

1 TWO EMERGENCY DEPARTMENTS, 6000 KILOMETERS APART: DIFFERENCES IN  
2 PATIENT FLOW AND STAFF PERCEPTIONS ABOUT CROWDING

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ABSTRACT

Introduction: Emergency department (ED) crowding is a worldwide public health issue. In this study, patient flow and staff perceptions of crowding were assessed in Pakistan (Aga Khan University Hospital (AKUH) and in the Netherlands (Medical Centre Haaglanden Westeinde (HMCW)). Bottlenecks affecting ED patient flow were identified.

Methods: First, a one-year review of patient visits was performed. Second, staff perceptions about ED crowding were collected using face-to-face interviews. Non-participant observation and document review were used to interpret the findings.

Results: At AKUH 58,839 (160 visits/day) and at HMCW 50,802 visits (140 visits/day) were registered. Length of stay (LOS) at AKUH was significantly longer than at HMCW (279 minutes (IQR 357) vs. 100 minutes (IQR 152)). There were major differences in patient acuities, admission and mortality rates, indicating a sicker population at AKUH. Respondents from both departments experienced hampered patient flow on a daily basis, and perceived similar causes for crowding: increased patients' complexity, long treatment times, and poor availability of inpatient beds.

Conclusion: Despite differences in environment, demographics, and ED patient flow, respondents perceived similar bottlenecks in patient flow. Interventions should be tailored to specific ED and hospital needs. For both EDs, improving the outflow of boarded patients is essential.

## INTRODUCTION

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### Background

46

47 One of the most critical issues affecting emergency department (ED) delivery of care worldwide is  
48 crowding [1]. ED crowding is defined as a state where care demands exceed available resources,  
49 resulting in long waits for tests and treatments [2-4]. Crowding is a major barrier to receiving timely  
50 emergency care and it contributes to poor quality care, such as prolonged waiting times, increased  
51 suffering for those in pain, poor clinical outcomes, delays in treatment and increased risks of adverse  
52 outcomes [5-10]. Supply-demand mismatch is often caused by large hour-to-hour, and day-to-day  
53 variation in care demands where large swings in demands exceed ED resources – including staff,  
54 treatment spaces, and interdependent resources – which results in long waiting times. In addition, one  
55 of the major causes for ED crowding is by delays in accessing inpatient beds for admitted patients (i.e.  
56 boarding), which throughout the day consumes more ED resources, leaving less staff and space to care  
57 for newly arriving patients.

58 The causes, consequences, and solutions for ED crowding have been extensively described in  
59 hospitals in the USA, Canada, Australia [2,4,11-13] and Europe [14-16]. However, the problem is not  
60 limited to high-income countries: ED crowding is also an issue in lower middle-income countries such  
61 as Pakistan [17]. Although no comparison has been made between crowding issues in high-income  
62 versus lower middle-income countries, fewer resources may result in more severe crowding in lower  
63 middle-income countries.

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65 Aim

66 The aim of our study was to compare patient flow and staff perceptions of the causes and solutions of  
67 ED crowding in two EDs: one in a lower middle-income country (Pakistan) and one in a high-income  
68 country (the Netherlands). By comparing patient flow and staff perceptions regarding crowding, we  
69 sought to identify bottlenecks affecting patient flow in the ED and provide insight into promising  
70 solutions.

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72 METHODS

73 Design

74 We conducted an exploratory mixed method study incorporating a retrospective review of patient  
75 visits and semi-structured face-to-face interviews, non-participant observation, and document review.  
76 This combination of methods was chosen to provide a more complete understanding and interpretation  
77 of the quantitative data and details of the differences and similarities in patient flow and perceived  
78 crowded conditions between the two EDs. The study was performed in two EDs: the Aga Khan  
79 University Hospital (AKUH), an academic university centre in Karachi, Pakistan, and Haaglanden  
80 Medical Centre Westeinde (HMCW), a level 1 trauma centre in the Hague, the Netherlands.

81 Setting

82 The AKUH is a mixed adult and paediatric academic medical centre with 60,000 ED visits per year.  
83 Patient care in a broad range of secondary and tertiary care services is provided to all patients who  
84 present for care. Patients who are unable to pay for treatment, receive assistance through the hospital's  
85 patient welfare program. The 62-bed ED is staffed by emergency physicians (EPs), residents from the  
86 emergency medicine training program, and rotating senior residents from the departments of  
87 Medicine, Surgery, and Pediatrics. At arrival, patients are triaged by nursing staff, assisted by  
88 physicians. After triage, patients are registered and advised to wait in the waiting room in case of non-

89 availability of ED beds. Critical patients (acuity 1 and 2) are immediately led to the resuscitation area.  
90 Per shift, 20 nurses are available, most of them recently (<1 yr) graduated from nursing school.

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92 The HMCW is a mixed adult and paediatric teaching hospital, with 52,000 ED visits annually. The 24-  
93 bed ED serves as a regional trauma centre. All incoming patients are registered before they undergo  
94 triage. A certified emergency nurse (CEN) performs the triage. This CEN decides whether patients  
95 need hospital emergency care or may be assessed by an emergency nurse practitioner (ENP) or general  
96 practitioner (GP), based on the triage outcome. The latter are redirected to the GP cooperative (GPC).  
97 Critical patients are brought to an ED room. When no beds are available, patients with acuity levels 3-  
98 5 wait in the waiting room. Per shift, 8 nurses (CENs, CENs in training, or ENPs) are available.

99 Hospital profiles are listed in Box 1.

#### 100 Data collection

101 A retrospective review of all patient visits was conducted using data from August 1, 2014 to July 31,  
102 2015. Data included arrival time and date, demographics, acuity level, length of stay (LOS) and  
103 disposition (discharged home, hospital admission, transferred to other facility, left without being seen,  
104 left against medical advice, dead). Acuity levels were registered according to 5-level triage scales in  
105 which acuity 1 (Immediate, Priority (P) 1) has the highest priority and 5 (Non-urgent, P5) has the  
106 lowest priority. Examples of P1 patients are patients in respiratory or cardiopulmonary arrest, major  
107 head trauma, unresponsiveness, or active seizures [18,19].

108 Additionally, we used three qualitative sources for evidence: face-to-face semi structured interviews,  
109 non-participant observation [20], and document review. Data were collected by two researchers  
110 through 14 site visits per ED between August and November 2015, varying in length between 1 to 3  
111 hours. ED and hospital staff were instructed to help and support the researchers with the data  
112 collection by hospital management. The researchers acted together during all three parts of the  
113 qualitative data collection, individually taking notes. For the interviews, purposive sampling was used  
114 to recruit those informants that were, according to hospital leadership and ED management, most

115 likely to have relevant information regarding ED processes. Interviews were conducted using an  
116 interview guide which was developed by the researchers and included open-ended questions regarding  
117 the causes of crowding and interventions to decrease crowding. Eighteen one-hour interviews were  
118 conducted with hospital administrators (1 in each setting), ED nurse managers (1 in each setting), ED  
119 nurses (4 in AKUH, 2 in HMCW), nurses and nurse managers from inpatient units (3 in AKUH, 1 in  
120 HMCW), EPs (1 in each setting) and other physicians (2 in AKUH). All respondents were questioned  
121 individually at their workplace. After 18 interviews (12 in AKUH) and 6 in HMCW) no new relevant  
122 knowledge was obtained (data saturation). Observations were performed at EDs, inpatient units,  
123 Operation Rooms, and Admission Offices. Observations focused on patient flow through the ED, and  
124 as such, the processes from waiting room, triage, and placement in an ED bed, to the diagnostic  
125 procedures and physician assessment, admission procedures and outflow of the department were  
126 observed. Finally, 24 documents that might add knowledge about the patient flow processes were  
127 reviewed. These documents included medical and nursing notes of 16 patients (8 per hospital),  
128 admission policies (1 per hospital), transfer protocols (1 per hospital), triage protocols (1 per hospital),  
129 and procedures for internal transportation (1 per hospital).

### 130 Ethical considerations

131 As the current project originated from a consultancy assignment carried out at the request of AKUH  
132 management, use of the data for scientific research and publication was not foreseen originally.  
133 Therefore, ethical review committee approval was not obtained before the moment of first data  
134 collection. While ethical approval for re-use and publication of the data was sought later, the ethical  
135 review committee at AKUH was not authorized to evaluate the re-use of data collected at a previous  
136 point in time. Formal ethical approval of the study is therefore only available from the Dutch ethical  
137 review committee (METC Southwest Holland, nr.15-111), which granted review board exemption.  
138 The patient datasets from both countries did not contain individual identifiers. In both countries,  
139 informed consent was gained before the interview began; the respondents were fully informed of the  
140 nature and purpose of the project, and the voluntary nature of their participation was emphasized. In  
141 both countries, consent for non-participant observation and document review was provided by hospital

142 leadership and ED management. Close involvement of authors from both countries in the project and  
143 the writing process ensured correct interpretation of location-specific findings.

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#### 145 Data analysis

146 Quantitative data were entered in SPSS v.22. Data were reported as mean and standard deviation (SD),  
147 or, in case of skewed distribution, median and interquartile ranges (IQR). Data were analyzed using  
148 two-tailed *t* tests, Mann Whitney U tests, and  $\chi^2$  tests where appropriate. Statistical significance was  
149 set at  $P \leq 0.05$ .

150 The transcription of the interviews was completed within 12 hours of the interview. Two researchers  
151 read these transcripts several times to achieve a general feeling of the whole. Then the transcripts were  
152 analyzed using inductive content analysis [20]. The unit of analysis was text relating to the  
153 respondents' perceptions of causes of crowding and interventions to reduce crowding. The text within  
154 the unit of analysis was extracted to meaning units; the meaning units were then condensed, coded and  
155 categorized [21] (Table 1). A pre-determined framework was used for the codes, based on the  
156 conceptual model of ED crowding [22], which structures crowding causes and interventions into ED  
157 input, ED throughput, and outflow of the ED / exit block. Where there was ambiguity, the final coding  
158 was determined by mutual agreement. Categories were causes of ED crowding and interventions to  
159 reduce crowding. Finally, we used member-checking with the respondents to verify the accuracy and  
160 validity of the codes and categories.

161 Observation notes and document review notes were transcribed within 12 hours. First, two researchers  
162 labeled the notes and coded and categorized the notes the same way as the interview data. Then the  
163 notes were shared and reviewed by the same two researchers. Second, we used member-checking by  
164 sharing initial drafts of the results with ED management to verify the accuracy and validity of the  
165 observations and document review.

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## RESULTS

168 The results emerging from the analysis are described below.

## 169 **Patient and visit characteristics**

170 At AKUH 58,839 ED visits were registered during the 1-year study period (160 visits/day, min. 117 -  
171 max. 247 visits). At HMCW 50,802 ED visits were registered (140 visits/day, min. 94 - max. 186  
172 visits). Both EDs have peak times in patient arrivals between noon and 8 pm, but at AKUH the peak  
173 lasts until midnight (Figure 1).

174 Basic characteristics are shown in Table 2. Median LOS at AKUH was 279 minutes (IQR 357). For  
175 37.9% of the AKUH patients LOS exceeded 6 hours. Median ED LOS at HMCW was 100 minutes  
176 (IQR 152). Only 3.3% of the patients at HMCW had LOSs >6 hours. There were major differences  
177 between AKUH and HMCW in acuity. Almost 17% of AKUH patients were assigned a P1 acuity,  
178 while this was 1% of HMCW patients. The P4 and P5 acuities were assigned to 10% of AKUH  
179 patients, while in HMCW more than 42% of the patients were assigned a standard or not-urgent acuity  
180 (Figure 2). At AKUH, significantly more patients were admitted (35%) than at HMCW (20.9%,  
181  $P<0.001$ ). Also, mortality was significantly higher at AKUH (1.4% vs. 0.1%,  $P<0.001$ ).

182 At AKUH, P1 patients have the longest LOS (387 minutes), followed by P2 patients (372 minutes). In  
183 HMCW, P2 patients have the longest LOS (168 minutes), followed by P3 patients (135 minutes)  
184 (Table 3 & Figure 2).

## 185 **Interviews**

### 186 Perceived causes for ED crowding

187 Respondents from both EDs indicated that crowding occurs on a daily basis. On an average day, the  
188 ED is crowded during 12 hours, from 12 AM until 12 PM (at AKUH) and during 4 hours, from 4 to 8  
189 PM (at HMCW).

190 *ED Input:* Respondents from both EDs mentioned an increase in visits of patients with complex  
191 problems (Table 4).



192 Many of our patients first go to cheaper doctors, until they are very sick; AKUH is the hospital  
193 of last resort, so our patients are really in need for specialist care, they are almost all P1 or P2  
194 (AKUH, physician).

195 HMCW respondents stated that the increase in severity is caused by the increase in geriatric patients  
196 with comorbidities, and the increase in number of referred patients since the implementation of the  
197 GPC.

198 Patients are getting more and more complex and also more and more elderly present to the ED  
199 (HMCW, ED nurse).

200 *ED Throughput:* Respondents at both EDs mentioned delays in triage and long waiting times for  
201 diagnostics. The actual waiting times for diagnostics differed from “up to 6 hours” at AKUH to “up to  
202 2 hours” at HMCW. The delay in decision-making process, especially in patients needing admission  
203 was also mentioned by respondents at both EDs. At AKUH, a specialty consultation is required in  
204 order to process the decision for admission, and these specialties often order extra diagnostic tests. At  
205 HMCW, EPs are allowed to admit patients independently, but involvement of multiple medical  
206 specialists delay the process. The lack of experienced nursing staff was mentioned at AKUH. Also,  
207 financial issues were mentioned by AKUH respondents. Patients keep ED beds occupied until advance  
208 payment is arranged by their family.

209 Money issues delay the admission process “[...]”. During the day, a financial help is available  
210 for the ED. During the evening, there is only one financial help for the entire hospital (AKUH,  
211 admission coordinator).

212 *Outflow of the ED / Exit block:* Staff of both EDs mentioned high hospital occupancy rates and a  
213 shortage of available inpatient beds.

214 Sometimes, there is no bed available in our hospital and we’re waiting for an ambulance to  
215 bring the patient to another hospital, and sometimes we’re just waiting for a nurse from an  
216 inpatient unit. Meanwhile, new patients can’t get in (HMCW ED nurse).

217 AKUH respondents stated that research and education activities are organized in the morning, and  
218 inpatient patient care in the afternoon. Therefore, inpatient beds come available in the evening and  
219 patient transfer from the ED to the wards is delayed (up to 8 hours waiting time at the ED, for the  
220 majority of the admitted patients). HMCW respondents also mentioned delayed patient transfer to the  
221 wards, in particular when more than one medical specialty is involved (up to 4 hours, for less than half  
222 of the admitted patients).

223

#### 224 Interventions that would be helpful in mitigating ED crowding according to the respondents

225 *ED Input:* Some AKUH nurses would like to be educated as ENP to handle patients with minor  
226 injuries and minor illnesses.

227 *ED Throughput:* Respondents wished for more mandate of EPs at AKUH, to cut back the delays in  
228 reaching a decision to admit or discharge a patient. AKUH respondents emphasized the need for more  
229 efficient processes for diagnostics, pharmacy, and financial issues, as well as a higher level of  
230 education for the nurses.

231 *Outflow of the ED / Exit block:* respondents at both EDs stated that an Acute Admission Unit (AAU)  
232 would be the solution to the crowding problems. The coordination of the discharged patients before  
233 noon was mentioned by the Admission Coordinator at AKUH.

234 The respondents at HMCW considered a more effective hospital bed coordination the most important  
235 intervention to decrease ED crowding.

236 At both EDs, respondents wanted additional nursing staff and EPs.

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#### 238 **Observations and document review**

239 Observations at both EDs supported the remarks mentioned by the respondents: delays in triage (both),  
240 in the decision-making process (both), in diagnostic imaging and laboratory results (AKUH), and  
241 inpatient boarding (both) were observed. Delays at AKUH were longer than delays at HMCW. There

242 was also a difference in activities and tasks of the nursing team; AKUH nurses wait for instructions of  
243 the physicians. The CENs at HMCW are allowed to request a variety of diagnostic procedures and  
244 administer analgesia without a physicians' order. Guidelines regarding nurse-initiated medication  
245 prescriptions and diagnostics are readily available for ED staff.

246 A real-time patient tracking system is available at HMCW, which warns ED staff when a patients'  
247 LOS approaches 4 hours and when target times to treatment elapse. AKUH staff working in the  
248 treatment bays cannot overview the waiting room, and have no visual on the patients waiting for triage  
249 and patients with elapsed target times to treatment.

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## DISCUSSION

252 Although patient populations and acuities differ between the EDs, both experience regular crowding.  
253 Contributing factors to crowding are similar: increased patients' complexity, long treatment times, and  
254 poor availability of inpatient beds. In both hospitals, ED crowding is caused by exit block from the ED  
255 and the resulting boarding of admitted patients. In addition, at AKUH major throughput causes are  
256 apparent: lengthy patient stays, waits for physicians' decision-making, and other time-consuming  
257 circumstances such as the pharmacy process and waits for financial clearance. At HMCW, patient  
258 outflow is considered an essential intervention. At AKUH throughput as well as output should be  
259 improved.

260

261 Both EDs have struggled against crowding for years. At HMCW, crowding is a problem since 2002.  
262 To improve patient flow, standing orders are used: triage nurses are trained to request analgesia, x-rays  
263 and blood tests. In response to an increasing demand for emergency care, an ENP service was  
264 established to handle non-urgent patients. Furthermore, flexible bed management was implemented to  
265 improve outflow of admitted patients [23]. Waiting times and LOSs were cut back with two hours per  
266 patient and are nowadays short in comparison with international standards [24].

267 At AKUH, ED crowding was first described in 2004 [25]. To improve patient flow a dedicated triage  
268 bay with 24/7 cover and physician-assisted triage (PAT) was introduced. PAT has been shown to  
269 improve patient flow [26]. The number of treatment bays at the AKUH ED was expanded from 26 to  
270 49 in 2008 and then to 62 in 2012. Personnel still experience a shortage of treatment bays, which is not  
271 surprising given the lengthy stays of patients.

272 Differences between the EDs were mainly found in the throughput phase, or more specifically, the  
273 time spent in the ED. Some problems at AKUH are not an issue at HMCW, such as the lack of  
274 experienced nursing staff (almost all nurses have a CEN-degree), financial issues (Dutch citizens have  
275 basic health insurance) and the time-consuming pharmacy process (a pharmacy-depot is readily  
276 available at the HMCW ED and nurses are allowed to arrange the needed medication themselves).

277 According to the respondents, the long LOSs at AKUH are caused by delays in reaching a decision to  
278 admit the patient. This is supported by the quantitative data: even the P1-patients have long LOSs at  
279 AKUH (>6 hours). One would expect that patients in the highest level of acuity wait for a shorter  
280 period of time than patients in the lower acuities since criteria for admission are usually clear-cut: the  
281 patient needs intubation and ventilation, or another life- or limb saving intervention. Since P2 and P3  
282 patients in general need more assessment in order to decide whether they need admission, their LOSs  
283 are expected to be longer than for P1-patients [27]. While this is the case at HMCW, it is not at  
284 AKUH. At AKUH, LOS increases simultaneously with acuity. Prolonged LOS is one of the  
285 throughput-causes of ED crowding [3].

286 AKUH staff perceived that crowding could be reduced by more efficient ED processes and by  
287 increased capacity within the hospital. Involving senior doctors in the rapid assessment and treatment  
288 could improve the decision-making process [28,29]. Waiting times for radiology and laboratory might  
289 reduce when installing service level agreements [29]. Coordinating the discharge process of hospital  
290 patients before noon could be helpful in speeding up the admission process at AKUH [28].

291 In both hospitals, urgency for improving flow is felt mainly in the ED and less in the hospital. At  
292 HMCW, ED staff is continuously focused on expediting patient flow. Having an average of 140

293 patients per day at a 24-bedded ED puts the focus on throughput and output, to be able to care for new,  
294 incoming patients. During crowding, an extra triage room is set up, inpatient units are summoned to  
295 pick up the admitted patients immediately and consultants are called by the EPs to help with the  
296 decision-making process. At the 64-bedded AKUH ED, nurses and EPs working in the treatment areas  
297 are not aware of the patients waiting for treatment in the waiting room and in triage. A patient tracking  
298 system visible for ED staff at AKUH could allow the nurses and EPs to anticipate on the incoming  
299 patients.

300 Crowding is an important patient safety issue [30,31]: patients presenting to a crowded ED experience  
301 poorer health outcomes [32]. Successful solutions to crowding are necessary to protect our patients.  
302 Individual organizations face different problems, and each organization should determine the best  
303 solutions to its crowding problem [8]. For example, early ward rounds at AKUH to match bed  
304 availability with demand is likely to improve patient flow at AKUH.

305 There are also similarities in possible solutions. Both hospitals may benefit from agreed, achievable,  
306 escalation policies: clear thresholds to what level of crowding is acceptable and when to recruit  
307 support from resources outside the ED, e.g. from inpatient units, admission office, and medical  
308 specialists. To achieve that, culture and process changes are necessary in both hospitals.

309 Acknowledgement from hospital management and medical specialists that crowding is a hospital-wide  
310 patient flow problem is key for both EDs [33,34].

311

### 312 Limitations

313 This study represents an initial effort to compare patient flow and perceived crowding issues between  
314 a hospital in a lower middle-income country and one in a high-income country. The EDs were grossly  
315 similar, both being level 1 trauma centers in large cities. Differences between both countries in  
316 healthcare systems, patient populations, financial regulations, and pre-hospital care directly influence  
317 ED patient flow, which became clear during the interviews and observations. Still, the generalizability  
318 of our findings is limited. The HMCW is not representative to all EDs in high-income countries, and

319 AKUH is not representative to all other EDs in Pakistan nor to other EDs in lower middle-income  
320 countries. Moreover, we were not able to include crowding measures [35] such as time to physician or  
321 other measures that can be linked to ED crowding besides patients' LOS. While at HMCW waiting  
322 room time and crowding scores (NEDOCS) are available per 15 minutes, these data were not available  
323 at AKUH. More studies are needed to substantiate the impact of crowding in lower middle-income  
324 countries.

325 The second part of this study, by nature of being a qualitative assessment, does not attempt to  
326 generalize findings. We assumed that hospital administrators, ED staff, nurse managers, nurses, and  
327 EPs correctly assess the operations in their department. During the data analysis procedure, data were  
328 reviewed and discussed by two researchers to ensure inter-reliability. Furthermore, we used member-  
329 checking and triangulation to increase data and conclusion credibility and transferability.

330 Finally, the cultural diversity of the EDs should be considered. There are major differences in attitudes  
331 and major differences in workflow and environment. Not all solutions to crowding that are used in  
332 HMCW are equally applicable to AKUH and the other way around. However, the model of input,  
333 throughput, and output [22,36] which we used to study the causes of crowding is very useful in  
334 recognizing the most important causes as well as the promising solutions for both EDs.

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## CONCLUSIONS

338 At the two EDs with different patient populations and different working strategies in two different  
339 countries, nurses and EPs experience bottlenecks in patient flow on a daily basis. Despite differences  
340 between the hospitals in environment, demographics, and health care organization, the causes of this  
341 hampered patient flow appear to be similar.

342 Solutions to mitigate crowding should be tailored to the specific ED and surrounding hospital,  
343 although improving the outflow of patients will improve patient flow in both EDs.

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438

439 Box 1. Hospital profiles

440

441		AKUH	HMCW
442	No. of ED beds	64	24
443	No. of staffed beds in hospital	597	300
444	No. of ICU beds in hospital	55	16
445	Triage system	Emergency Severity Index	Manchester Triage System
446	Triage staffing	Physician Assisted Triage	Certified Emergency Nurse
447	Average no. of physicians per shift	16 (3 consultants, 13 residents)	8 (1 consultant, 7 residents)
448	No. of nurses per shift	20	8
449	No. of nurse-assistants per shift	7	0
450	No. of nurse practitioners per shift	0	1

451

452 Abbreviations: AKUH, Aga Khan University Hospital; ED, emergency department; ICU, intensive  
453 care unit; HMCW, Haaglanden Medical Centre Westeinde.

454

455

456

457 Table 1. Example of Content Analysis Categorization

Meaning Unit	Condensed meaning unit	Code	Category
“The main problem are the patients who are waiting for a bed, ready to be admitted to the hospital, waiting and waiting in an ED exam room just to get picked up by the hospital nurses.	Patients waiting to get picked up by the nurses of the inpatient unit	Outflow of the ED / exit block	Perceived cause of ED crowding
The hospital nurses have no clue that when they [hospital nurses] don’t show up timely, we [ED nurses] have a problem.	Hospital nurses have no clue of ED problem	Outflow of the ED / exit block	Perceived cause of ED crowding
Often, they [hospital nurses] are reluctant in accepting a new patient – as if patients are not their core business!”(HMCW, ED nurse)	Reluctance of hospital nurses in accepting new patients	Outflow of the ED / exit block	Perceived cause of ED crowding

458

459 Abbreviations: ED, emergency department; HMCW, Haaglanden Medical Centre Westeinde.

460

461 Table 2. Visit characteristics (N=109,641)				
462		463 AKUH (n=58,839)	463 HMCW (n=50,802)	463 <i>P</i>
464				
465	Median ED LOS, minutes (IQR)*	279 (357)	100 (152)	<0.001
466	LOS > 6 hours (% , n)*	37.9 (22,313)	3.3 (1,676)	<0.001
467				
468	Gender, male (% , n)	53.3 (31,360)	52.3 (26,571)	0.001
469				
470	Mean age, y (SD)**	35.1 (25.4)	41.4 (23.1)	<0.001
471				
472 Age categories (% , n)**				
473	<17 y	29.5 (17,384)	14.9 (7,556)	<0.001
474	18-60 y	49.1 (28,866)	61.6 (31,299)	<0.001
475	>60	21.4 (12,588)	23.5 (11,944)	<0.001
476				
477 Acuity level (% , n)				
478	No triage	0	2.5 (1,283)	<0.001
479	P1, immediate	16.7 (9,834)	1.0 (500)	<0.001
480	P2, high urgent	19.9 (11,688)	16.6 (8,440)	<0.001
481	P3, urgent	53.4 (31,427)	37.5 (19,032)	<0.001
482	P4, standard	8.2 (4,810)	41.3 (21,003)	<0.001
483	P5, non-urgent	1.8 (1,080)	1.1 (544)	<0.001
484				
485 Disposition (% , n)				
486	Admitted to the hospital	35.0 (20,584)	20.9 (10,625)	<0.001
487	Discharged home	52.2 (30,874)	57.2 (29,077)	<0.001
488	Transferred to other facility	0.7 (435)	0.6 (312)	0.012
489	Dead	1.4 (825)	0.1 (59)	<0.001
490	Left against medical advice	7.2 (4,257)	0.9 (458)	<0.001
491	Left without being seen	0	0.4 (205)	
492	Assessed by ENP	0	19.5 (9,888)	

493      Other                                      3.2 (1,864)                                      0.4 (178)                                      <0.001

494

495      Abbreviations: AKUH, Aga Khan University Hospital; ED, emergency department; ENP, emergency  
496      nurse practitioner; HMCW, Haaglanden Medical Centre Westeinde; IQR, interquartile range; LOS,  
497      length of stay; SD, standard deviation.

498

499      \*Based on 109,632 cases, due to 9 with missing data on LOS

500      \*\* Based on 10,963 cases, due to 4 with missing data on age

501

502

503 Table 3. Length of stay per acuity level (N=108,358)

504

505	Median LOS in minutes (IQR)	AKUH (n=58,839)	HMCW (n=50,802)	<i>P</i> *
506				
507	LOS No triage	-	3 (27)	-
508	LOS P1, life-threatening	387 (415)	116 (149)	<0.001
509	LOS P2, high urgent	372 (335)	168 (111)	<0.001
510	LOS P3, urgent	254 (323)	135 (138)	<0.001
511	LOS P4, standard	71 (117)	44 (98)	<0.001
512	LOS P5, non-urgent	34 (50)	10 (24)	<0.001

513

514 Abbreviations: AKUH, Aga Khan University Hospital; HMCW, Haaglanden Medical Centre  
515 Westeinde; IQR = interquartile range; LOS, length of stay.

516 \*Based on 108,358 cases, due to 1,283 observations with missing data on acuity level and 9 missing  
517 data on LOS.

518

519

520 Table 4. Perceptions of causes for ED crowding, similarities of AKUH and HMCW

<b>ED INPUT</b> <ul style="list-style-type: none"><li>- Increase in ED visits of patients with complex problems.</li><li>- Increase in severity over the years.</li></ul>
<b>ED THROUGHPUT</b> <ul style="list-style-type: none"><li>- Delay in triage</li><li>- Long waiting time for diagnostic procedures</li><li>- Delay in decision-making process, especially in patients needing admission, leading to long LOS.</li><li>- Delay in admission-time when more than one specialty is involved.</li></ul>
<b>OUTFLOW OF THE ED / EXIT BLOCK</b> <ul style="list-style-type: none"><li>- Boarding of patients</li><li>- High hospital occupancy rate / shortage of available inpatient beds.</li><li>- Delayed transfer of patients to wards.</li></ul>

521 Abbreviations: AKUH, Aga Khan University Hospital; ED, emergency department; HMCW,

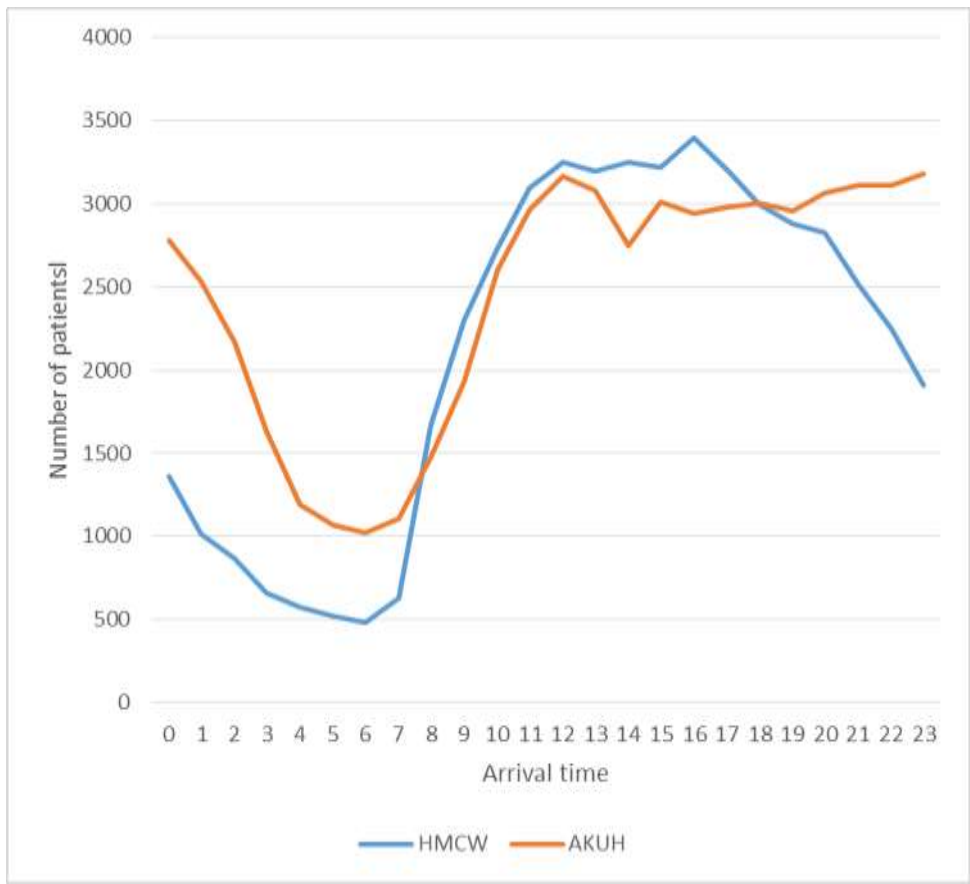
522 Haaglanden Medical Centre Westeinde; LOS, length of stay.

523

524



525 Figure 1. Arrival times of the patients

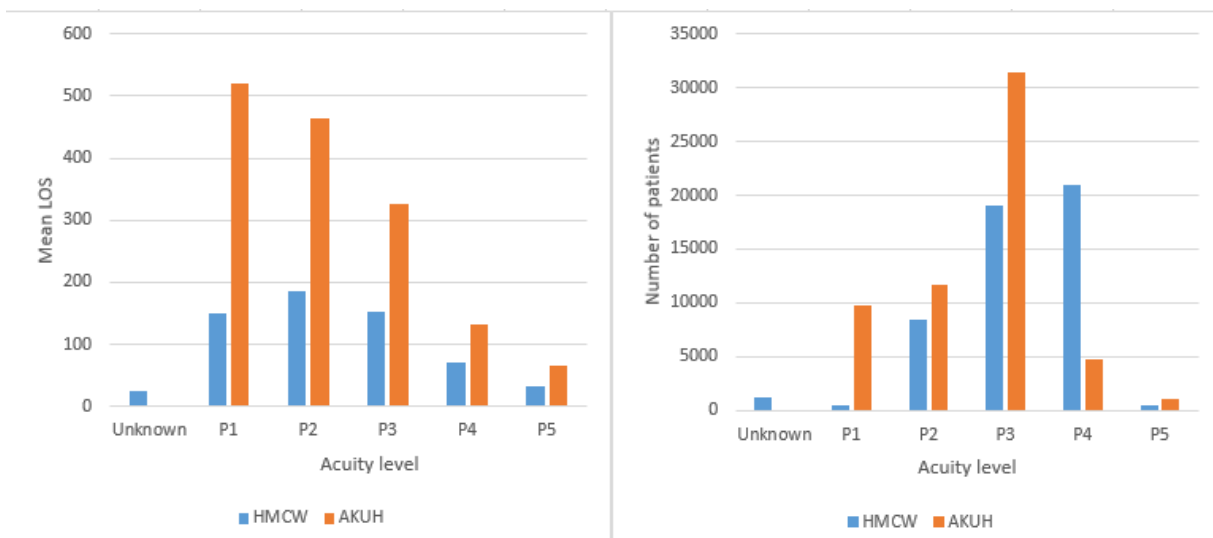


526  
 527  
 528 Abbreviations: AKUH, Aga Khan University Hospital; HMCW, Haaglanden Medical Centre  
 529 Westeinde.

530

531 Figure 2. Length of stay and No. of patients per acuity level

532



533

534

535 Abbreviations: AKUH, Aga Khan University Hospital; LOS, length of stay; HMCW, Haaglanden

536 Medical Centre Westeinde.

537