

Influence of patient and provider factors on the workload of on-call physicians

A general internal medicine cohort observational study

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Abstract

Factors associated with the physician workload are scarcely reported. The study aims to investigate the associated factors of on-call physician workload based on a published conceptual framework.

The study was conducted in a general internal medicine unit of National Taiwan University Hospital. On-call physician workloads were recorded on a shift basis from 1198 hospitalized patients between May 2010 and April 2011. The proxy of on-call workloads included night calls, bedside evaluation/management (E/M), and performing clinical procedures in a shift. Multivariable logistic and negative binomial regression models were used to determine the factors associated with the workloads of on-call physicians.

During the study period, 378 (31.6%) of patients had night calls with related workloads. Multivariate analysis showed that the number of patients with unstable conditions in a shift (odds ratio [OR] 1.89 and 1.66, respectively) and the intensive care unit (ICU) training of the nurse leader (OR 2.87 and 3.08, respectively) resulted in higher likelihood of night calls to and bedside E/M visits by the on-call physician. However, ICU training of nurses (OR=0.37, 95% confidence interval: 0.16–0.86) decreased the demand of performing clinical procedures by the on-call physician. Moreover, number of patients with unstable conditions (risk ratio [RR] 1.52 and 1.55, respectively) had significantly increased the number of night calls and bedside E/M by on-call physicians by around 50%. Nurses with N1 level (RR 2.16 and 2.71, respectively) were more likely to place night calls and facilitate bedside E/M by the on-call physician compared to nurses with N0 level. In addition, the nurse leaders with ICU training (RR 1.72 and 3.07, respectively) had significant increases in night calls and bedside E/M by the on-call physician compared to those without ICU training.

On-call physician workload is associated with patient factors and the training of nurses. Number of unstable patients in a shift may be considered in predicting workload. The training of nurses may improve patient safety and decrease demand for clinical procedure.

Abbreviations: BI = Barthel index, CCI = Charlson comorbidity index, CI = confidence interval, CWS = clinical warning sign, DNR = do-not-resuscitate, E/M = evaluation/management, ICU = intensive care unit, NTUH = National Taiwan University Hospital, OR = odds ratio, RR = risk ratio.

Keywords: general internal medicine, on-call physician, workload

1. Introduction

Shift work dominates current inpatient care.^[1] Cumulative evidence has demonstrated that physician workload poses a

potential threat to the physician's health and patient safety.^[2] Although the United States mandated limits on resident work hours with a 30-hour limit on continuous shifts,^[3] shift length is only 1 determinant to physician workload. As advocated, shortened work hour is prone to work compression, which may endanger patient safety.^[4] The physician workload per se should never be neglected in the current work hour reform.

A conceptual model of physician work intensity has been proposed in 2012 by Horner et al. In this framework, work intensity comes from clinical work demand, which results from 3 main factors: patient, provider, and practice-based factors.^[5] Horner et al^[5] pointed out that previous studies that addressed provider-based factors such as age, gender, and years in practice, and practice-based factors such as call schedule and number of patients seen, generated negative results. These negative findings implicate that physician workload is more complex than expected. It may be not plausible to evaluate any workload-associated outcomes without controlling for relevant factors.

Physician workload is complex, including direct and indirect patient care, learning, and teaching activities.^[6] The complex nature of this workload results in difficulties in synthesizing or comparing results from different institutions and medical subspecialties. The night shift is a time when on-site supervision is reduced.^[7] The workload of patient care typically depends on 1 or 2 physicians responsible for the night duty. During night shifts, the workload of the physician does not usually include external

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confounders such as communication to paramedical staff, education, or teaching activities, which may therefore provide a better opportunity to study the essential workload of physician regarding direct and indirect patient care.

Patient factors that are associated with on-call physician workload have been studied by our group, including clinical severity and treatment goals of each patient.^[8,9] However, provider factors which contribute to physician workload remain unknown as well as their impact on workload compared to patient-related factors. Based on a well established conceptual framework, this study aimed to evaluate the relationship between patient, provider and practice factors, and on-call physician workload.

2. Materials and methods

2.1. Study setting

The study was conducted at the National Taiwan University Hospital (NTUH), a 2000-bed medical center in Taiwan. The general internal medicine unit has 3 attending physicians (i.e., hospitalists) to admit general internal medicine patients from the emergency department.^[10] Three shifts were designed for the hospitalist team that remained unchanged during the study period. The night shift was from 11 pm to 8 am the next morning and covered a maximum of 36 beds overnight.

2.2. Ethics statement

The study protocol was approved by the Research Ethical Committee of NTUH (approval no. 201112161RIC, Taiwan). This night shift recording was a daily practice from the beginning of this pioneer model. No personal identifiers of any participants were collected. This observational study did not affect the process of care.

2.3. Conceptual framework

We applied the 3 main factors of clinical work demand according to the conceptual model proposed by Horner et al.^[5] Figure 1 depicts the conceptual framework used in our study. For each main factor, we selected at least 2 relevant factors as the study variables for analysis.

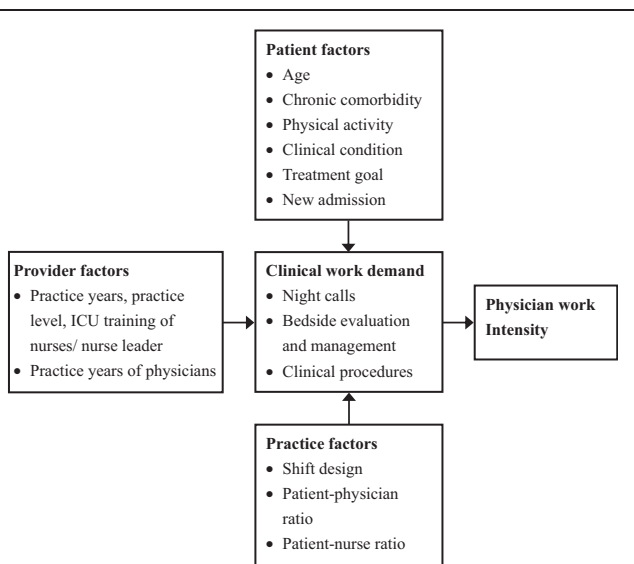


Figure 1. Conceptual framework of on-call physician workload.

2.4. Data collection

The night shift nurses who worked from 11 pm to 8 am were responsible for recording every event that required calling the on-call physician; they were also responsible for the responses, evaluations, management, and procedures done by them. The recording of night events, which was initiated from the beginning of our hospitalist program, was an important quality control and nurse–physician communication tool.

Because the patient, provider, and practice factors were dynamic in clinical settings, they were measured at the beginning of each shift. First, patient factors that were measured for a particular shift included the number of older patients (age >75 years), more comorbid patients (i.e., Charlson comorbidity index [CCI] >3), number of patients with poor physical activity (defined by Barthel index [BI] <60), number of patients in an unstable condition (defined by clinical warning sign [CWS] criteria), and number of patient with do-not-resuscitate (DNR) orders. The CWS system used in our setting^[11] includes 10 items: desaturation, tachycardia/bradycardia, tachypnea/bradypnea, hypotension, coma, seizure, cardiac arrhythmia, chest pain, oliguria, and any other condition about which the staff were worried. Patients meeting the CWS criteria, who were not indicated for intensive care after evaluation by in-charge physicians, remained on the ward. These patients were reevaluated on the next shift, and the alarm code was terminated when the condition became stable. In addition, the number of patients who were newly admitted on each day was also considered as a relevant patient factor because this group may generate a different workload.

Second, the years of practice, practice level, intensive care unit (ICU) training for the night shift nurses, and the practice year of the on-call physician were chosen as the provider factors. Third, the number of patients covered by an on-call physician (patient–physician ratio) and the mean patient number covered by a night shift nurse (patient–nurse ratio) were used as practice factors. Third, the years of practice, practice level, intensive care unit (ICU) training for the night shift nurses, and the practice year of the on-call physician were chosen as the provider factors. Before starting each night shift, all of these factors were obtained prospectively in order to correlate them with subsequent workloads in the night shift.

The on-call physician workloads in our study included answering night calls, bedside evaluation/management (E/M) visits, and performing clinical procedures. These 3 types of workload served as proxies of the on-call physician workload. Clinical procedures consisted of all kinds of procedures performed by the on-call physicians, in contrast to physician orders that can be done by nurses alone.

In Taiwan, hospitals use a clinical ladder system to categorize nurses at different levels, which is guided and modified by the Taiwan Nurse Association.^[12] The practice level of nurses was classified as N0 (new nurses under trial), N1 (nurses capable of general patient care), N2 (nurses capable of critical care), or N3 (nurses with capabilities in clinical teaching and quality improvement), according to the clinical nursing ladder system. In addition, the nurse leader had at least 5 years of general nursing experience at the registered nurse level and had completed additional leadership training. Senior nurses usually have to complete ICU training, but this is not mandatory.

2.5. Statistical analysis

The data were analyzed using SPSS version 16 (SPSS Inc., Chicago, IL). Univariate logistic regression analysis was used to

examine the association between factors and the occurrence of the 3 types of on-call workload. To assess the independent association between patient, provider, and practice factors and outcomes, all variables associated with the occurrence of clinical work demand at a threshold of *P* values less than 0.15 in the univariate logistic regression analyses were included in the final multivariate models. Multivariate logistic regression analyses, with backward stepwise elimination, tested which of the variables had the best ability to explain the occurrence of the 3 types of clinical work demand. For counted workloads, the negative binomial regression model was used to analyze the association of each patient, provider, and practice factor and the number of night calls, the number of bedside E/M visits, and the number of procedures performed by the on-call physician during a shift. A *P* value less than 0.05 was considered significant.

3. Results

3.1. Demographics of the study sample

From May 2010 to April 2011, a total of 1198 patients admitted to the general internal medicine unit were identified. The demographics of the study sample are shown in Table 1. Overall, the mean age was 69.3 years (standard deviation 16.6) and 634 (52.9%) were men. The mean CCI score was 2.1 (± 2), the mean BI score was 51.4 (± 37.1), and the mean length of stay was 10.1 days (± 9). In addition, approximately 18.8% of patients had DNR orders, and the in-hospital mortality was 8.8% (Table 1).

Table 1
Demographics of the study sample.

	Study patients (n = 1198)
Age, y	69.3 \pm 16.6
Male	634 (52.9)
Comorbidity (CCI)	2.1 \pm 2.0
Functional status (BI)	51.4 \pm 37.1
Hospital LOS, d	10.1 \pm 9.0
ICU admission	43 (3.6)
In-hospital mortality	105 (8.8)
Diagnosis at discharge	
Cancer	331 (27.6)
Pneumonia	268 (22.4)
UTI	162 (13.5)
Occult infection	75 (6.3)
Gastrointestinal bleeding	69 (5.8)
IAI	66 (5.5)
CHF	53 (4.4)
COPD exacerbation	45 (3.8)
Renal failure	44 (3.7)
Ileus	35 (2.9)
Cellulitis	13 (1.1)
Other	37 (3.0)
DNR orders	225 (18.8)
Disposition status	
Home	862 (72.0)
Nursing home	81 (6.8)
Death	85 (7.1)
Discharge home to die	20 (1.7)
Other department/institution	146 (12.2)

Data are expressed as mean \pm standard deviation or number of cases (%).

BI = Barthel index, CCI = Charlson comorbidity index, CHF = congestive heart failure, COPD = chronic obstructive pulmonary disease, DNR = do-not-resuscitate, IAI = intra-abdominal infection, ICU = intensive care unit, LOS = length of stay, UTI = urinary tract infection.

During the study period, 378 night calls, 146 bedside E/M visits, and 57 clinical procedures were recorded.

Eighteen nurses participated in the night shift rotation in the general medicine unit during the study period, with 3 at the N0 level, 8 at the N1 level, 4 at the N2 level, and 3 nurses at the N3 level. In addition, 2 senior residents (R4) and 22 junior residents (R2) were observed in the study period.

3.2. Patient, provider, and practice factors and occurrence of on-call workloads

The number of patients with CWS and ICU training of the nurse leader was positively associated with occurrences of night calls for patients and bedside E/M visits. In addition, patient/physician ratio and practice level of the nurse leader were also related to occurrences of night calls for patients. However, ICU training of nurses was only related to clinical procedures (Table 2).

Multivariate analysis showed that the number of patients with CWS (odds ratio [OR] = 1.89, 95% confidence interval [CI]: 1.38–2.59 and OR = 1.66, 95% CI: 1.22–2.25, respectively) and ICU training of the nurse leader (OR = 2.87, 95% CI: 1.67–4.94 and OR = 3.08, 95% CI: 1.52–6.78) resulted in a higher likelihood to place night calls and facilitate bedside E/M visits by the on-call physician. However, ICU training of nurses (OR = 0.37, 95% CI: 0.16–0.86) decreased the demand for performing clinical procedures by the on-call physician (Table 2).

3.3. Patient, provider, and practice factors and the amount of on-call workloads

In terms of patient factors, the number of patients with CWS (risk ratio [RR] = 1.52, 95% CI: 1.22–1.89 and RR = 1.55, 95% CI: 1.16–2.09, respectively) increased the number of night calls and bedside E/M visits by on-call physicians by around 50%, a significant increase (Table 3).

Regarding provider factors, nurses with N1 level (RR = 2.16, 95% CI: 1.08–4.34 and RR = 2.71, 95% CI: 1.02–7.25, respectively) were more likely to place night calls and facilitate bedside E/M by the on-call physician compared to nurses with N0 level. In addition, compared with those without ICU training, for nurse leaders with ICU training (RR = 1.72, 95% CI: 1.02–2.89 and RR = 3.07, 95% CI: 1.34–7.00, respectively) there were increased numbers of night calls and bedside E/M visits by the on-call physician in the night shift (Table 3).

4. Discussion

This study is the first report to demonstrate the association between patient, provider and practice factors, and 3 proxies of on-call workload. We extend the findings in our previous work^[9] and show that patients with warning signs contributed to on-call workload for both incidence and amount. The nurses' experience and training also had a significant impact on physician's workload.

In the conceptual model of physician work intensity proposed by Horner, patient, provider, and practice-based factors contributed to the clinical work demands and subsequently to work intensity, which in turn influenced patient outcomes.^[5] Most of the previous studies have addressed practice factors such as schedule stability^[13] and protected sleep time design,^[14] which showed positive associations with fatigue. However, a recently published systemic review of the effect of an 80-hour work week restriction concluded that most studies did not measure or adjust

Table 2**Patient, provider, and practice factors predict the occurrence of clinical work demand.**

Univariate model ^{*†}	OR (95% CI)	P
For night calls for patients		
Patient/physician ratio	1.06 (1.01–1.13)	0.019
Number of patients with CWS	2.02 (1.48–2.74)	<0.001
Practice year of resident	1.66 (0.86–3.16)	0.120
Practice year of nurse leader	0.98 (0.95–1.01)	0.141
Practice level of nurse leader	0.71 (0.54–0.93)	0.012
ICU training of nurse leader (yes/no)	2.81 (1.67–4.70)	<0.001
For bedside E/M		
Patient/physician ratio	1.06 (1.00–1.12)	0.069
Number of patients with CWS	1.69 (1.26–2.28)	0.001
ICU training of nurse leader (yes/no)	3.47 (1.66–7.26)	0.001
For clinical procedures		
Patient/nurse ratio	0.59 (0.29–1.20)	0.146
Number of patients with DNR	1.08 (0.98–1.20)	0.124
Practice level of nurses	1.53 (0.94–2.49)	0.085
Practice year of nurses	1.11 (0.99–1.25)	0.075
ICU training of nurses (yes/no)	0.39 (0.17–0.92)	0.031
Multivariate model[†]	OR (95% CI)	P
For night calls for patients		
Number of patients with CWS	1.89 (1.38–2.59)	<0.001
Practice level of nurse leader	0.68 (0.51–0.91)	0.010
ICU training of nurse leader (yes/no)	2.87 (1.67–4.94)	<0.001
For bedside E/M		
Number of patients with CWS	1.66 (1.22–2.25)	0.001
ICU training of nurse leader (yes/no)	3.08 (1.52–6.78)	0.002
For clinical procedures		
Practice year of nurses	1.13 (1.00–1.27)	0.050
ICU training of nurses (yes/no)	0.37 (0.16–0.86)	0.021

CI = confidence interval, CWS = clinical warning sign, DNR = do-not-resuscitate, E/M = evaluation/management, ICU = intensive care unit, OR = odds ratio.

* Predictive variables included patient/physician ratio, patient/nurse ratio, number of patients with age >75 years, number of male patients, number of patients with BI <60, number of patients with Charlson comorbidity index >3, number of patients with CWS, number of patients with DNR, number of new admission, practice year of resident, practice year of nurse leader, number of nurses, practice level of nurse leader, practice level of nurses, ICU training of nurse leader, ICU training of nurses in logistic regression model (variables with *P* values less than 0.15 in univariate associations were candidates for multivariate models).

† Multivariate logistic regression analyses with backward stepwise elimination were used to determine the influence of predictive variables on the occurrence of clinical work demand.

for possible confounders.^[15] Most studies neglected the fact that patient and provider factors of the study setting should be adjusted to allow for generalization to other settings. Therefore, positive results generated limited policy impact.

Consistent with previous studies that examined the on-call workload, we used several proxies to measure workload. Earlier studies tended to use an inpatient census to represent on-call workload.^[16] Later, both previously admitted patients and new admissions were considered.^[17] Recently, the number of paging was reasonably included as a proxy of on-call workload by Meyer et al.^[18] The lack of consensus in the definition is reflected by the fact that on-call workload involves several aspects and that it is somewhat unpredictable in nature. In our study, we used 3 proxies of on-call workload, including call, bedside E/M, and clinical procedures, which can, although not comprehensive, depict a better contour of the on-call workload.

There may be several clinical implications of the present study to improve our knowledge about physician workload. First, patients with CWS were more significantly associated with workload compared to those with a stable condition. In previous studies, most of these warning signs have been proven to predict worse outcomes^[19] and have been widely used as activation criteria of the medical emergency team.^[20,21] In this study, we found that warning signs were a relevant workload-associated patient factor, and the quantity of patients with warning signs matters. The number of unstable patients, if counted in the

beginning of the on-call shift, may inform us of the amount of workload that will result. Since the patients' condition is dynamic throughout the hospital stay, the physician workload summated from all admitted patients is also dynamic. However, traditional medical services provide almost constant labor, especially during after-hours, to cope with a dynamic workload. This may cause the high burnout rate in high-burden clinical settings.^[22]

The nurses play an important role in on-call physician workload. Although it is a platitude that we care for patients through multidisciplinary teamwork, it has scarcely been reported how an individual within a team influences the others. In this study, the nurses' experience and training had a significant impact on physician workload. As this study revealed, the ICU training of nurses contributed to higher call and bedside E/M, but lower demand of clinical procedure. More calls to physicians may indicate more problems that were noticed by experienced nurses, while fewer procedures needed may mean higher quality of care at night shift. The present study could not answer if fewer procedures at the cost of more calls alleviate physician workload, but it is probable. This finding also suggested that physician workload can be modified through training of the other team members and proposed the mechanism of how training influences patient safety.

The results of this study may give rise to an expectation that on-call workload is predictable. On-call residents currently do not know whether the forthcoming shift will be easy or challenging.

Table 3
Patient, provider, and practice factors predict the 3 types of clinical work demand.

Factors	Night calls for patients (N=378)		Bedside E/M (N=146)		Clinical procedures (N=57)	
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)
Patient factors						
Number of male patients	0.96	(0.98–1.02)	0.90*	(0.92–0.98)	0.99	(0.86–1.12)
Number of patients with BI < 60	0.97	(0.92–1.03)	0.97	(0.90–1.05)	0.96	(0.86–1.07)
Number of patients with CCI > 3	1.01	(0.94–1.08)	0.90*	(0.82–0.99)	0.94	(0.81–1.09)
Number of patients with age > 75 y	0.95	(0.88–1.03)	0.99	(0.90–1.09)	1.02	(0.89–1.18)
Number of patients with DNR	1.04	(0.97–1.12)	1.02	(0.92–1.12)	1.07	(0.93–1.24)
Number of patients with CWS	1.52 [†]	(1.22–1.89)	1.55 [‡]	(1.16–2.09)	1.38	(0.89–2.15)
Number of new admission patients	1.01	(0.91–1.11)	0.98	(0.85–1.13)	0.98	(0.79–1.22)
Provider factors						
On-call resident						
Senior (R4)	1.42	(0.65–3.12)	1.19	(0.36–3.90)	1.45	(0.26–8.24)
Junior (R2)	1.00		1.00		1.00	
Practice level of nurse leader						
N3	1.02	(0.22–4.68)	1.21	(0.20–7.36)	3.27	(0.17–64.20)
N2	0.63	(0.31–1.27)	0.96	(0.40–2.30)	1.19	(0.30–4.69)
N1	1.00		1.00		1.00	
Practice level of nurses						
N3	1.83	(0.27–12.48)	1.80	(0.16–19.88)	2.24	(0.08–62.83)
N2	2.00	(0.63–6.35)	2.84	(0.63–12.74)	1.15	(0.11–12.34)
N1	2.16*	(1.08–4.34)	2.71*	(1.02–7.25)	1.61	(0.35–7.46)
N0	1.00		1.00		1.00	
ICU training of nurse						
ICU training of nurse leader	1.72*	(1.02–2.89)	3.07 [‡]	(1.34–7.00)	1.36	(0.42–4.44)
ICU training of nurses	1.10	(0.54–2.21)	1.29	(0.55–3.04)	0.66	(0.19–2.35)
Practice year of nurse leader	0.99	(0.91–1.08)	1.00	(0.90–1.10)	0.93	(0.79–1.10)
Practice year of nurses	1.01	(0.86–1.17)	1.00	(0.83–1.20)	1.10	(0.84–1.44)
Practice factors						
Patient/physician ratio	1.05	(0.92–1.19)	1.02	(0.87–1.20)	0.95	(0.81–1.13)
Patient/nurse ratio	0.92	(0.57–1.47)	0.57	(0.33–1.00)	0.78	(0.35–1.74)

BI = Barthel index, CCI = Charlson comorbidity index, CI = confidence interval, CWS = clinical warning sign, DNR = do-not-resuscitate, E/M = evaluation/management, ICU = intensive care unit, RR = rate ratio, N0 = new nurses under trial, N1 = nurses capable of general patient care, N2 = nurses capable of critical care, N3 = nurses with capabilities in clinical teaching and quality improvement.

* $P < 0.05$.

[†] $P < 0.001$.

[‡] $P < 0.01$.

In the present study, we provided a potentially feasible method to predict workload of on-call shifts. Most importantly, these factors are readily available before, rather than after, workload produced to the physicians. The information of unstable patients and the nurse team to work with can be valuable in hand off. We believe that the method used can be generalized to other settings using the same conceptual framework. If workload is partially predictable, the assignment of more personnel or the division of the on-duty area for on-call physicians are feasible ways to prevent overloading, which endangers patient safety. In addition, our results also indicated that nurses with greater experience and training may help alleviate procedural workload.

Our study has several limitations. First, the practice factors remained similar in 1 setting, and we did not successfully verify this dimension in this study. Second, the on-call physicians in our study had a similar level of experience. Although it is a common phenomenon in most settings, the physicians' experience and training should be important factors with regard to workload. The small differences observed between patient, provider, and practice factors may affect the interpretation of the results. The estimated effect had a wide 95% CI and should be interpreted with caution. Third, on-call workload and behavior is a complex phenomenon that is impossible to explain thoroughly with a handful of factors. Other unmeasured factors may influence the occurrence of clinical work demand. Although several factors in

this study were found to be significant, other factors should be investigated in the future to improve the predictive ability. In doing so, the team leaders will be able to estimate how many patients a resident physician can cover and avoid overload and negative perception by the on-call physicians.^[18,23] Fourth, the generalizability of the results may be a concern. Our findings derived from an internal medicine cohort might be different from those of other specialties such as surgical departments.

Recently, the workload perceived by hospitalist physicians was reported in a large survey.^[24] Forty percent of the hospitalists reported an unsafe workload at least once a month, and nearly one-quarter reported that excess workload adversely impacted patient outcomes. After establishing work hour restrictions for residents, both surveillance and measurement of workload are warranted.^[25] As advocated, it is time to address the crucial issue of residents' workload directly.^[4] More first-hand information is imperative.

5. Conclusion

Capturing the unpredictable on-call workload may be possible through collection of relevant real-time clinical information. In this study, we demonstrated that both patient and provider factors determined the on-call workload in a general internal medicine unit. Clinical stability as well as nurse experience and

training are significant factors that effect on-call physician workload. Researchers, who work on physician workload, should be aware that at least some of these factors mandate adjustment to allow comparisons to be made between different settings.

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