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Research Article

A Comparison of Self-evaluated Survey and Work Sampling Approach for Estimating Patient-care Unit Cost Multiplier in Genetic Nursing Activities

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S U M M A R Y

Purpose: To compare patient care multipliers estimated from subjective evaluation against work sampling (WS) techniques in genetic nursing activities.
Methods: An observational WS technique was conducted from November to December 2019 with nine genetic nurses in a tertiary referral center in Malaysia. The WS activity instrument was devised, validated, and pilot tested. All care- and non-care-related activities were sampled at 10-minute intervals within 8 hours of working over 14 days, followed by a subjective evaluation of activities survey over the same period. Bonferroni correction was undertaken for multiple testing with a *p value* of 0.0025.
Results: The two techniques produced significant differences in genetic nurses' activities categorization. The WS showed that compared with subjective evaluation, direct care (19.3% vs. 45.0%; $p < .001$) was estimated to be significantly lower, and indirect care (40.4% vs. 25.6%; $p < .001$) and unit-related care (28.5% vs. 16.9%; $p < .001$) were higher. Both techniques produced a similar proportion of time spent in other non-7care activities (12.0%) but differed in genetic meetings and information-gathering activities. While the multipliers for patient face-to-face contact were significantly larger between WS (4.57) and the survey (1.94), the multipliers for patient care time were smaller between WS (1.47) and the survey (1.24), indicating that caution should be taken when multiplying for patient contact time compared to patient care activity to determine the cost of care provision.
Conclusion: A considerable proportion of time spent away from the patient needs to be allocated to patient-related care time. Thus, estimating the paid cost solely based on direct time with patients considerably underestimates the cost per hour of nurses' care. It is recommended to employ 'patient-related activity' instead of the 'face-to-face contact' multiplier because the former did not significantly differ from the one estimated using WS.

Introduction

Rare disease (RD) is a debilitating hereditary disease that affects only a small fraction of the population and is extremely difficult to treat. There are between 7000 and 8000 RDs worldwide. Approximately 80% of them are genetic disorders affecting young children, and the remainders are rare cancers, autoimmune diseases, congenital malformations, and the rare manifestation of common diseases. Unfortunately, due to a lack of attention from health care providers (HCPs), health system leaders, and health policy-makers, these patients are at a risk of missing life-saving treatment. The issue stems from gaps in disease knowledge among HCPs, diagnostic difficulties, and high treatment costs [1]. In Malaysia, patients with RD are managed by a tertiary referral genetic unit. Geneticists, paediatricians, genetic counsellors, and nurses are the front-line providers of medical genetics services in the country [2].

Nurses remain the largest group of personnel resources employed by the Ministry of Health in the labor force [3]. In today's economic climate, HCPs, including nurses, must constantly perform at the highest level by re-evaluating their quality of care. As a result, there is considerable interest in measuring nurses'

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activities and/or workload via a professional judgement or subjective evaluation [4], clinical work indicators (or productivity data) [5], and time and motion study (TMS) [6,7], for instance, in intensive care units (ICUs) [8–10], emergency departments (Eds) [11], medical wards and surgical wards [12], ambulatory care [13], general wards [14], and community nurses [15]. In recent years, outpatient genetic care has played a significant role in medical genetic management [1]. However, there have been no works published thus far to the best of the author's knowledge about the work activity of genetic nurses in comparison to geneticists [16] and genetic counsellors [17,18]. Thus, there is an obvious need to comprehend and disseminate information regarding their progressive role as the patient's primary point of contact in this largely unexplored area of RD.

Patient care is a time-consuming [18,19] and complex activity [10,16] because of the lengthy process and skill mix [20] that nurses engage in while performing clinical activities, patient-related tasks, administrative work, communication, and personal tasks. Generally, these multitasking activities are categorized as either direct or indirect patient care activities, depending on whether they are performed in front of or away from the patient [8,21,22]. There are significant disparities in the proportion of time spent by nurses on direct and indirect care activities that have been reported in other areas of practice [11]. In addition, previous studies over the last decade have demonstrated that the workload and the interplay between direct and indirect patient-related activity significantly impact the quality-of-care delivery [10,16,23]. Thus, estimating direct contact time alone will underestimate the time required to provide care.

Cost and cost-effectiveness (CE) intervention is designed to achieve the maximum possible health care delivery through the optimum use of limited resources. However, despite the wealth of literature available in this field [24,25], there is a dearth of discussion of how ‘hidden’ or indirect patient-related activities should be handled and how they ultimately affect costs. The cost of care accounts for a sizeable amount of HCPs' time. Previously, the problem was addressed with the hidden-to-observed cost ratio [26] or ‘overhead’ associated with patient care delivery [23]. While a recent study [27] focuses more on cost-effective care, less attention is placed on how to account for this overhead that was needed for the provision of care-related activity [10]. In addition, the CE guidelines indicate that all costs that are likely to be impacted by intervention should be included in the analysis [28]. Thus, this study extends and generalizes the concept of an adjustment factor or multiplier (e.g., the ratio of direct to indirect time spent on care activity) as a metric to allow for the higher costs associated with providing patient-related care activity than the direct care cost [23,26].

The multiplier is typically approximated via time diaries, sheet surveys, focus groups, and verbal reports [23,29,30], or by explicitly requesting the percentage (or minutes) of time spent in the actual practice from the HCP [31]. The given estimate is then converted to a ratio of direct to indirect time spent with patients or performing patient-related activities. When calculating the total time required to deliver patient care, the ratio's components are added together and multiplied by the total direct contact time and unit cost component. This time allocation more accurately reflects actual care activities, resulting in a more equitable valuation of the resources required to hire an HCP. These approaches have become the incumbent method for obtaining information on the proportion of direct and indirect time spent on different locations (e.g., patient, clinic) or activities due to practical and cost reasons. This is the approach employed by the Personal Social Services Research Unit (PSSRU) [32] to reflect current care practices in their health and social care services unit cost estimates.

In contrast, other work pattern estimation methods exist, such as the gold-standard TMS [14], activity log [33], video recording [15], and work sampling (WS) [34], which have been used in health care service research. For instance, WS is widely used as an experimental and practical technique for measuring work in nursing and non-nursing research [33,35]. However, it was not used to estimate the multiplier because it required more time and effort than the previous methods. Compared to TMS, WS measures activity frequencies that can easily be proportioned to determine the percentage of total time spent and the ratio of direct to indirect time [36]. Moreover, WS is less prone to personal and recall bias than the typical methods, e.g., focus groups, surveys, and verbal reports, which rely heavily on subjective judgement. The WS method not only provides an estimate of the amount of time spent in each activity but also accounts for actual work patterns in circumscribed working areas [15,20]. Nonetheless, the direct observational technique may introduce other instances of bias, known as the Hawthorne effect [34,36]. To our knowledge, no prior studies have explicitly compared the generation of multipliers for nurses' paid care hours unit cost between WS and the survey.

Therefore, it is imperative to investigate nursing care time allocation, as the provision of medical genetics management has shifted dramatically over the past two decades. Clearly, additional evidence is required for the conference, continuous medical education, and general administrative tasks that we assumed to be overheads on patient activity to accurately reflect the actual cost of care provision [37].

The purpose of this study was to compare the proportions of time spent on each activity in the total activity using two methods: WS and the survey. The following goals are of interest: (1) estimate the percentage of time required for patient-related care activities; (2) calculate the multipliers for future EE's human resource cost Q1 estimations in RDs.

Methods

Study design

The study was conducted in two stages. First, an observational WS technique was used to describe the work activities of genetic nurses for two weeks within an eight-hour working period, immediately followed by a subjective evaluation of activities over two weeks. Nurses were unaware that the subjective evaluation technique would subsequently be employed.

Setting and participants

The observations were taken at a tertiary referral genetic centre at a government hospital in Malaysia between November and December 2019. The centre is overseen by a head nurse and 11 registered nurses who work during office hours (from 8.00 PM to 5.00 PM). The centre provides care to approximately 735 patients with RD and receives approximately 300 new referrals monthly. A total of nine registered nurses were recruited. The nurses were purposively sampled with job scopes focusing on patient care rather than managerial roles.

Sample size and power

The study was designed to capture the least often occurring activity for indirect care activity (ICA) in obtaining a representative number of observations needed to allow for acceptable statistical inferences to be made in line with earlier studies [19,34]. The following formulas are used to determine the minimum: (1) sample size, e.g., $N = z^2P(1 - P)/d^2$ [38]; (2) sampling period, e.g., $T = \tau/$

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480.p.ηʃ [39]. First, the preliminary sample estimates are obtained from the trial runs. Then, the minimum number of observations for each activity category is determined (Table 1). For instance, ICA was expected to occur 43% of the time, and the minimum number of observations needed was 600, so we have 95% confidence that the activity is within the ±5% level of accuracy (i.e., the minimum acceptable error, *d*, was set to 0.04 as presented in Table 1). To determine the sample period, we have τ = time interval between observations (10 minutes), p = minimum probability of occurrence for an activity (0.001), ηʃ = number of nurses per shift, and 480 = 8 h × 60 minutes; hence, the minimum sample period corresponded to 11 days. With observations every 10 minutes, the maximum working time is 8 hours per day, and the number of nurses who can be observed simultaneously is 2; the daily data points required are 28 (e.g., 600 observations ÷ 11 days ÷ 2 nurses).

Instruments and validation

A literature review identifies the list of potential nurses' activities attributable to care delivery. Then, interviews with practising nurses and leaders were conducted to elicit the normal work activities. These lists were contrasted and grouped. Then, a single list of activities was discussed for inclusion or exclusion from the final WS instrument. We adopted a categorization of work activity from the established sources [19,21,22,33,39]: (1) direct care activity, DCA (e.g., care activity requires patient's interaction or is performed directly with patient and family); (2) indirect care activity, ICA (e.g., care activity that is performed from a distance of patient and family but benefitting them); (3) unit-related activity, URA (non-care activity pertaining to the normal maintenance of the unit and its organization); (4) personal activity, PA (including rest periods and personal requirements unrelated to the professional task). Alternatively, we classified PA, idle time, and breaks as 'other' activities (OA).

Additionally, the activity descriptions are developed and refined during the testing period by the author. Next, the author and nurse manager validated the instrument's content by standardizing the terminology and comparing the listed activities to local clinical practices [33]. This process informed the refinement of techniques and methods for the trial runs. The runs help the author become familiar with the criteria and activity descriptions that will be used to identify the dominant activity occurring concurrently during the observations [33]. The emphasis was to document what had taken place and not to define which activity had the greater priority. Following this procedure, the final data collection form organized 26 nurse activities (Figure 1) that were mutually exclusive, defined, and precoded into four categories of work: DCA, ICA, URA, and OA. The list of work activity descriptions with inclusion and exclusion criteria is available from the corresponding author upon request.

Procedure

A pilot WS study was initially undertaken with seven nurses for three working days at random. The trial runs and study observations were made from 8.00 AM to 4.30 pm and from 8.00 am to 5.00 pm, respectively, at 10-min fixed intervals by the first author. The interval set time was considered less demanding than the randomly distributed time sampling and a standard method in health services research [34]. In addition, it allows the sample to be randomized adequately since the nature of the health care activity follows some to no patterns [40]. The pilot study provided an opportunity to test the data tool and gain insight into the following observation techniques. The observer moved to an exact spot from eight observation locations at random and positioned within earshot of the nurses prior to observing the activity while remaining as unobtrusive as possible. Then, two observations were made at each time interval instantaneously. The observed activities were logged on a tabular data collection form using a unique numbering assigned to each task adopted from a previous study [33]. The observer documented all unforeseeable events that occurred during the period.

Following that, the same author provided the nurses with similar activity descriptions and forms to evaluate and reflect on over the same period. Then, they were required to give estimates on the amount of time they spent on the specific activities and rate their confidence for those estimates via a survey form.

Table 1 *Activity categories' frequency and sampling required.*

	% Category (no of observations)			
	DCA	ICA	URA	OA
Preliminary trial 1	14.5 (17)	47.0 (55)	28.2 (33)	10.3 (12)
Preliminary trial 2	17.5 (32)	38.8 (71)	21.3 (39)	22.4 (41)
Estimated proportion	16.0 (25)	42.9 (63)	24.8 (36)	16.3 (27)
Minimum observations needed, n	350	600	400	350
Limit of error	0.04	0.04	0.04	0.04

Note. n = number of data points; DCA = direct care activity; ICA = indirect care activity; URA = unit-related activity; OA = 'others' activity.

Data analysis

First, data from WS were aggregated by individual activity and grouped into categories. Then, the descriptive statistics were used to compute the average proportion of time for each activity and category. All values are reported as the mean and standard error of the mean. Second, the summarized data are contrasted with the estimates we obtained from the survey. The survey data are presented as the mean and standard deviation (SD) of the mean. The Bonferroni correction was undertaken for multiple testing and adopted a *p value* of 0.0028 for the significance test [41]. Finally, the multiplier for the respective unit cost is calculated following the published method [23,32]. All data were entered into Microsoft Excel 2013 (Microsoft Corporation, Redmond, Wa) and then transferred electronically to R version 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria) for data wrangling and statistical analyses.

Ethical considerations

Ethical approval was granted by the Medical and Research Ethics Committee of the Ministry of Health, Malaysia (NMRR-19-610-46077). This study poses no risk to patients and nurses, and the observations did not disrupt the patient's visit or nurse's routine care. The participants volunteered to participate in the study.

Results

Demographic characteristics

The participants' age ranged from 28 to 35 years, with a median age of approximately 30 years [IQR = 3.51]. The majority were female (77.8%, n = 7), and most had obtained a 3-year diploma in nursing and were staff nurses (75.5%, n = 6). In addition, the vast majority (75.5%, n = 6) had between 5 and 10 years of clinical experience. The nurses qualified as nurses as early as 2001 (the latest in 2016).

Work sampling

A total of 2,333 observations were recorded (including 300 trial run observations). The minimum daily observations required were

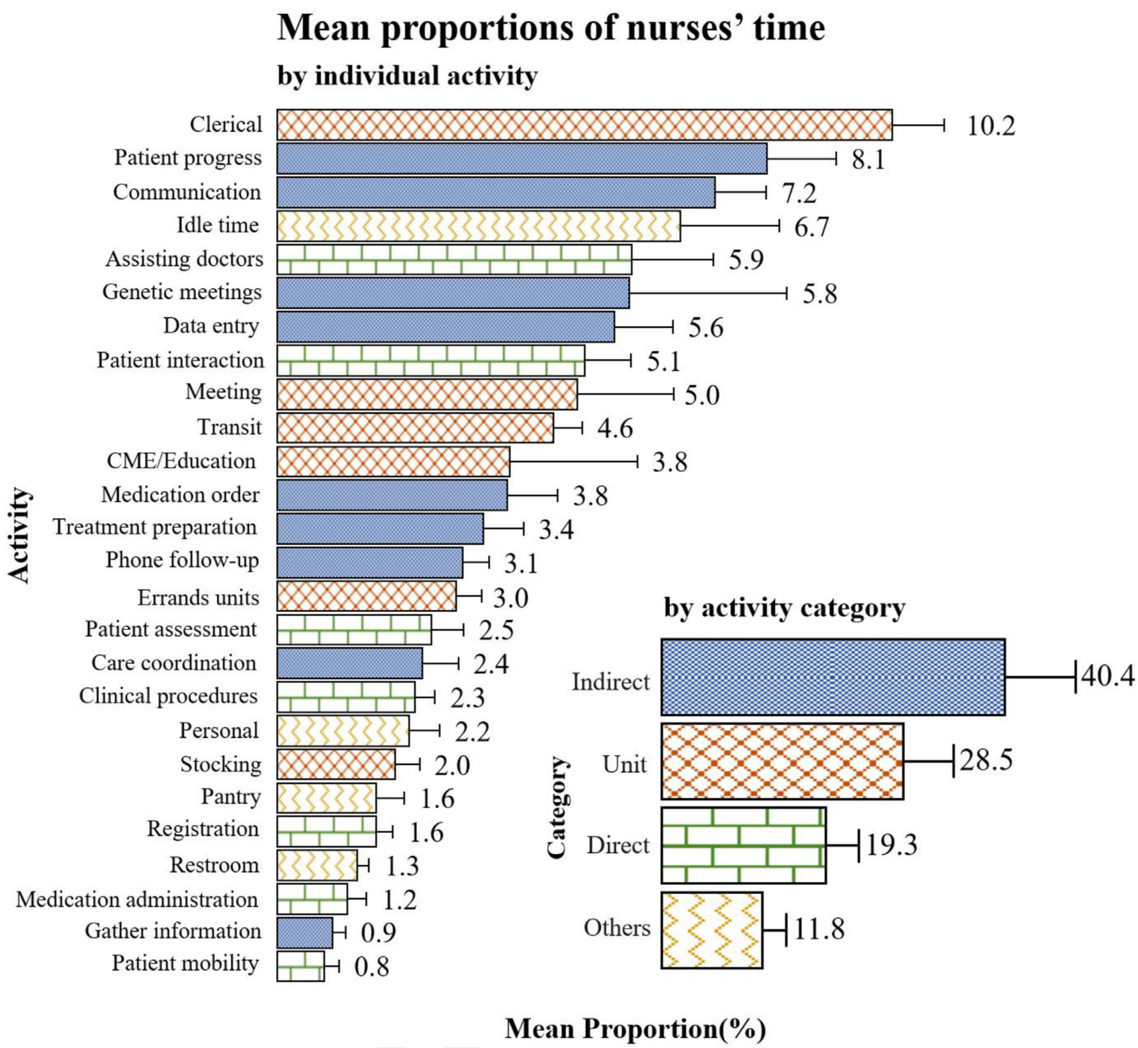

Figure 1. Genetic nurse activities and their categorization identified from the study. *Note.* CME = continuous medical education. The normal activities of genetic nurses obtained from the work sampling. The insert shows the mean proportions for the category. The error bar represents the standard error.

not achieved at three periods for category OA due to one nurse being on emergency leave and meeting the week after. No significant changes to the WS instrument were made except for one activity, i.e., 'hygiene/cleaning' was excluded from the finalized instrument because it was not observed during trials. There are 26 types of activity descriptions that have been identified; of these, the 7, 9, 6, and 4 activities are categorized into DCA, ICA, URA, and OA, respectively (see Table 2 for list of activities).

Nurses in our study spent 19.3% of their clinical operational time on direct patient contact performing DCA. Most of the activities were spent away from the patient (80.7%); 40.4% were on ICA, 28.5% on URA, and 11.8% on OA. Together, DCA (19.3%) and ICA (40.4%) equate to 59.7% of patient-related care activities. On the other hand, time spent on non-patient care activities accounted for 40.3% of the activities, with 28.5% and 11.8% on URA and OA, respectively. The complete time distribution of the activities is presented in Table 2 below.

Overall category analysis indicates that nurses spend the most time on ICA (40.4%), followed by URA (28.5%), DCA (19.3%), and OA (11.8%) (see insert in Figure 1). The three activities for ICA with the most significant frequency were 'daily patient progress documentation' (19.2%), 'professional communication' (18.0%), and 'attending genetic meetings' (16.6%). These three combined equal 53.8% of ICA (508 observations). In the URA category, 'clerical work' dominated with 36.1%, followed by 'patient transit' and 'education' at 16.1% and 16.0%, respectively. These three combined equal 68.2% of URA (448 observations). In the DCA category, the three activities with the highest frequency of observed activities were 'assisting the doctor during review' (31.1%), 'patient/family interaction' (26.5%), and 'patient assessment' (12.8%). These combined activities equal 70.4% of DCA (319 activities). Conversely, in OA, nurses spend more than half of the time in 'idling' (56.8%) activity alone, more than in 'personal' (18.2%) and 'pantry' (14.3%) combined. These three combined equal almost 90.0% of OA (251 observations) (see Table 2).

Overall activity analysis shows that nurses spend most of their time on 'clerical work' (10.2%), 'patient progress documentation' (8.1%), 'professional communication' (7.3%), 'idle time' (6.7%), 'assisting doctor during review' (5.9%), and 'genetic meetings' (5.8%). In contrast, the lowest proportion of time was spent on 'mobilizing patient' (0.8%), 'gathering information' (0.9%), 'medication administration' (1.2%), and 'using the restroom' (1.3%). From Table 2, we can see that, although 'education,' 'administrative meetings,' 'genetic meetings,' and 'mobilization of patient' activities were not observable (higher number of zero observations) daily, the activities had a significant impact on the overall

Table 2 *Genetic nurses' time distribution during clinical operation hours.*

Category, by activity	Obs, n	'0' obs, n (Total %)	%[a] (SE)[b] Total	By Activity	By Category	Max %
Direct care	**453**	**(14.3)**	**19.3 (3.8)**	—	—	—
Assisting Dr	141	1	—	5.9 (1.3)	31.1 (0.5)	14.3
Pt. interaction	120	0	—	5.1 (0.8)	26.5 (0.3)	10.8
Pt. assessment	58	1	—	2.6 (0.5)	12.8 (0.2)	7.4
Clinical procedures	54	1	—	2.3 (0.3)	12.0 (0.2)	4.3
Registration	38	2	—	1.6 (0.3)	8.4 (0.1)	4.0
Meds. admin	25	3	—	1.2 (0.3)	5.5 (0.1)	3.2
Pt. mobility	17	6	—	0.8 (0.2)	3.8 (0.1)	3.2
Indirect care	**944**	**(15.1)**	**40.4 (8.3)**	—	—	—
Pt. progress	181	0	—	8.1 (1.1)	19.2 (0.2)	15.1
Communication	170	0	—	7.3 (0.9)	18.0 (0.2)	11.6
Genetic meetings	157	8	—	5.8 (2.6)	16.6 (0.6)	31.3
Data entry	123	0	—	5.6 (0.9)	13.0 (0.2)	13.5
Meds. order	88	3	—	3.8 (0.8)	9.3 (0.1)	8.4
Treat. preparation	86	1	—	3.4 (0.7)	9.1 (0.2)	7.3
Phone follow-up	70	2	—	3.1 (0.4)	7.4 (0.1)	6.0
Care coordination	49	2	—	2.4 (0.6)	5.2 (0.1)	6.4
Gather information	20	3	—	0.9 (0.2)	2.1 (0.0)	2.6
Unit-related	**656**	**(22.6)**	**28.5 (5.9)**	—	—	—
Clerical	237	0	—	10.2 (0.9)	36.1 (0.3)	16.8
Meeting	98	6	—	5.0 (1.6)	14.9 (0.4)	19.1
Transit	106	0	—	4.6 (0.5)	16.1 (0.1)	7.7
Education	105	10	—	3.8 (2.1)	16.0 (0.7)	26.2
Errands units	67	0	—	3.0 (0.4)	10.2 (0.1)	7.1
Stocking	43	3	—	2.0 (0.4)	6.6 (0.1)	4.4
Others	**280**	**(10.7)**	**11.8 (2.8)**	—	—	—
Idle time	159	0	—	6.7 (1.6)	56.8 (1.1)	18.5
Personal	51	2	—	2.2 (0.5)	18.2 (0.3)	5.7
Pantry	40	3	—	1.6 (0.5)	14.3 (0.3)	5.4
Restroom	30	1	—	1.3 (0.2)	10.7 (0.1)	2.6

Note. '0' = zero; Admin. = administration; Dr = doctor; Max = maximum; Meds. = medication; n = number of data points; Obs. = observations; Pt. = patient; Treat. = treatment.
[a] Percentage of weighted proportion.
[b] Standard error of percentage

proportion of the time spent. Collectively, URA (22.6%) had the highest percentage of zero observations, followed by ICA (15.1%), DCA (14.3%), and OA (10.7%).

Subjective evaluation

The nurses had estimated that they spent 45.0% of their time on DCA [SD = 14.4], 25.6% (SD = 8.21) on ICA, 16.8% (SD = 5.94) on URA, and 12.5% (SD = 7.07) on OA. The nurses were 67% (SD = 13.35) confident with their estimates (on a 0–100 scale). Regarding specific care activities, the nurses approximated a minimum of 30–60 minutes and a maximum of 60–90 minutes weekly for 'gathering information.' In contrast, 'genetic meetings' had twice that weekly time spent, ranging from 60 to 120 minutes to a maximum of 120 to 210 minutes. We divided these activity estimates (minutes per week) by the total minutes per week (2,400 minutes) to obtain the expected proportion of time for the survey method (see Table 3). The chi-square tests showed that the given estimates differed significantly from the WS data for DCA, ICA, and URA, with $p < .001$ except for OA, for which $p = .578$ indicated no significance. Additionally, the two techniques showed no significant difference in the proportion of time spent on 'genetic meetings' (5.8% vs. 7.3%, $p = .578$), whereas 'gathering information' was significant (0.9% vs. 3.4%, $p < .001$).

Multiplier

We have identified that the 'others' activity can be removed from the proportion of time used for patient care. Therefore, this overhead should not be included in the ratio and multiplier. Our results can be interpreted likewise (Table 4). Since we have a complete breakdown of time use, time spent on OA is classified outside of these care and non-care activities that did not generate outputs to the patient care delivery. The procedure for estimating multipliers to allocate time is illustrated using the three steps below [23].

Step 1. To calculate loading, we require a multiple of patient care-providing hours that reflect the relationship between care (C) and non-care (NC) activities and the total number of hours worked (T). The basic equation for this multiple (q) is represented as follows:

$$T = qC$$

$$T = C + NC$$

Table 4 shows the breakdown of time spent delivering patient care at 59.7%. The proportion of time is:

$$C = 0.597$$

$$T = 1.0$$

Thus, $NC = 0.403$

Step 2. The multiplier, q, is then calculated as follows:

$$1 = 0.597 + 0.403$$

$$1 = q0.597$$

$$q = \frac{1}{0.597}$$

Table 3 *Comparison frequency of activities derived from work sampling and subjective evaluation.*

Category/activity	Observed (%) WS	Expected (%) SEV	d.f.	χ^2	p	Modified Bonferroni adjusted alpha	Adjusted significance
Direct	453 (19.3)	1,049 (45.0)	1	616.94	<.001***	<.001 ***	No
Indirect	944 (40.4)	596 (25.6)	1	594.55	<.001***	<.001 ***	No
Genetic meetings	157 (5.8)	170 (7.3)	1	1.12	.289	.578	No
Gather information	20 (0.9)	79 (3.4)	1	45.92	<.001***	<.001 ***	No
Unit	656 (28.5)	394 (16.9)	1	209.06	<.001***	<.001 ***	No
Others	280 (11.8)	291 (12.5)	1	0.53	.467	.578	No

Note. SEV = subjective evaluation; WS = work sampling; d.f. = degree of freedom; ***p < .001.

Step 3. However, we identified the need to include the information above to ensure that OA is not allocated to patient care delivery. To calculate the time spent on patient care, we must subtract the time spent on 'others': 'n 'others':

$$qC = T - OA$$

$$q = \frac{T - OA}{C} = \frac{0.882}{0.597}$$

$$= 1.47$$

Therefore, when estimating the cost per hour of a nurse in the genetic clinic, cost = 1.47 × 'cost per hour.' In comparison, the multiplier calculated from the survey data was 1.24. Similarly, other multipliers, e.g., patient face-to-face contact, can be approximated as 4.57 and 1.94 for WS and the survey, respectively (calculation not shown).

Discussion

This study explicitly compares two techniques for estimating unit cost multipliers of nurses in medical genetics. The WS and the survey indicated that nurses spend more than half of their time working away from patients, at 80.7% and 55.0%, respectively. The nurses spent half (40.4%) and less than half (25.6%) of that away time on patient care activities in WS and the survey, respectively. In addition, the nurses reported that they spent more time on DCA (45.0%) than on ICA (25.6%) in the survey. However, we discovered from WS that the nurses spent significantly less time on DCA (19.3%) than on ICA (40.4%). This finding is consistent with nurses who work in the ICU [8], ED [11], surgical ward [12], and as research nurses [29,42], all of which indicate that HCPs tend to overestimate the time spent on the direct patient-related activity. While surveys are beneficial in providing insights into work patterns, their accuracy might be impacted by recall error and desirability bias [43].

We demonstrated that OA was excluded from the multiplier, with idle (6.7%) and personal (2.2%) activity accounting for the majority (75.0%) of the category. Studies have shown that PA varied widely among nurses in surgical wards (2.5%), home nursing (5.1%), medical–surgical clinics (12–18%), neurorehabilitation units (19%), ICUs (24%), critical care units, and EDs (42%) [11,12,39,44–46]. Our nurses' personal time was lower due to further subdividing OA into smaller activities to help us identify the activity unrelated to services, patient care, and professional development. Additionally, some authors classified education and training as personal tasks [19], contrary to our approach, which categorized them as an overhead of patient care. Furthermore, variations also existed in the major categorization of the activities. In an Australian study [8], medication preparation was defined as DCA for ICU nurses, whereas we categorized it as ICA. These variations in definitions and categorization are well accepted to accommodate the particular objective of a study [33,47]. Thus, the specific definition and categorization of the activities should be further inspected whenever a multiplier is to be estimated from the published study.

Table 4 *Care and contact types of activity with their associated time use.*

Category (notation in equation)	Care type	Contact type	% of time
Care activity (C)	All patient care	—	59.7
Direct care activity (DCA)	Direct care	Face-to-face	19.3
Indirect care activity (ICA)	Indirect care	Away	40.4
Noncare activity (NC)	All noncare	—	40.3
Unit-related activity (URA)	Unit-related	Away	28.5
'Others' activity (OA)	Others	Away	11.8
Total time (T)	Total	Total	100

There are significant disparities in the proportions of time spent by nurses on direct and indirect care activities that have been reported in other areas of practice [11]. In comparison, research indicates that geneticists spend more time directly contacting patients [17], and genetic counsellors spend less time directly contacting patients than they do indirectly [18]. Moreover, the considerable time spent on indirect patient-related activity distinguishes genetic management from many other disciplines. These include gathering disease information, case conferencing, and continuing education of HCPs [16,17]. Thus, estimating direct contact time alone will underestimate the time required to provide care.

The study highlighted 'genetic meetings' as the activity that significantly contributed to the provision of patient care. Specialists led the meeting, and nurses took turns attending to discuss patient treatment. This is crucial because most patient cases are complicated and require collective input from team members to make pragmatic treatment and care management decisions. These are the most prominent features of genetic nurses compared to nurses in other fields. It is important to note that documentation activities classified as 'clerical' and 'patient progress documentation' are the most time-consuming tasks for nurses. The timely documentation was congruent with medical-surgical units, acute care, and nursing home nurses [7,44,47]. The required documentation is not only necessary for compliance with local health-related policies and regulations but also the maintenance of care quality.

Many studies consistently report that nurses can perform multiple activities simultaneously [8,27], with communication being the most common multitasking activity among DCAs in high-care nursing homes (40%) and medical-surgical units (25%) [27,44]. Overall, 'professional communications' ranks third according to our study and recent findings of neurorehabilitation and medical-surgical unit nurses [19,27]. Moreover, communication with patients represents the second largest proportion of the nurses' direct care time, contrary to a previous study that indicated nurses devoted little time to interact with their patients [10]. The finding demonstrates that two modes of communication are essential for maintaining the organization's effectiveness and ensuring the delivery of quality genetic care.

Limitations

Our study has some limitations. First, it was conducted in a single genetic clinic. Then, the observation period happened to be two weeks full of unit briefings, audits, and renovation activities to meet the end of the current year. This may partly explain why activities such as 'education' were recorded at a slightly higher percentage (4%) than for nurses in the rehabilitation unit (<1%) [19,33]. A previous report suggested that HCPs [16] also use a significant amount of preclinic and postclinic time to research, read, and prepare cases for patients. We have limited evidence of how this might impact nurses' total care activities. This may limit the generalizability of the findings.

Second, the differences arising from the two techniques could also be attributed to the observer not practicing in nursing and potentially having a different interpretation of the activity definitions. However, we believe the impact was minimal because we rectified any discrepancies with the nurse leaders during the trial runs. In addition, we conducted a short communication with the nurses at gaps between time intervals to resolve any discrepancies immediately. Moreover, we have tested both techniques to differ significantly, prompting the methods themselves to influence the results.

The observer was not permitted to enter observation rooms during patient assessment in certain circumstances. In this instance (unobserved activity), we made a reasonable assumption based on the information provided to the observer about the tasks the nurses were performing. Additionally, we left the observation unrecorded when participants failed to disclose their planned destination (e.g., outside the clinic) to the observer. Occasionally, participants engage in an activity that lasts longer than the activity being recorded. Nonetheless, the pattern identified in this study was obtained from a primary referral centre in Malaysia, and these limitations were found to be minimal.

Advantages

There were activities that we recorded at a distance from the participant to reduce the Hawthorne effect. Previous reports suggested that the effect was likely to affect time engaged in personal time, meal breaks, and idle time [41]. However, we did not find any significant difference in the OA category between the two techniques. Moreover, while the previous study showed that the HCP tends to give estimations in favour of PRA [29], we found that the estimated proportion of PRA was lower for WS than that of the survey, suggesting that there was no significant Hawthorne effect in this study.

Whilst surveys are relatively less expensive and take less time to administer, they lack the degree of detail required in assessing the overhead. In this instance, surveys may further reduce the representativeness of the multipliers. It is worth mentioning that WS is incomparable to the 'gold standard' TMS study [48] in terms of the sequence of activities and actual duration of time [33,49]. However, the level of information obtained in this study was sufficient for the purpose of describing the working pattern. Despite its inferiority to TMS, WS enables a more objective description of time distribution while potentially avoiding the recall error and personal bias associated with surveys or self-reports. This suggests that WS appears to be a straightforward and cost-effective technique for estimating the multiplier.

Implications and recommendations

The two techniques produced high variability in the overall categorization of nurses' activities except for OA. While the multipliers for patient face-to-face contact were significantly larger between WS (4.57) and the survey (1.94), the multipliers for patient care time were smaller between WS (1.47) and the survey (1.24). Consequently, when comparing the true cost of patient care delivery between WS ($1.47 \times \$20/h = \$29.40$) and the survey ($1.24 \times \$20/h = \$24.80$), the gap in the true cost of patient face-to-face contact was 2.5 times greater between WS ($4.57 \times \$20/h = \$91.40$) and the survey ($1.94 \times \$20 = \$38.80$). Thus, estimating the paid cost solely based on direct time with patients considerably underestimates the cost per hour of nurses' care delivery. Additionally, caution should be taken when multiplying the patient contact time by the patient-related activity to determine the cost of care provision, as demonstrated in this study.

The study demonstrates the importance of adequately allocating overhead to ensure that the activities unrelated to patient care (e.g., PA) are not included as overhead on patient care costs, particularly when evaluating human resource expenses. However, numerous CE studies have ignored this critical component entirely from the analyses [25]. One possible explanation for this is the complexity and difficulty of quantifying overhead. Cost estimation is a fundamental component of economic analysis. Despite the wealth of literature available in this field [24,25], there is a dearth of discussion of how 'hidden' or indirect patient-related activities should be handled and how they ultimately affect costs. This study sheds light on quantifying the actual cost of nursing care intervention for resource prioritization, as highlighted by previous CE studies in nursing [29,50]. The differences in cost and unit cost estimates can alter the final CE conclusion of whether a new intervention is effective. While the sensitivity analysis [50] can be used to account for the uncertainty around the estimates, it is crucial to have a realistic range of parameter values (e.g., a multiplier) rather than being utterly arbitrary during the model simulation [29].

A critical first step is to raise awareness to bridge gaps in knowledge and attitudes regarding the role of economic analysis in minimizing harm to the patient by recognizing the 'value' of nursing interventions for a cost-effective care strategy. This emphasizes the theoretical basis for characterizing genetic nursing care workloads and work patterns in estimating the actual cost of care delivery [50]. However, a conservative approach can be used by assuming that all time is spent on patient care [23] when there is no detailed breakdown of time; for instance, limited information is available from standard workload measurements (e.g., patient turnover) for non-care-related activity [10]. This necessitates the use of alternative (e.g., WS) or combined-with-standard methods to reconcile the actual pattern of care provision, provided that the findings and sensitivity of the results are explicitly stated as demonstrated by this study.

The overarching process proves that the multiplier is beneficial in converting other forms of unit cost into terms that are also important compared to the cost per hour, e.g., cost per bed. Alternatively, the term 'patient-related activity' found in previous studies can be used in reference to patient care delivery, as in our study, for instance, when estimating geneticist [16] and genetic counsellor [17,18] multipliers from published sources. We recommend employing 'patient-related activity' instead of the 'face-to-face contact' multiplier because the former did not significantly differ from the one estimated using WS in this study. The actual cost will include care overheads in the cost per hour of care delivery.

Conclusion

The observational data reflect current genetic nurses' work practices. The ratio of time on patient care activities to time spent on non-care activities is 1:0.47. This means that for every hour nurses spend on care activity, e.g., assisting doctors, an additional

28 minutes are spent on non-care activity, e.g., clerical time, to deliver appropriate patient care. Hence, every hour spent with a patient requires 1.47 paid hours. We will utilize the adjusted total paid hours per nurse attributable to patient care delivery in a future CE model. This ensures that the total cost approximately reflects our current local practices.

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Conflict of interest

The authors declared no conflict of interest.

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Appendix

For editor and reviewers' reference only. Q4

Quantitative work-sampling activity definitions.

The definitions of normal work activities performed with inclusion and exclusion of examples.

Code	Activity	Activity definition	Inclusions and exclusions
Direct Care: Performed in the presence of the patient and/or family			
1.	Registration and new admission	This involves taking registration at the counter.	Includes: Telephone registration, clearing patient appointment routine. New and returning patients at the main counter. Excludes: Rewriting/re-entering ER in computer
2.	Patient assessment	This involves nursing assessing patient overall health status. Additionally, readings taken from medical devices	Includes: Vital signs, objective and subjective findings, measurement, weighing. Obtaining temperature. Excludes: Other clinical procedures specified at Activity **4**.
3.	Medication administration	Administration of medication during clinic hours	Includes: ERT and non-ERT injections such as premedications. Excludes: Activity **2** and **4**
4.	Clinical procedures	This involves all medical procedures conducted in the treatment room.	Includes: Branula insertion, poking, equipment attaches to patient, blood and urine samples, emergency procedures Excludes: Procedure conducted in the doctor's room will be classified under **6**. Performing patient assessments prespecified under **2**.
5.	Patient mobility	This involves moving and directing patient to another location within the clinic.	Includes: Infusion area. Treatment area. Excludes: Activity **7**
6.	Assisting doctor during a review	This involves any clinical and administrative procedures done in the presence of the doctor.	Includes: Conducted in the assessment and treatment room. Filling out other forms. Excludes: Filing conducted outside prespecified rooms
7.	Patient interactions	Spend time communicating and addressing the needs of the patient and family physically.	Includes: Child's handling, instruction or counselling, and conversation with patient or family. Excludes: Over the phone patient contact is classified under Activity **15**. Moving and directing patients is under Activity **5**.
Indirect Care: Performed away from the patient, but specifically on the patient's behalf			
8.	Professional communications	This involves asking, reporting patient results and other required information for patient care.	Includes: Reporting results of patient to other colleagues within the clinics. Seeking consultations, specialist, other hospital staff. Excludes: Activity **14**
9.	Room and equipment setup, cleaning	This involves preparatory time before and after seeing the patient.	Includes: Treatment and assessment room. Gathering supplies. Preparing equipment. Excludes: Medication-related is classified under **3**
10.	Medication tasks	Indent, send Rx, and collect medication at the pharmacy. Prepare IV administration and dilute.	Includes: Present the prescription to the pharmacy and wait for the medication to be dispensed. Prepare and check medication.
11.	Progress and discharge notes documentation	This involves working on making discharge summaries and progress notes on the observation day.	Includes: Yellow files only Excludes: Long overdue files

(*continued*)

Code	Activity	Activity definition	Inclusions and exclusions
			management. This will be classified under Activity **20.**
12.	Data entry and retrieval	This is specific to the activity conducted using the computer.	Includes: White computer. Entry into the SMS system Excludes: Black computer
13.	Gathering information from phones, computers	This includes information searches conducted during patient assessment.	Includes: Reviewing images, diseases information, journals Excludes:
14.	Telephone contact for follow-up	This includes getting information of the lab results and other relevant units ready prior to the assessment and arranging the collection of samples.	Includes: Pediatrics, MRI via phones. Excludes: Activity **15**
15.	Coordination of care	This involves the planning of care over the phone and the clinic's mobile phone. Referring to support groups	Includes: Call and text messages via clinic's mobile phone (iPhone4 unit's phone) Excludes: Personal mobile phone, Activity **14**
16.	Genetic meetings	This includes general metabolic meetings specific to patients.	Includes: Thursday and Friday Excludes: Other administrative meetings are classified under Activity **21**
17.	Education and in-service	This involves participation in teaching and learning activities such as CME to meet learning needs.	Includes: Departmental audits, continuous medical education Excludes:
18.	Supplies check (stocking)	This involves checking medical equipment stocks and ordering supplies.	Includes: Storage area Excludes:
Unit-related task: Non-care activity related to general maintenance of the genetic unit			
19.	Errands of unit	This involves getting necessary tasks completed as soon as possible.	Includes: Lab results, obtain urgent stock. Excludes:
20.	Clerical work	This involves unit-related work and records. Nurse will spend time in counselling room after noon.	Includes: Brown files Excludes: Yellow files classified under **11**
21.	Administrative meetings	This involves meetings and administrative work purposes.	Includes: Ad hoc and planned meetings Excludes: Genetic and metabolic meetings
22.	Transit	This involves time spent between tasks for work-related activities	Includes: Getting equipment from one patient to another. Movement from patient to equipment Excludes: **5**
Others: Not patient- and unit-specific			
23.	Personal	This involves using a personal phone during working hours.	Includes: Web surfing, praying, talking, sleeping Excludes: Use of phones for gathering information is classified under Item **13**.
24.	Idle time	Waiting for the end of some activities. This involves no prespecified activity being conducted when the observation is made.	Includes: Inactive time Excludes: Personal, pantry, and praying
25.	Pantry	Time spent in pantry during the observation time	Includes: Middle pantry. Extra room in the unit. Excludes:
26.	Restroom	Toilet use	Includes: Built-in toilet

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