

Calculation of the Optimal Number of Nurses Based on Nursing Intensity by Patient Classification Groups in General Units in South Korea: a Cross-sectional Study

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Research

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1 Calculation of the optimal number of nurses based on nursing intensity by patient classification groups in
2 general units in South Korea: a cross-sectional study

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15

16

Abstract

17 **Background:** Calculating the accurate number of nursing personnel based on a patient
18 classification system that clearly reflects the nursing needs of patients is a problem directly
19 related to the nursing unit's budget management, productivity, etc. This study aimed to
20 calculate the total daily nursing workload and the optimal number of nurses per general unit
21 based on the nursing intensity and direct nursing time per inpatient through patient
22 classification.

23 **Methods:** Three units at one general hospital were investigated. To calculate nursing intensity,
24 patient classification according to nursing needs was performed for over 10 days in each unit
25 in September 2018. The direct and non-direct nursing time and nursing intensity scores were
26 analyzed using descriptive statistics (e.g. frequency, percentage, and average) generated using

27 Microsoft Excel.

28 **Results:** For the internal medicine unit, the average direct nursing time per patient was 1.0,
29 1.5, 2.2, and 2.9 hours for Groups 1, 2, 3 and 4, respectively. For the surgical unit, the average
30 direct nursing time per patient was 0.9, 1.4, 2.1, and 2.6 hours for Groups 1, 2, 3, and 4,
31 respectively. For the comprehensive nursing care unit, the average direct nursing time per
32 patient was 0.8, 1.2, 1.7, and 2.2 hours for Groups 1, 2, 3, and 4. The optimal number of nurses
33 was 25 in the internal medicine unit, 37 in the surgical unit, and 22 in the comprehensive
34 nursing unit. There was a shortage of five nurses in the internal medicine unit and nine in the
35 surgical unit.

36 **Conclusion:** Based on the nursing time according to patient classification groups, this study
37 confirmed that the optimal number of nurses cannot be secured and that the nursing intensity
38 is very high. The results of this study suggest that long-term efforts, such as improving the
39 nursing environment, should be made to secure an optimal number of nurses in various hospital
40 nursing units.

41

42 **Keywords:** Nursing intensity, Nursing time, Patient classification, General units

43 **Background**

44 Estimating the accurate number of nursing personnel according to nursing needs using a patient
45 classification system that clearly reflects patients' nursing needs is an issue directly related to
46 the budget management and productivity of the concerned nursing unit. Therefore, if nursing
47 intensity based on nursing needs can be calculated by using a more sophisticated patient
48 classification tool and the calculation criteria for nurse staffing can be more elaborately
49 designed, realistic standards for nursing unit operations can be established.

50 Currently, the optimal number of nurses per nursing unit can be calculated using a method
51 based on nursing time by patient classification groups [1]. This approach involves quantifying
52 nursing time taken according to patients' nursing needs and is limited in considering the
53 differences in qualitative characteristics, such as available resources for each hospital and unit,
54 nurses' qualifications, and nurses' competencies. Since it cannot realistically reflect nursing
55 time taken according to the severity of inpatients' diseases in clinical settings and does not
56 record time-consuming nursing activities—such as dealing with difficult caregivers—this
57 approach does not reflect the reality of clinical nursing practice [2]. Most previous studies
58 measuring nursing time have used direct measurement methods such as the work sampling
59 method and time-and-motion studies [3, 4]. Since nurse staffing is calculated based on the
60 required nursing time per patient, the required nursing time should be measured and predicted
61 using tools [5]. While traditional time studies using a direct measurement method require much
62 time and effort, such a method does not comprehensively reveal the attributes of nursing
63 activities and essence of nursing care. Since nursing activities are complex, with several
64 occurring simultaneously, there are practical limitations to their estimation by breaking them
65 down and measuring them individually [6]. Therefore, there is a need to develop a new method
66 that can more efficiently measure nursing time based on a comprehensive approach.

67 Santos et al. [7] suggested that working time should be described in three dimensions: the

68 duration, distribution, and intensity. Working time refers to the total time spent on work. The
69 distribution refers to how it is spread across days, weeks, months, and years; it includes
70 intermittent work, compensatory time, home office or remote work, and all the free time used
71 to obtain qualifications to work more competently.

72 Meanwhile, Fagerström et al. [6] in Finland defined nursing intensity per patient as the sum
73 of the means of the weighting coefficients per patient classification group divided by the
74 number of nurses, presenting a method for relatively concisely quantifying nursing intensity.
75 Fagerström et al. [6] believed that this method would enable comparisons of nursing intensity
76 between various nursing units and the accumulated data can be used as a basis for resource
77 allocation in hospitals. This study attempted to calculate the optimal number of nurses in
78 general units in South Korea by applying the method developed by Fagerström et al. to
79 inpatients in nursing units using the calculated nursing intensity and the total working time
80 taken for each nurse. The nursing time by patient classification groups was calculated using a
81 comprehensive rather than a direct measurement method, which saves not only time but also
82 the costs required for the calculation and is, thus, highly likely to be used in nursing units. The
83 findings can be used as basic data for calculating the optimal number of nurses required in
84 nursing units, establishing effective nurse staffing strategies, and enabling better management
85 of human resources.

86

87 *Objectives*

88 This study aimed to calculate the total daily nursing workload per nursing unit and the optimal
89 number of nurses based on the nursing intensity and direct nursing time per inpatient. The
90 specific objectives were as follows:

- 91 1. to calculate direct and non-direct nursing time by investigating the total working time,
92 non-direct nursing time, and personal time perceived by nurses in each nursing unit

- 93 (internal medicine, surgical, and comprehensive nursing care units);
- 94 2. to calculate and compare nursing intensity in nursing units based on patient
- 95 classification scores;
- 96 3. to calculate nursing intensity and direct nursing time taken per patient by patient
- 97 classification groups in the nursing units; and
- 98 4. to calculate the total daily nursing workload and the optimal number of nurses per
- 99 nursing unit based on the nursing intensity and nursing time by patient classification
- 100 groups.

101

102 **Methods**

103 *Research design*

104 This study was a descriptive research aimed at not only investigating nursing intensity through

105 patient classification based on nursing needs, but also calculating direct nursing time per

106 inpatient, total daily nursing workload, and the optimal number of nurses in each nursing unit

107 based on the non-direct nursing time (indirect nursing time and break time) perceived by

108 nurses.

109

110 *Data collection and measures*

111 This study involved the following four steps. In the first step, all patients admitted to the

112 nursing units were classified into four groups according to their nursing needs; the mean patient

113 classification score for each group was first calculated, after which the nursing intensity score

114 for each nursing unit was calculated. In the second step, direct and non-direct nursing times,

115 including personal time and break time for all nurses working in the nursing units, were

116 calculated. In the third step, direct nursing time per patient classification group was calculated

117 based on the results of the first and second steps. In the fourth step, the total daily nursing

118 workload and the optimal number of nurses in the nursing units were calculated using direct
119 nursing time by patient classification groups.

120

121 *Participants*

122 In order to classify patients according to their nursing needs and calculate nursing intensity,
123 three nursing units at a single tertiary general hospital in J Province, South Korea, were selected
124 as the study units. The comprehensive nursing care unit is a unit equipped with necessary
125 features, such as appropriate nursing personnel and enhancing the nursing work environment
126 by providing necessary care services to patients without a family caregiver or a privately
127 employed one. The number of patients per nurse in the comprehensive nursing care unit is
128 lower than that in the general units [8]. Given that the comprehensive nursing care unit system
129 in South Korea is expanding and revolutionizing nursing work and the nurse staffing system,
130 it was included in this study.

131 According to nursing needs, patient classification and nursing time in each unit were
132 investigated over 10 days between September 1 and 30, 2018, excluding weekends. Night shift
133 nurses in charge of intensive care nursing and general nurses classified all patients admitted to
134 the respective units using the Korean Patient Classification System on Nursing Needs for
135 Intensive Care Units (KPCSNI), a tool developed by Ko and Park [9]. The total number of
136 patients who were subjected to classification comprised 473, 278, and 143 patient-days in the
137 internal medicine, surgical, and comprehensive nursing care units, respectively.

138 The nursing time of all nurses in the nursing units who performed patient classification were
139 investigated on that same day in the relevant nursing unit. Nurses who worked day, evening,
140 or night shifts were instructed to complete a self-report questionnaire immediately after the end
141 of their working, thereby minimizing recall errors. The number of nurses who participated in
142 the survey of nursing time comprised 87, 125, and 77 person-days in the internal medicine,

143 surgical, and comprehensive nursing care units, respectively, totaling 289 person-days.

144

145 *Definitions of terms*

146 1. Patient classification

147 The patient classification system is a method of classifying patients according to the amount
148 and complexity of nursing care provided to them over a certain period [10]. Here, it refers to
149 classifying patients admitted to the units into groups 1 to 4 using the KPCSNI. As the patient
150 classification group number increases from 1 to 4, the total score for each item increases,
151 indicating that patients' nursing needs are higher.

152

153 2. Nursing intensity

154 Nursing intensity refers to direct and non-direct nursing activities related to patients; it includes
155 patients' dependency, severity of the disease, complexity of nursing care, and time required for
156 nursing as factors directly affecting such nursing activities [11]. To calculate nursing intensity,
157 patient classification scores were calculated using a tool that was modified and supplemented
158 based on the one developed by Ko and Park [9]. This tool comprises 50 direct nursing activities
159 covering eight domains (symptom management infection control, nutrition and medication,
160 personal hygiene and secretion, activity, sleep and rest, guidance in nursing/emotional support,
161 nursing activity planning, and coordination), and 11 indirect activities. Based on the calculated
162 patient classification scores, the weighting coefficient per nursing unit, that is nursing intensity,
163 was calculated following a method used by Fagerström et al. [6].

164

165 3. Personal time

166 Personal time excludes direct and non-direct nursing activity times during working time and

167 includes meal and rest times.

168

169 4. Non-direct nursing time

170 Non-direct nursing activities include managing the necessary items and environment for
171 nursing and maintaining the operation of nursing units except for direct nursing care for
172 patients [12]. Non-direct nursing time refers to the sum of the nursing time required for
173 handover, making rounds, work delay, recording, patient-related calls and deliveries,
174 administrative affairs, cognitive workload, education/supervision, research, and so on, as
175 measured using the patient classification tool developed by Ko and Park [9].

176

177 5. Direct nursing time

178 Direct nursing time refers to nursing time [12] for providing direct nursing care to patients, as
179 well as preparing and organizing nursing care. Here, it refers to total working time after
180 subtracting personal and indirect nursing times.

181

182 *Instruments*

183 1. Patient classification and calculation of nursing intensity for nursing units based on nursing
184 needs

185 Patient classification based on nursing needs was conducted using the KPCSNI. This tool is a
186 factor-type classification tool and includes scores for the clinical features of patients in addition
187 to scores for nursing needs when calculating patient classification scores. It consists of 8
188 domains and 18 sub-domains covering 50 nursing activities. After the tool was reviewed by
189 the researchers, its content validity was tested in consultation with six nursing professors. The
190 average daily value of the calculated patient classification scores for each date was calculated.

191 As a result, a patient classification score of 1–30 points was classified as Group 1, a score of
192 31–60 points was classified as Group 2, a score of 61–90 points was classified as Group 3, and
193 a score of 91 points or more was classified as Group 4 based on the results of the study by Ko
194 and Park [9].

195 Nursing intensity was measured following the calculation method presented in a study by
196 Fagerström et al. [6]. After setting the patient classification score in Group 1 as the reference
197 value of “1,” the patient classification scores in groups 2–4 were each divided by the patient
198 classification score in Group 1 to calculate nursing intensity weighting coefficients for the
199 groups. Nursing intensity scores for nursing units were calculated by multiplying the weighting
200 coefficient for each group by the number of patients in each group and then summing up the
201 values. Fagerström et al. [6] propounded the “Professional Assessment of Optimal Nursing
202 Care Intensity Level” (PAONCIL), a new method that goes beyond the traditional time study
203 methodology. It calculates nursing intensity based on patient classification results and assesses
204 nursing intensity for nursing units by reflecting statistical estimations and expert opinions.
205 Fagerström et al. [6] suggested this method as an alternative to the classical time studies, stating
206 that it could establish optimal nursing intensity levels for individual units.

207

208 2. Calculating nursing time

209 Nursing time was measured using a questionnaire developed by the researchers of this study
210 with reference to non-direct nursing activities in a tool developed by Ko and Park [9]. This
211 questionnaire comprises 28 items, including total working, break, and non-direct nursing times
212 of the day. Total working time was calculated based on the time at which nurses logged into
213 work and left for the day, while the break time was calculated by summing up the meal and
214 rest times. Non-direct nursing time was calculated by summing the time for each subdomain
215 of the three domains (nursing activity planning and coordination, non-direct activity, and break

216 time). Direct nursing time was calculated by subtracting the non-direct nursing time including
217 leisure time from the total working time (Formula 1). The validity of the direct nursing
218 calculation method was reviewed by six nursing professors and one expert.

219

220

$$\text{Formula 1: } \sum_{i=1}^n \text{DNT}_i = \sum_{i=1}^n \text{TWT}_i - \sum_{i=1}^n \text{NDNT}_i$$

Optimal Number of Nurses

221 DNT = Direct nursing time

222 TWT = Total working time

223 NDNT = Non-direct nursing time

224 n = Number of nurses in a nursing unit

225

226 3. Calculating direct nursing time per inpatient by patient classification groups

227 To calculate direct nursing time by patient classification groups, direct nursing time per nursing
228 intensity point was calculated (Formula 2). This value was then multiplied by the weighting
229 coefficient for each patient classification group to calculate direct nursing time per inpatient by
230 patient classification groups (Formula 3).

231

$$\text{Formula 2: } DNT_{pNI} = \frac{\sum_{i=1}^n DNT_i}{\sum_{i=1}^m N I_i}$$

232 DNT_{pNI} : Direct nursing time per nursing intensity weighting coefficient

233 DNT: Direct nursing time

234 NI: Nursing intensity weighting coefficient

235 n: Total number of nurses in a nursing unit

236 m: Total number of inpatients in a nursing unit

237

238

$$\text{Formula 3: } DNT_{pP} = WC_i \times DNT_{pNI}$$

239

240 DNT_{pP} : Direct nursing time per patient

241 WC: Weighting coefficients

242 DNT_{pNI} : Direct nursing time per nursing intensity weighting coefficients

243 i: Patient classification group

244

245 4. Calculating the optimal number of nurses

246 The optimal number of nurses in the internal medicine, surgical, and comprehensive nursing
 247 care units was estimated by applying the calculated nursing time results to formulas 4-6. After
 248 non-direct nursing time was calculated using the ratio (20%) of non-direct nursing time to the
 249 total nursing working time—calculated with the nursing time analysis results—the total
 250 nursing time was calculated (Formula 5). The optimal number of nurses was calculated by
 251 adding 40% to the value obtained by dividing the total nursing work time by the mean daily
 252 work hours (Formula 6).

253 The total number of annual holidays in the current clinical reality is estimated to be about 134
 254 days, considering weekly holidays: 52 weeks × 2 (Saturday and Sunday) based on an average
 255 of 20 working days per month, plus 15 legal holidays (excluding Sundays), 15 basic annual
 256 holidays, and additional annual holidays according to the nurses' professional positions.
 257 Although 1.4 can be assigned as an additive value due to the number of holidays by rounding
 258 off 1.37 [(134+365)/365], a constant of 1.6 was used in this study following previous studies
 259 [13, 14].

260

262 Formula 4: TDNT

$$263 \quad = (m_1 \times DNTpPt_1) + (m_2 \times DNTpPt_2) + (m_4 \times DNTpPt_3)$$

$$264 \quad + (m_4 \times DNTpPt_4)$$

261

$$266 \quad \text{Formula 5: TNW} = \text{TDNT} + \text{TNDNT} = \text{TDNT} + \text{TDNT} \times \frac{20}{80}$$

265

$$267 \quad \text{Formula 6: ONN} = \frac{\text{TNW}}{8} \times 1.6$$

268 TDNT: Total direct nursing time

Optimal Number of Nurses

269 DNT_{p1}: Direct nursing time per patient for Group 1

270 DNT_{p2}: Direct nursing time per patient for Group 2

271 DNT_{p3}: Direct nursing time per patient for Group 3

272 DNT_{p4}: Direct nursing time per patient for Group 4

273 m_1 : Number of patients in Group 1; m_2 : Number of patients in Group 2; m_3 : Number of patients
274 in Group 3; m_4 : Number of patients in Group 4

275 TNDNT: Total non-direct nursing time

276 ONN: Optimal number of nurses

277 TNW: Total nursing workload of the nursing unit

278 8 = Working time per day

279 1.6 = Additive value due to the number of holidays

280

281 *Data Analysis*

282 The collected data were analyzed using the Microsoft Excel program. The general
283 characteristics of the participants, direct nursing time, and nursing intensity for each date by
284 patient classification groups were analyzed using descriptive statistics such as frequency,
285 percentage, and average. Direct nursing time among the nursing unit nurses, direct nursing time
286 per patient classification point or nursing intensity point, and direct nursing time per patient
287 were calculated using Microsoft Office Excel 2017.

288

289 *Ethical considerations*

290 This study was conducted after explaining the purpose to the head of the nursing department
291 at the study hospital. The researchers visited the nursing units to explain the purpose of this
292 study. Nurses who agreed in writing to participate were selected. The anonymity of all the data
293 they provided was guaranteed, and they were assured that they could withdraw from

294 participation at any time if they so wished. This study was approved by the Institutional Review
295 Board at C University for the development of a nurse staffing prediction model based on
296 nursing intensity in nursing units (approval number: 1040271-201808-HR-026). A study on
297 the calculation of the optimal number of nurses based on nursing intensity in the intensive care
298 unit using the same research model has been published in the Korean Journal of Hospital
299 Management [2].

300

301 **Results**

302 1. Calculation of patient classification and nursing intensity based on nursing needs

303 The average daily number of patients was 39.7, 67.7, and 20.4 while patient classification
304 scores per patient were 64.1, 54.7, and 51.0 points in the internal medicine, surgical, and
305 comprehensive nursing care units, respectively. Using the calculation method presented by
306 Fagerström et al., [6] the average score for each patient classification group was calculated
307 based on the score for Group 1 to calculate a weighted value. Nursing intensity score was
308 calculated by multiplying the weighted value with the number of patients. They were 5.4, 5.7,
309 and 2.4 in the internal medicine, surgical, and comprehensive nursing care unit, respectively
310 (Table 1).

311 <Table 1 here>

312

313 2. Calculation of nursing time

314 The proportion of nurses' non-direct nursing time and break time out of total working time
315 was 41.1%, 46.9%, and 74.4% and 4.1%, 3.0%, and 5.1% in the internal medicine, surgical,
316 and comprehensive nursing care units, respectively. The proportion of direct nursing time was
317 calculated to be 54.7%, 50.0%, and 20.5% in the internal medicine, surgical, and

318 comprehensive nursing care units, respectively.

319 Specifically, the proportion of meal time was 2.5%, 2.1%, and 3.3% and when converted into
320 time required per nurse, it was 15.5, 12.7, and 18.8 minutes for the internal medicine, surgical,
321 and comprehensive nursing care units, respectively. The average handover time per nurse was
322 30.5, 44.4, and 58.8 minutes in the internal medicine, surgical, and comprehensive nursing care
323 units, respectively (Table 2).

324 <Table 2 here>

325

326 3. Direct nursing time per patient by patient classification groups

327 The direct nursing time per patient calculated through patient classification groups in internal
328 medicine unit was 1.0, 1.5, 2.2, and 2.9 hours for Groups 1, 2, 3, and 4, respectively; and in
329 the surgical unit was 0.9, 1.4, 2.1, and 2.6 hours for Groups 1, 2, 3, and 4, respectively.

330 Further, in the comprehensive nursing care unit it was 0.8, 1.2, 1.7, and 2.2 hours for Groups
331 1, 2, 3, and 4, respectively (Table 3).

332

333 <Table 3 here>

334

335 4. Calculation of optimal number of nurses in the internal medicine unit

336 The optimal number of nurses in the internal medicine, surgical, and comprehensive nursing
337 care units were calculated by reflecting the nursing time composition and intensity among
338 nurses working in each unit and summing up the calculated nursing time by patient
339 classification groups. The results revealed that the calculated optimal number of nurses was 25
340 (n=24.6), 37 (n=36.9), and 22 (n=21.2) in the internal medicine, surgical, and comprehensive
341 nursing care units, respectively. At the time of data collection, 20, 28, and 22 nurses were
342 assigned in these units, respectively. Therefore, if the number of previously assigned nurses

343 was subtracted from the calculated optimal number, 5 and 9 additional nurses would be needed
344 in the internal medicine and surgical units, respectively; however, the number of nurses in the
345 comprehensive nursing care unit was found to be appropriate (Table 4).

346 <Table 4>

347

348 **Discussion**

349 Currently, the most recommended method for calculating the optimal number of nurses in
350 hospital nursing units is to use nursing time by patient classification based on nursing needs.
351 When calculating nursing time in South Korea, observers directly measure all direct nursing
352 activities, which entails a considerable amount of time and effort. Therefore, this study
353 developed a method based on a literature review and expert advice that is different from the
354 existing practice.

355 This study calculated the optimal number of nurses in each nursing unit using a
356 comprehensive approach based on the total working time, indirect nursing time, and nursing
357 intensity, considering all nurses in each nursing unit. Nurses were asked to respond to
358 questionnaire items related to indirect nursing time immediately after the end of working hours,
359 which could have resulted in recall bias. Whether nursing activities that occur simultaneously
360 with nursing time or only key nursing activities should be reflected in nursing time
361 measurements is a topic of debate and follow-up studies are thus needed.

362 The results of nursing time composition revealed that the proportions of non-direct nursing
363 time were 45.3%, 50.0%, and 79.5% in the internal medicine, surgical, and comprehensive
364 nursing care units, respectively. According to the data from the Labor Union of Korean
365 Healthcare Service, the average working time per week among hospital nurses in 2016 was
366 46.6 hours, with 12% of them working longer than 52 hours per week [15].

367 In this study, nurses' total working times were calculated to be 7,593.6, 10,994.6, and 6,283.7

368 minutes with 612.4 (10.2 hours), 614.2 (10.2 hours), and 571.2 minutes (9.5 hours) per nurse
369 in the internal medicine, surgical, and comprehensive nursing care units, respectively. The
370 average working time per week is 51, 51, and 47.6 hours in the internal medicine, surgical, and
371 comprehensive nursing care units, respectively, indicating a slightly longer duration than
372 reported by the Labor Union of Korean Healthcare Service [15]. Meal time out of the total
373 working time was 192.1 minutes with 15.5 minutes per nurse, 227.3 minutes with 12.7 minutes
374 per nurse, and 206.4 minutes with 18.8 minutes per nurse in the internal medicine, surgical,
375 and comprehensive nursing care units, respectively, indicating that the meal time was the
376 longest in the comprehensive nursing care unit. It could be estimated that the meal time in all
377 three units respectively accounted for 2.5%, 2.1%, and 3.3% of the total working time,
378 indicating that nurses hurriedly eat meals in substantially limited time (20 minutes). The Labor
379 Standards Act, Article 54[16] stipulates that workers should be given a rest break of 30 minutes
380 or longer or 1 hour or longer if they work 4 or 8 hours, respectively. Break times including
381 meal and personal times were very small, comprising 4% of the total working time, suggesting
382 that there is high working intensity in clinical practice. Therefore, it is essential to secure a
383 minimum meal time, provide break opportunities to enhance nurses' well-being, and create a
384 nursing working environment that encourages nurses to serve effectively for long periods [17].

385 Nursing intensity includes nurses' technical and physical efforts, mental efforts, and
386 judgment and nursing time. However, this study calculated a representative value of nursing
387 intensity in each nursing unit using weighting coefficients by patient classification groups [6].
388 The results revealed that the nursing intensity score per patient was 5.4, 5.7, and 2.4 points in
389 the internal medicine, surgical, and comprehensive nursing care units, with nursing intensity
390 in the surgical unit being highest. This nursing intensity index makes it possible to directly
391 compare nursing intensity scores and can be effectively used for nurse staffing at hospitals.

392 The total nursing intensity score in the nursing units was 67.49, 101.55, and 26.52 points in

393 the internal medicine, surgical, and comprehensive nursing care units, respectively. In a study
394 by Lundgren-Laine and Suominen [18], the average nursing intensity score in the intensive
395 care unit was found to be 12.4 points. In a study by Fagerströmn and Rauhala [19], the average
396 nursing intensity per patient was found to be 13.4 points in 86 nursing units of 14 hospitals in
397 Finland. Compared with the study results by Fagerströmn and Rauhala [19], the nursing
398 intensity in this study was high. Although it is difficult to directly compare the two studies,
399 such a difference in nursing intensity may be attributed to differences in working environments,
400 data collection period, and study participants.

401 Park et al. [20] estimated nursing costs by patient classification groups in a general nursing
402 unit and revealed that the proportion of direct nursing time was 44.1% of the average total
403 nursing time per patient per day, while that of non-direct nursing time was 55.9%. The results
404 of this study revealed that the proportion of non-direct nursing time in the internal medicine
405 and surgical units was less than 50%, while that of non-direct nursing time was 74.4%, which
406 indicate a distinct difference according to the units' characteristics.

407 To determine the appropriate nurse staffing in nursing units, factors related to a particular
408 patient's nursing needs should be identified [21]. Fagerström et al. [22] claimed that personal
409 characteristics of inpatients such as gender, age, health status, and situational factors affected
410 their nursing needs, thereby affecting nurses' workload and nursing intensity. It is also
411 important to distinguish between patient- and unit-related workload when measuring nurses'
412 workload by a patient classification system based on the measurement of nursing intensity. It
413 has been pointed out that when measuring nursing intensity, only nurses' workload related to
414 patients was measured, while workload related to the unit to which nurses belonged was not
415 included [23]. In other words, although nurses' workload may increase due to factors related
416 to the respective units, their unit-related workload may be overlooked and may thus be
417 underestimated.

418 Although nurses' nursing activities may vary depending on the severity of patients' illness,
419 the latter may not always affect their nursing needs [24]. Even patients with low severity of
420 illness may have high nursing needs due to physical and emotional discomfort, and the quantity
421 of nursing activities actually performed may increase. Patients with a high severity of illness
422 can also benefit from different lengths of nursing time and skill levels [25].

423 Patients' individual characteristics, such as gender, age, diagnosis, length of hospital stay,
424 activities of daily living, weight, presence or absence of mental illness, terminal patient status,
425 route of admission, surgical status, and the need for a guardian or a privately employed
426 caregiver, were differentially scored and reflected in examining nursing needs using the patient
427 classification tool. The handover time for individual patients was divided into < 30 minutes
428 and ≥ 30 minutes, and was differentially scored. The number of times required for nursing
429 assessment and planning nursing activities was also subdivided and scored. The number of
430 times doctors were notified was divided into < 5 times, ≥ 5 times, < 10 times, and ≥ 10 times
431 and differentially scored. Related to training and supervising new nurses, efforts were made to
432 reflect situational factors related to nurses, such as adjusting scores for preceptors whose
433 preceptee had < 2 or ≥ 2 months of experience.

434 To determine whether the nurse staffing level is appropriate for patient care, an accurate basis
435 for nursing needs [5] with a detailed patient classification tool to calculate the optimal number
436 of nurses is required. However, if additional indicators or scales are added, it will be another
437 burden for nurses to observe patients and record data every day as in the current system, with
438 the accuracy of data being lower than it is now [5].

439 The results of this study revealed that the optimal number of nurses in each nursing unit was
440 25, 37, and 22, which amounts to 1.80, 1.94, and 1.0 beds per nurse in the internal medicine,
441 surgical, and comprehensive nursing care units, respectively, corresponding to nurse staffing
442 grade 1 level. This proves that applying the nurse staffing grade 1 for general units to the

443 respective nursing units is an appropriate staffing level.

444 South Korea's nursing workforce problem is not a shortage of licensed nurses, but one of an
445 active nursing workforce, due to working conditions. To create an environment in which
446 experienced nurses can continue to work effectively, it is necessary to reflect an experienced
447 nurse retaining index in the reimbursement policies or to develop policies that offer economic
448 rewards for experienced nurses and build stable working environments.

449 This study's limitations are as follows: Because it involved only three nursing units at a
450 single hospital, it may not represent all nursing units in South Korea. Repetitive studies are
451 needed to verify as to whether the research method used is applicable even in situations where
452 the size and type of medical institutions, the characteristics of nursing units, and the level of
453 securing nursing personnel are different.

454 Despite these limitations, the results of this study are significant: First, previous studies have
455 measured nursing needs to calculate nursing workload. However, this study measured nursing
456 intensity in the nursing units using patient classification scores based on nursing needs,
457 presenting it as coefficients in the nursing units. This can be a useful indicator for the allocation
458 of resources such as workforce at hospitals by comparing nursing intensity between nursing
459 units. Second, this study proposed a new approach to the current situation that lacks various
460 attempts to develop calculation methods for optimal nurse staffing.

461

462 **Conclusion**

463 This study attempted to calculate not only the direct nursing time per patient and nursing
464 intensity per nurse in nursing units using data from a survey on total working time and indirect
465 nursing time, but also the direct nursing time by patient classification group and the optimal
466 number of nurses in nursing units to provide basic data for calculating the required number of
467 nursing personnel. The nursing intensity score per nurse in each nursing unit was the highest

468 in the surgical unit, followed by the internal medicine and the comprehensive nursing care
469 units. The results of comparing the optimal number of nurses in each nursing unit, calculated
470 by reflecting nursing time and nursing intensity with the currently assigned number of nurses,
471 revealed that additional nurses were needed in the internal medicine and surgical nursing units.
472 The results also revealed that break time was not properly guaranteed during working hours.
473 Therefore, it is necessary to secure an optimal number of nurses through additional
474 employment and to create a working environment encouraging nurses to work effectively for
475 long periods.

476

477 **List of Abbreviations**

478 KPCSNI: Korean Patient Classification System on Nursing Needs for Intensive Care Units

479 PAONCIL: Professional Assessment of Optimal Nursing Care Intensity Level

480

481 **Declarations**

482 **Ethics approval and consent to participate**

483 This study was approved by the institutional review board at C University (approval number:
484 1040271-201808-HR-026).

485 **Consent for publication**

486 Not applicable

487 **Availability of data and materials**

488 Data sharing is not applicable to this article

489 **Disclosure statement**

490 The authors declare no conflicts of interest.

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495 **Author contributions**

496 YK conceived the study, participated in its design and coordination, and drafted the manuscript. BP

497 participated in the design of the study and performed the statistical analysis. Both authors read and

498 approved the final manuscript.

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