendCare category timings is a modified version of the traditional timing study method. This adaption has been necessary to capture all direct and indirect midwifery and nursing care provided. This adapted methodology, using total contact timings, is unique to the TrendCare acuity system and provides a process that enables the reliable prediction and actualisation of midwifery workloads. TrendCare acuity studies are conducted across a large sample size and a wide cross-section of services with variations in models of care. A wider range of acuity indicators can be developed from these studies to provide a reasonable average for any group of patients of the same patient type. The TrendCare system now includes timings for a total of 170 uniquely defined patient types, 14 of which are maternity patient types. Individual patient characteristics are accounted for by having specific acuity indicators that collectively contribute to higher weightings for complex patients.

A. Research Instruments

Instruments used during this study included:

- Powerpoint presentation (TrendCare acuity timing study methodology)
- The TrendCare Maternity Timing Study Guide
- The TrendCare Inter-rater Reliability System
- The TrendCare Acuity System
- The TrendCare Patient Contact Timing Form
- The TrendCare Patient Contact Timing Record Form (for various locations)
- The list of TrendCare Midwifery Activity Codes
- The TrendCare Timing Study Database
- Digital stopwatches

B. Research Preparation

The following activities were completed to maximise research outcomes:

- The purpose of the study, the research objectives and the research hypothesis were developed.
- Maternity patient types to be included in the study were identified.
- The timeframe for the study was negotiated between the participating maternity Services, maternity advisory groups and Trend Care Systems.
- Training sessions were conducted for all unit/ward midwives involved in the study and practical demonstrations were conducted on site.
- Digital timers were supplied and education on their use provided.
- Hard copies and soft copies of the Maternity Timing Study Guide were supplied for distribution to all units/wards involved in the study.
- Hard copies and soft copies of the TrendCare Midwifery Activity Codes, Maternity Timing Study forms for each shift and the TrendCare Patient Contact Timing form were provided for photocopying and distribution to participating units/wards.
- Contact timing forms were colour coded for each shift to minimise documentation errors.
- All units/wards completed Inter-rater Reliability (IRR) testing on 100% of staff prior to commencing the timing study. This involved testing the accuracy of midwives in selecting the correct patient type and the correct acuity ratings for each relevant indicator when rating women and babies in TrendCare. An IRR score of >90% was required for all staff prior to the commencement of the study.

C. Process Design

- All maternity patients admitted to the study were randomly selected candidates within the specified patient types.
- A minimum of 1200 patient shifts was set for each participating service in order to meet the required total sample size for the study.
- Women and babies included in the study were flagged at the beginning of each shift and a patient contact timing form was completed for these women and babies for each shift.

- The midwife responsible for the woman and baby care was responsible for the accurate completion of the TrendCare patient contact form. Entries to the form were made throughout the shift by all staff who attended to any care requirements for the woman, baby and relatives. All midwives and other carers in the unit wore stopwatches throughout the shift to identify the time spent providing care to women, their babies and relatives. The TrendCare patient contact timing record form (used for various locations) was used to capture timings for interventions related to the mothers and babies in locations remote from the TrendCare patient contact timing form, e.g. the reception desk taking phone calls.

- Any Registered Midwife, Registered Nurse, Enrolled Nurse, or Care Assistant who spent time doing ANYTHING relating to care for a woman and baby in the study, recorded the activity code and the total contact time of an intervention. N.B: Two midwives spending 10 minutes to complete a set of actions within an intervention equates to 20 minutes of contact time. Two minutes taken to speak with relatives on the phone by a midwife, who was not allocated to care for the woman, was also recorded on the form. If a midwife had to perform a non-clinical task related to a woman included in the study, e.g. wipe blood off the floor or clean the bed after discharge, the time taken was recorded on the contact form for that woman.

- In order to identify the degree of completeness of the shift timings, additional information was required regarding patient activity. This included the number of hours a patient was present on the shift, if a patient required "one on one" care during the shift, confirmation that all care requirements were completed on the shift, and confirmation that the patient's acuity indicators were actualised within the TrendCare acuity system. The midwife responsible for the woman's and baby's care completed this additional information on the bottom section of the patient contact timing form at the end of the shift.

- All forms were collected at the end of the shift (individual patient record forms and remote location forms), checked for completeness and placed in the TrendCare timing study folder.

- When timings were completed for each woman and baby, the TrendCare Patient Episode Acuity Report, relevant to the woman's and baby's care episode was printed and attached to the recorded contact timings for each woman and baby. Patient names were not required for the study and were blacked out on all TrendCare reports/forms.

- All completed woman and baby contact timing forms and the relevant TrendCare Patient Episode Acuity Report were sent to Trend Care Systems for entry into the TrendCare timing study database.

- Confidentiality agreements related to patient data were in place for all sites involved in the study. And all patient information was de-identified.

D. Timeframe for Study

The following timeframes were set for the study:

- Two months to prepare research objectives and research tools for the four maternity patient types included in the study and for the completion of Inter-rater Reliability testing in all participating units/wards.

- One month to educate participants and distribute research tools.

- Four months to complete the timing study data collection.

- Six months for research assistants to enter the timing study data into the TrendCare timing study database, and identify questions relating to data integrity.

- One month to test data validity, finalise the rejection of samples and complete data tables for analysis.

- Four months to analyse the data, discuss research questions related to findings with participating maternity services and to complete a report on findings for each site.

- Two months to combine the research data for all participating maternity services and report on findings from an international perspective.

VII. DATA ANALYSIS

The data analysis used the following data sources for women and babies included in the study:

1) Midwife/woman and baby contact times for each patient type per category per shift.
2) Activity codes for each mother and baby contact (direct and indirect) on each shift.
3) Contact timings for each mother and baby contact (direct and indirect) on each shift.
4) TrendCare categories allocated to each mother and baby, for each shift.
5) Times attached to the patient type categories allocated to each patient shift using the TrendCare Patient Episode Acuity Report.
6) The TrendCare Daily Hours Graph for the period of the study for each participating maternity service.

VIII. FINDINGS

The original sample size for the study was 7,109 patient shifts. The total rejection rate of the original sample was 5.5%, a total of 392 patient shifts. Fifty six patient shifts were excluded because the woman received "one on one" care during part of the shift, and 326 patient shifts were excluded because the data collection form was incomplete. 231 of the rejected patient shifts were from the labour patient type co-hort. Table I displays the rejection rate for the study.

TABLE I
TOTAL SAMPLE SIZE – POSTNATAL PATIENT TYPE

Original	Rejected	Sample Used
7,109	392	6,717
100%	5.5%	94.5%

The contact times and activity codes for each direct and indirect midwifery contact with the women and babies included in the study were able to be viewed in the research

database enabling "one on one" care to be identified and rejected. "One on One" care is accommodated in the TrendCare maternity acuity tool, but was not part of this study. The data included for analysis are displayed in Table II.

TABLE II
SAMPLE INCLUDED IN THE STUDY

Timed Patient Shifts	Timed Care Contacts	Activities
6,717	41,002	102,133

The sample size for the antenatal patient types was too small across the 30 acuity categories. There are two antenatal patient types, one for inpatient antenatal and one for short stay antenatal patients (less than 4 hours). The sample collected was a mixture of both inpatient and short stay patient types.

The labour and assistance to independent midwife patient types were included as there are only 5 categories for each patient type enabling an adequate sample for most acuity categories. The total number of patient shifts for each patient type in the study is displayed in Table III.

TABLE III

Patient Types	Shifts (8hr) Timed
Postnatal Vaginal Birth	3,012
Postnatal Caesarean	2,859
Labour	292
Assistance to Independent Midwife	95
Antenatal	459

The sample distribution across the three shifts of the day is displayed in Table IV.

TABLE IV
POSTNATAL PATIENT TYPES PER SHIFT

Patient Types	Day	Evening	Night	Total
Vaginal Birth	1,115 39.4%	956 33.8%	757 26.8%	2,828 100%
Caesarean Section	1,035 35.5%	1,011 34.7%	867 29.8%	2,913 100%
Labour	114 39.1%	97 33.2%	81 27.7%	292 100%
Assist. To Indep. Midwife	39 41%	24 25.3%	32 33.7%	95 100%

The time allocated for day, evening and night shifts vary for each category in the TrendCare system.

The dispersion of postnatal patient shift samples across acuity categories when women were rated in the TrendCare acuity system is displayed in Tables V and VI.

TABLE V
CATEGORY PROFILE - VAGINAL BIRTH

Category	Day	Evening	Night	Total
1	288	228	172	688 (24.3%)
2	604	321	312	1,237 (43.8%)
3	208	386	230	824 (29.1%)
4	13	18	37	68 (2.4%)
5	2	3	6	11 (0.4%)
Total	1,115	956	757	2,828 (100%)

The raw mean of all patient shift timings and the mean within one, two and three standard deviations of the mean were calculated for each patient type. The extreme outliers in the sample were identified and excluded from the comparative analysis where actual contact times are compared to the TrendCare times within three standard deviations of the mean. See examples of the postnatal patient types in Table IX and X.

The highest number of extreme outliers excluded outside of three standard deviations from the mean was in the postnatal caesarean section patient type, with 59 patient shifts (2%) being excluded. There were only 27 (1%) of postnatal vaginal birth patient shifts excluded. No labour patient type patient shifts were excluded and only one assist to independent midwife patient shift was excluded.

TABLE VI
CATEGORY PROFILE - CAESAREAN SECTION

Category	Day	Evening	Night	Total
1	105	103	124	332 (11.4%)
2	591	444	362	1,397 (48%)
3	225	333	278	836 (28.7%)
4	104	119	94	317 (10.9%)
5	10	12	9	31 (1%)
Total	1,035	1,011	867	2,913 (100%)

The acuity category hours allocated in TrendCare for labour and assist to independent midwife patient types are the same for each shift. Tables VII and VIII show the dispersion of patient samples within each TrendCare acuity category.

TABLE VII
DISPERSION OF PATIENT SAMPLES - LABOUR

Category	Labour
1	127
2	60
3	46
4	39
5	20

TABLE VIII
DISPERSION OF PATIENT SAMPLES – ASSIST. TO INDEPENDENT MIDWIFE

Category	Assist. To Indep. Midwife
1	50
2	16
3	23
4	3
5	3

Some patient categories in the postnatal patient types did not have a big enough sample size (less than 20 patient shifts) to be included in the comparative analysis study. Excluded categories included; category 5 (day, evening and night shifts) for the postnatal caesarean section, and category 4 (day and evening shifts) and category 5 (day, evening and night shifts) for the postnatal vaginal birth patient type.

TABLE IX
POSTNATAL VAGINAL BIRTH

Category	Shift	+(3σ)	-(3σ)	W/I (3σ)	Total Shifts
1	Day	1	5	282	288
	Evn	1	3	224	228
	Night	2	2	168	172
2	Day	3	0	601	604
	Evn	2	0	319	321
	Night	2	0	310	312
3	Day	1	0	207	208
	Evn	3	0	383	386
	Night	1	0	229	230
4	Day	0	0	13	13
	Evn	0	0	18	18
	Night	1	0	36	37
5	Day	0	0	2	2
	Evn	0	0	3	3
	Night	0	0	6	6
	Totals	17	10	2,801	2,828
		0.6%	0.4%	99%	100%

Number of Patients per Category Per Shift +(3σ), -(3σ) and within (3σ)

TABLE X
POSTNATAL CAESAREAN SECTION

Category	Shift	+(3σ)	-(3σ)	W/I (3σ)	Total Shifts
1	Day	2	2	101	105
	Evn	2	1	100	103
	Night	5	2	117	124
2	Day	11	0	580	591
	Evn	5	0	439	444
	Night	11	0	351	362
3	Day	4	0	221	225
	Evn	8	0	325	333
	Night	4	0	274	278
4	Day	1	0	103	104
	Evn	0	0	119	119
	Night	0	0	94	94
5	Day	0	0	10	10
	Evn	0	0	12	12
	Night	1	0	8	9
	Totals	54	5	2,854	2,913
		1.85%	0.15%	98%	100%

Number of Patients per Category Per Shift +(3σ), -(3σ) and within (3σ)

TABLE XI
COMPARISON TABLE FOR MEAN CALCULATIONS AND TRENDCARE CATEGORY TIMINGS AND VARIANCE – VAGINAL BIRTH

Cat.	Shift	New Zealand (μ)+12.5% W/I(3σ)	Queensland (μ)+12.5% W/I(3σ)	Singapore (μ)+12.5% W/I(3σ)	(μ) Rounded up to closest multiple of 5	TrendCare (μ)+12.5% W/I(3σ)	Variance / 8 Hours	Variance / Hour
1	Day	57.654	59.03658	57.87848	60	70	+10 mins	+1.25 min/hr
	Evn	41.23676	36.14214	46.50037	45	55	+10 mins	+1.25 min/hr
	Night	26.14596	28.2642	30.22369	30	35	+5 mins	+0.6 min/hr
2	Day	108.35033	108.16323	110.2125	110	130	+20 mins	+2.5 min/hr
	Evn	88.63768	80.78594	86.99796	90	95	+5 mins	+0.6 min/hr
	Night	57.34969	55.04625	57.45952	60	55	-5 mins	-0.6 min/hr
3	Day	155.28542	152.2	152.52784	155	165	+10 mins	+1.25 min/hr
	Evn	127.01106	133.29374	121.78456	130	140	+10 mins	+1.25 min/hr
	Night	90.93975	89.21	92.0903	95	110	+15 mins	+1.8 min/hr
4	Day	186.34167	199.36875	186.00624	195	185	-10 mins	-1.25 min/hr
	Evn	166.33125	155.99999	161.25536	165	170	+5 mins	+0.6 min/hr
	Night	142.6802	155.86875	141.351	150	135	-15 mins	-1.8 min/hr
5	Day	N/A	N/A	N/A	N/A	310	N/A	N/A
	Evn	N/A	N/A	N/A	N/A	275	N/A	N/A
	Night	N/A	N/A	N/A	N/A	275	N/A	N/A

TABLE XII
COMPARISON TABLE FOR MEAN CALCULATIONS AND TRENDCARE CATEGORY TIMINGS AND VARIANCE – CAESAREAN SECTION

Cat.	Shift	New Zealand (μ)+12.5% W/I(3σ)	Queensland (μ)+12.5% W/I(3σ)	Singapore (μ)+12.5% W/I(3σ)	(μ) Rounded up to closest multiple of 5	TrendCare (μ)+12.5% W/I(3σ)	Variance / 8 Hours	Variance / Hour
1	Day	52.56771	59.87457	56.28951	60	70	+10 mins	+1.25 min/hr
	Evn	39.64936	36.57266	43.50042	40	55	+15 mins	+1.8 min/hr
	Night	25.53259	29.8399	27.40338	30	35	+5 mins	+0.6 min/hr
2	Day	113.22515	119.88234	119.7836	120	130	+ 10 mins	+1.25 min/hr
	Evn	86.45372	89.65179	87.49554	90	95	+5 mins	+0.6 min/hr
	Night	56.75764	53.39531	58.03948	60	55	-5 mins	-0.6 min/hr
3	Day	155.47406	169.79999	154.2364	160	165	+5 mins	+0.6 min/hr
	Evn	125.2225	125.21625	130.19375	130	140	+10 mins	+1.25 min/hr
	Night	95.605	93.82812	94.03443	95	110	+15 mins	+1.8 min/hr
4	Day	192.65966	203.7375	197.02688	200	185	-15 mins	-1.8 min/hr
	Evn	172.09687	174.19124	170.16923	175	170	- 5mins	-0.6 min/hr
	Night	141.18749	142.22187	141.84896	145	135	- 10 mins	-1.25 min/hr
5	Day	267.09141	254.45625	256.37813	260	310	N/A*	
	Evn	281.15626	N/A	253.5509	270	275	N/A*	
	Night	239.91136	254.56875	215.67589	240	275	N/A*	

The first draft of the collated Tables I-XII was circulated and discussed with the midwifery team for each service that participated in the study. This was to identify that the acuity profiles reflected in the data were congruent with what midwives had experienced during the two months of the study. No data adjustments were made following these discussions; however, trends identified in the data were clarified.

Points of discussion included;

1) A significant positive variance between the TrendCare category hours for the lower acuity postnatal patient types. It was identified that independent women in these low TrendCare categories actually received less than the expected contact time with midwives. This was discussed with all midwifery teams and most acknowledged that

customer surveys also reflected this phenomenon. Midwives confirmed that when they are busy they do not have enough time to follow up on the independent women. However, when the TrendCare Daily Worked Hours Graphs were reviewed for the study period, there was very little difference in contact time for independent women for shifts where midwives were understaffed and shifts where sufficient staff was provided.

2) The increased demand for care on the night shift was reflected in both postnatal patient types. All maternity services confirmed that their postnatal length of stay had decreased substantially and that there was a much greater demand for breastfeeding assistance on the night shift. All services included in the study had the baby rooming in with the woman.

Midwives confirmed that all direct contacts were entered on the forms. However, some indirect contacts may have been omitted.

The TrendCare postnatal and labour ward category timings were developed using the mean within three standard deviations plus an additional allowance of 12.5% to accommodate paid tea breaks (4%), general work interference (2%) and a buffer of 6.5% for unpredictable work. To compare the patient type shift contact times with the times allocated by the TrendCare categories, a value of 12.5% has been added to the mean within three standard deviations. The comparison Tables XI and XI) show the variance between timed contacts and the time allocated for the TrendCare acuity categories.

TABLE XIII
COMPARISON TABLE FOR MEAN CALCULATIONS AND TRENDCARE CATEGORY TIMINGS AND VARIANCE – LABOUR

Cat.	Shift	(μ) + 12.5% W/I (σ)	(μ) + 12.5% W/I (2σ)	(μ) + 12.5% W/I (3σ)	(μ) Rounded up to closest multiple of 5	TrendCare (μ)+12.5% W/I(3σ)	Variance / 8 Hours	Variance / Hour
1	Day	127.73487	120.74699	117.2113	125	120	-5 mins	-0.6 min/hr
	Evn	103.50225	101.47449	102.81354	105	120	+15 mins	+1.8 min/hr
	Night	105.77969	110.12557	103.60585	110	120	+10 mins	+1.25 min/hr
2	Day	199.25781	197.90437	196.87604	200	210	+10 mins	+1.25 min/hr
	Evn	198.08352	200.87187	199.10156	200	210	+10 mins	+1.25 min/hr
	Night	192.4825	193.6875	192.37219	195	210	+15 mins	+1.8 min/hr
3	Day	261.23863	263.62812	264.23705	265	270	+5 mins	+0.6 min/hr
	Evn	258.14999	258.54049	259.4272	260	270	+ 10mins	+1.25 min/hr
	Night	271.74375	271.02138	268.28281	275	270	-5 mins	-0.6 min/hr
4	Day	366.39751	356.40313	343.07501	360	360	+ 0 mins	+0 min/hr
	Evn	332.67422	336.97749	335.59772	340	360	+20 mins	+2.5 min/hr
	Night	335.58938	338.51719	335.23333	340	360	+20 mins	+2.5 min/hr
5	Day	N/A	N/A	N/A		480		
	Evn	N/A	N/A	N/A		480		
	Night	N/A	N/A	N/A		480		

A tolerance level of +/-2 minutes/hour was set for each day and evening shift and +2 minutes/hour for the night duty for postnatal patient types. There is no negative tolerance for the night shift to account for the inevitable downtime in postnatal wards.

The analysis indicated that the acuity category timings for two night shift categories required an increase for both postnatal patient types.

A review of the labour ward data revealed that all categories provided adequate hours and all raw contact timings +12.5% fell within the variance tolerance level of +/-3 minutes/hour (a higher tolerance level was selected for the labour ward patient type as the midwifery intensity for labour ward is approximately 60% higher than the midwifery intensity for postnatal units). Labour ward contact times compared to TrendCare category times are displayed in Table XIII.

An analysis of the data collected for the labour assist to independent midwife patient type, showed that the amount of time core midwives in labour ward spend assisting LMC midwives (Lead Maternity Carer Midwives) has increased substantially since the last timing study in 2009. The minimum time for assistance to LMC midwives has increased from 20 to 30 minutes and the maximum time has increased from 3 to 6 hours. See Comparison Table XIV.

TABLE XIV
COMPARISON TABLE FOR LABOUR ASSIST TO INDEPENDENT MIDWIFE

	Minimum (Mins)	Maximum (Mins)
TrendCare Range	20	180
Contact Timings	30	360

A review of the profile of activities on the timing study forms identified the need to change some existing acuity indicators and to include some new indicators into the postnatal and labour ward patient types. Changes to postnatal patient type acuity indicators included; the addition of a new indicator "baby procedures" and the change of one existing indicator "bottle/tube feeding" into two separate indicators, "bottle feeding" and "tube feeding". This was to accommodate babies having photo therapy and babies that had both methods of feeding on one shift.

Changes to labour ward acuity indicators included; "admission assessments" and "foetal loss" to identify the higher midwifery intensity required by women admitted directly to the labour ward, and the high midwifery intensity required when there is a foetal loss.

IX. DISCUSSION

The study hypothesised that the TrendCare hours provided for maternity postnatal and labour patient type shift categories

provide an accurate measurement of midwifery workloads. The findings from this study largely confirmed this hypothesis. The variance between actual timed contacts for each shift, and the TrendCare category times for each shift fell within the pre-set tolerance range for 32 of the 36 TrendCare categories compared in the study. Nine TrendCare categories were unable to be compared due to the sample sizes being statistically insignificant. Two night duty categories for postnatal patient types, maternity postnatal vaginal birth and maternity postnatal caesarean, fell outside the tolerance level giving a negative variance. The need to increase the time for two night duty categories for both postnatal patient types was identified. The study also confirmed the hypothesis that the care provided by core midwives to assist LMC midwives in the labour ward has increased. This has resulted in an increase of the category timings for the labour assist to independent midwife patient type.

The results of this research study confirmed that it is necessary to repeat timing studies on a regular basis to capture workload requirement changes driven by factors such as changes in models of care, care delivery or length of stay.

X. RECOMMENDATIONS

Recommendations resulting from this study were;
1) That four night shift categories in the TrendCare acuity tool for postnatal patient types be increased to meet the new time requirements identified in this study.
2) That the time selections in the assist to independent midwife patient type be increased in TrendCare to a minimum of 30 minutes and a maximum of 6 hours.
3) That the new acuity indicators required for postnatal and labour patient types be added into the next TrendCare upgrade.
4) That the model of care currently being delivered to independent postnatal women, patients in low acuity categories, be reviewed in all maternity services that participated in the study to ensure that these women have adequate contact time with midwives.

XI. CONCLUSION

The ability to make accurate estimations of the care requirement is fundamental to effective resource planning for Maternity services. Making accurate staffing determinations is neither a simple nor static process. Automated reasoning systems such as TrendCare are obligated to ensure that the data underpinning the algorithms and acuity indicators are sufficiently rigorous to provide confidence to the midwives using the system.

Over time, patient demographics change, clinical advances are made, and patterns of care evolve. It is important that category timings are regularly retested for all patient dependency systems so that changes in midwifery workloads resulting from changing demographics and evolving clinical practice can be identified and accommodated.

Without these data and subsequent system adjustments, the staffing resource would become increasingly desynchronised with the service demand, leading to either impaired productivity or capacity deficits that expose patients to the risk of harm and sub-optimal outcomes. This validation study undertaken by Trend Care Systems for maternity services across three countries reinforces the value of using rigorous validation methodologies and provides confidence to users of the system when they are making resource decisions.

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Cherryl J. Lowe became an Associate Fellow of the Australasian College of Health Service Management in 2010. Cherryl became an Honorary Lecturer and Associate of Monash University for the Faculty of Nursing, Victoria in 2008 and is about to commence her Doctorate through Monash University making use of the extensive research undertaken for the development of the TrendCare acuity system. Cherryl completed a Diploma in Teaching (Nursing) from Armidale College of Advanced Education in 1987 and a Graduate Diploma in Nursing Studies Administration from the University of New England in 1990. Cherryl is a Registered Nurse and Registered Midwife with the Nursing and Midwifery Board of Australia.

She is the Co-owner and Director of Trend Care Systems Pty Ltd est. 1994 in Brisbane, Australia and the Owner and Director of Lowes Health Trend Consulting. She is a Senior Quality Surveyor for the Australian Council on Healthcare Standards. She is an experienced health service manager, her last position in that role was as Director of Clinical Services at Greenslopes Private Hospital, Brisbane from 1994 to 2000, during which time she was able to demonstrate the value of using the TrendCare system, a valid and reliable patient nurse acuity system. She has presented over 65 papers for Australian and International nursing bodies, Government agencies, private and public hospitals.

Mrs Lowe has published Chapter 16 – Rostering in: Crowther (Ed) Nurse Managers – A Guide to Practice, Ausmed Publications Melbourne 2nd Edition, 2007. This was first published in 2003. Mrs Lowe is a member of the Australian Information Industry Association, Health Informatics Society of Australia, New Zealand Health I.T. Cluster, Queensland Leaders, and the Australian College of Nursing.

Mrs Lowe has received many awards including; Royal College of Nursing – Distinguished Nursing Service Award, Freehills Breakthrough Award from the Australian Chamber of Commerce, Singapore. Three awards from the Australian Information Industry Association; Queensland State iAward for e-Health, National iAward for e-Health, and ICT Exporter of the Year. One Award from the Asia Pacific ICT Awards – a Merit Award. One Award from the Australian Computer Society for Service, Delivery and Training.