

# Journal of Patient Safety and Risk Management

## Hand hygiene compliance among healthcare workers in Ghana's health care institutions: an observational study.

Journal:	<i>Journal of Patient Safety and Risk Management</i>
Manuscript ID	CR-20-006.R2
Manuscript Type:	Original Research Paper
Date Submitted by the Author:	07-Aug-2020
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Keyword:	Compliance, Infection control, Primary care, Ghana
Abstract:	<p><b>Objective</b> To assess hand hygiene compliance in selected primary hospitals in Ghana.</p> <p><b>Design</b> A cross-sectional health facility-based observational study.</p> <p><b>Setting</b> Primary health care facilities in five regions in Ghana.</p> <p><b>Participants</b> A total of 546 healthcare workers including doctors, nurses, midwives and laboratory personnel from 106 health facilities participated in the study.</p> <p><b>Main outcome measures</b> The main outcome measures included availability of hand hygiene materials and alcohol job aids; compliance with moments of hand hygiene; and compliance with steps in hygienic hand washing. These were assessed using descriptive statistics.</p> <p><b>Results</b> The mean availability of hand hygiene material and alcohol job aids was 75% and 71% respectively. This was described as moderately high, but less desirable. The mean hand hygiene compliance with moments of hand hygiene was 51%, which was also described as moderately high, but less desirable. It was observed that, generally, hand hygiene was performed after procedures than before. However, the mean compliance with steps in hygienic hand washing was 86%, which was described as high and desirable.</p> <p><b>Conclusion</b> Healthcare workers are generally competent in performance of hygienic hand washing. However, this does not seem to influence compliance with moments of hand hygiene. Efforts must therefore be made to translate the competence of healthcare workers in hygienic hand washing into willingness to comply with moments of hand hygiene, especially contact with patients.</p>

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3 **Hand hygiene compliance among healthcare workers in Ghana's health care institutions: an**  
4 **observational study.**  
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9 **Acknowledgements**  
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11 The authors are grateful to the Ghana Health Service, and by extension USAID and Systems for  
12 Health, for providing this data for analysis towards publication.  
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16 **Author Contributions**  
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18 The coauthors have all contributed substantially to this manuscript and approve of this  
19 submission. AAA, JA and PAA: study concept and design. SKA and GN: acquisition of data.  
20 AAA, JA, AAD and RKA: analysis and interpretation. All authors: critical revision of the  
21 manuscript for important intellectual content. SKA: study supervision.  
22  
23

24 **Declaration of Conflicting Interests**  
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26 The Authors declare that there is no conflict of interest  
27

28 **Funding** This study was undertaken by the Ghana Health Service with funding support from  
29 USAID and Systems for Health. The University of Ghana Business School supported with  
30 funding for data analysis and report writing.  
31

32 **Ethical Approval /Patient consent**  
33

34 This study was undertaken by the Ghana Health Service as part of their routine monitoring and  
35 evaluation of programmes in the Ghana health sector.  
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## Introduction

Infection prevention and control (IPC) is a universally important component of all health systems and affects the health and safety of both people who use services and those who provide them. Healthcare associated infection (HAI) is a common adverse event that can result in prolonged hospital stay, long-term disability, and death, and increased resistance of microorganisms to antimicrobial agents. It also creates an additional financial burden for the health system, patients and their families.<sup>1 2</sup> Threats posed by epidemics, pandemics and antimicrobial resistance (AMR) have become a top priority for action on the global health agenda. Instituting an effective infection prevention and control program is key to address these challenges. The International Health Regulations has therefore positioned effective IPC as a key strategy for dealing with public health threats.<sup>3</sup> The United Nations Sustainable Development Goals (SDG) emphasised the importance of IPC as a contributor to safe, effective high-quality health service delivery, in particular those related to water, sanitation and hygiene (WASH) and universal health coverage.

Hand hygiene is acknowledged to be the single most important measure to prevent HAI.<sup>4</sup> The transfer of microorganisms by health care workers (HCWs) has been identified as a major factor in the transmission of hospital-acquired infections.<sup>5-7</sup> However, HCW compliance with good hand hygiene practice is low in most settings<sup>8-10</sup>. Multiple factors influence hand hygiene performance, and its promotion is particularly complex in developing countries where limited resources and culture-specific issues can strongly influence practices.<sup>9 11-13</sup> A study by Sax, et al. on determinants of good adherence to hand hygiene among HCWs with extensive exposure to hand hygiene campaigns found that high self-reported rates of adherence to hand hygiene was independently associated with female sex, receipt of hand hygiene training, participation in a previous hand hygiene campaign, peer pressure from colleagues, perceived good adherence by colleagues, and the perception that hand hygiene is relatively easy to perform.<sup>14</sup>

Several studies have reported large differences with hand hygiene compliance among HCWs before patient contact. A systematic review of 35 studies by Erasmus, et al.<sup>15</sup> reported median compliance rates with hand hygiene by all HCWs before patient contact of 21%, whereas compliance after patient contact was higher, with a median compliance rate of 47%. They also reported that high compliance associated with glove use (8 of 8 studies), accessibility of hand hygiene materials (4 of 7 studies) and type of task, with higher compliance with dirty tasks (5 of 5 studies).

In Ghana, a cross-sectional observational study at the Komfo Anokye Teaching Hospital in Kumasi<sup>16</sup> indicated that the most commonly identified barriers to hand hygiene by HCWs were limited resources and lack of knowledge on appropriate times to perform hand hygiene. A 2009 study of the Neonatal Intensive Care Unit (NICU) of the Department of Child Health in the Korle-Bu Teaching Hospital<sup>17</sup>, indicated low hand hygiene compliance by physicians and nurses. In 2011, a cross-sectional, observational study assessed personal and care-related hand hygiene compliance among doctors and nurses and hand hygiene resources in 15 service provision centres of the Korle-Bu Teaching Hospital (KBTH). The authors found that care-related hand hygiene compliance of doctors and nurses was low and basic hand hygiene resources were deficient in all 15 service centres, ranging from 9.2% to 57% and 9.6% to 54% among nurses. Hand hygiene compliance was higher when risk was perceived to be higher (i.e., in emergency and wound dressing/treatment rooms and labour wards).

Even though these studies reveal that hand hygiene compliance is low in Ghana, they focused on only teaching hospitals which are tertiary level or referral hospitals, excluding primary hospitals. This is a majority limitation since in Ghana, primary hospitals are in the majority. Whereas Ghana had 10 regional (secondary) hospitals corresponding to the ten regions of Ghana and four teaching (tertiary) hospitals in 2013, the total number of primary hospitals distributed across the 134 Districts of Ghana was 392.<sup>18</sup> Primary hospitals play important roles because, unlike regional and teaching hospitals that are expected to attend mainly to referred patients, primary hospitals serve as the primary contacts for patients and only refer to regional or tertiary hospitals for specialist attention. In addition, primary hospitals also serve as referral hospitals to health centres and clinics in remote and rural communities. However, primary hospitals have fewer professional HCWs compared with teaching hospitals. It might be expected that hand hygiene compliance in primary hospitals will be lower than teaching hospitals. However, to our knowledge there have been no studies of hand hygiene compliance at the primary level of care in Ghana. Previous studies have also focused on observations of moments of hand hygiene to the neglect of the steps in performing hygienic hand washing. It is important to assess the competence of HCWs in performing hygienic hand washing since this could have an influence on compliance. We hypothesize that the more competent HCW are in performing hand hygiene, the more likely

they will be to comply with hand washing requirements.

## **METHODS**

### **Study design**

This was a cross-sectional, observational study of HCWs in selected primary hospitals in Ghana. It is based on primary data collected from September to November 2017 ~~in [INSERT DATES HERE]~~ by the Ghana Health Service as a follow-up study on compliance to IPC training organized during the previous six months in 106 health facilities in five regions of Ghana. Direct observation of HCWs during patient care activity by trained and validated observers has been recognized as the gold standard for hand hygiene monitoring.<sup>19-21</sup>

### **Sampling methods/selection of survey sites**

The five regions were selected for training by ~~the~~ 'Systems for Health', an agency of USAID program of through the Ghana Health Service, with funding support from USAID. In all, 546 HCWs from the 106 health facilities participated in the study. The study regions include Western, Central, Greater Accra, Volta and Northern. These regions were selected based on the operational areas of Systems for Health. The other five regions were under a different non-governmental organization (NGO), JHPIEGO. However, unlike Systems for Health, JHPIEGO's IPC activities were not co-ordinated by the national headquarters of the Ghana Health Service where these data were obtained. JHPIEGO dealt directly with the five regions under them.

### **Zoning the regions**

The Deputy Director of Clinical Care in each of the five regions zoned their region into three areas, based on proximity between health facilities and numbers to be monitored in each region. The facilities visited range from nine facilities per zone in the northern region to five facilities per zone in the Greater Accra region with an average of seven health facilities per zone.

### **Study population**

The population for the survey comprised health care workers including doctors, nurses, midwives and laboratory personnel in the selected service centres.

### **Data collection**

Trained health personnel collected the data using a modified version of WHO standardized infection prevention checklist.<sup>22</sup> The checklist took into consideration availability of hand hygiene materials and alcohol hand rub, hand hygiene moments and steps in hygienic handwashing. Overall, 68 health personnel who had prior training and experience in infection prevention procedures collected the data. The personnel were grouped into teams for data collection. Each team comprised of a national trainer and three regional trainers. Each region had three teams except Greater Accra region which had five, in view of the many health facilities in Greater Accra. The teams worked in their allocated zones. Each team spent three to four days in a facility. The team spent about a month on the field working concurrently in the regions.

In each facility seven clinical departments were scheduled for monitoring. These were; Accident/Emergency, Laboratory, Maternity, Out-patient/Treatment Room, Neonatal Intensive Care Unit (NICU) and Surgical Wards. However, some of the facilities had a combined ward named adult ward for both male and female and others did not have all the seven units. The Central Sterile Supply Department (CSSD) was also visited to observe the display of job aids for wrapping of instruments. The clinical departments were observed by two trained experts for availability of hand hygiene materials and alcohol hand rub. Three persons were observed in each unit on moments of hand hygiene and performance of hygienic hand washing.

### **Patient and public involvement**

Patients were not involved in this study.

### **Moments of Hand hygiene**

Moments of hand hygiene are specific occasions when workers should perform hand hygiene. Seven items were scored during monitoring: arrival at work; before touching a patient; before putting on gloves or other personal protective equipment (PPE); after touching patient environment; after attending to a patient; before contact with blood and body fluid, and after contact with blood or body fluids. Three staff from each facility were observed on their performance

of these items.

### Data analysis

We hypothesized that:

H1: Availability of hand hygiene materials will have a significant positive correlation with moments of hand hygiene and hygienic hand washing.

H2: Availability of alcohol hand rub will have a significant positive correlation with moments of hand hygiene and hygienic hand washing.

The positive hypotheses are motivated by the fact that staff of the hospitals studied were trained on infection prevention and control (IPC) six months prior to the study. It is expected that in the light of the recent training, hospital management will be motivated to provide more hand hygiene materials and alcohol hand rub. It is also expected that staff of the hospitals studied will easily remember the skills acquired during the recent IPC training and, given the availability of hand hygiene materials and alcohol hand rub, will highly comply with hand hygiene.

~~Mahida<sup>10</sup> argues that the question of what level of compliance is satisfactory remain unanswered despite a large amount of research into hand hygiene compliance. A systematic review Kingston, et al.<sup>23</sup> reported a mean hand hygiene compliance of 34%, rising only to 57% following interventions.~~

Frequency distributions of compliance were calculated. The mean compliance of the three staff observed were reported. The five regions studied were compared in respect of availability of hygienic hand washing materials, availability of alcohol hand rub, moments of hand hygienic and hygienic hand washing practice.

We categorized hand hygiene compliance into three group: below 50% were considered low compliance and were categorized as 'undesirable'; between 50% to 80% were considered moderately high compliance and categorized as less desirable; between 81% to 100% were considered as high compliance, and categorized as desirable. Pearson product-moment correlations were used to calculate the association between availability of hand hygiene materials and alcohol hand rub on one hand, and moments of hand hygiene and hygienic hand washing on the other. The strength of relationship were: weak,  $r = .10$  to  $.29$ ; medium,  $r = .30$  to  $.49$ ; strong,  $r = .50$  to  $1.0$ .<sup>24</sup> A percentage index score was generated through the addition of the indicators of each of the variables used to run the correlation analysis.

Data were entered into Microsoft Excel 2016 and analysed using SPSS (version 24).

### Ethical issues

This study did not require approval by the local ethics committee because it was deemed a quality improvement project of the Ghana Health Service. However, the management of the health facilities as well as heads of the involved clinical departments were informed of the study and the research methodology before research activities started.<sup>25</sup> The observed health care workers were however not aware of the fact that they participated in a hand hygiene study.

### Results

Hand hygiene materials and job aids for hygienic hand washing and alcohol hand rub were monitored to check if they were available and conspicuously displayed at hand hygiene areas. Moments of hand hygiene and performance of hygienic hand washing were then observed.

#### Availability of hand hygiene materials and alcohol hand rub

The performance of hand hygiene depended on the availability of hand hygiene materials and alcohol hand rub. Tables 1 and 2 show that on average, the availability of hand hygiene materials and alcohol hand rub were 75% and 71% respectively. The availability of a hand wash basin for staff, hand washing facility within 6 meters, running water, liquid or cake soap, and clean soap containers was between 82% to 98%. Conspicuous display of alcohol hand rub and staff orientation on alcohol hand rub were also generally present.

**Table 1. Frequency of respondents by region**

<u>Region</u>	<u>Frequency</u>	<u>Percent</u>
<u>Western</u>	<u>99</u>	<u>18.1</u>
<u>Central</u>	<u>130</u>	<u>23.8</u>
<u>Greater Accra</u>	<u>77</u>	<u>14.1</u>
<u>Volta</u>	<u>117</u>	<u>21.4</u>
<u>Northern</u>	<u>123</u>	<u>22.5</u>
<u>Total</u>	<u>546</u>	<u>100.0</u>

**Table 24. Frequency distribution of availability of hand hygiene material**

No.	Hand hygiene material	Frequency		Interpretation ('Yes' % only)		
		N (100%)	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Hand wash basin for staff	539	530(98)			√
2	Hand washing facility within 6 meters	535	428(80)			√
3	Availability of running water	540	482(89)			√
4	Liquid/cake soap is available	535	522(98)			√
5	Liquid/cake soap containers are clean	533	438(82)			√
6	Cake soap dishes perforated to allow drainage	450	302(67)		√	
7	Cake soaps cut in small sizes	432	226(52)		√	
8	Single-use hand towels/absorbent paper towels	533	436(82)			√
9	Adequate number of hand towels (20 per person per shift)	520	96(18)	√		
10	Single-use hand towels/absorbent paper towel in dispensers	522	392(75)		√	
	Mean hand hygiene material	514	385(75)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of availability of hand hygiene material

**Table 32. Frequency distribution of availability of alcohol hand rub**

No.	Availability of alcohol hand rub	Frequency		Interpretation ('Yes' % only)		
		N	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Alcohol hand rub are available at the point	543	370(68)		√	
2	Alcohol (60%-90%) labelled	523	255(49)	√		
3	Conspicuously displayed	540	442(82)			√
4	Available at all hand hygiene areas	539	411(76)		√	
5	Staff oriented on the use of job aids	531	428(81)			√
	Mean availability of alcohol hand rub	535	381(71)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of availability of alcohol hand rub

### Moments of Hand hygiene

Moments of hand hygiene are specific occasions that staff are supposed to do hand hygiene. When hand hygiene is not done during those times it means they missed those moments or opportunities. Seven items were scored during the monitoring. These were, arrival at work; before touching a patient; before putting on gloves or other personal

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protective equipment (PPE); after touching patient environment; after attending to a patient; before contact with blood and body fluid and after contact with blood and body fluid. Three staff from each facility were observed on their performance of these items. Table 3 shows frequency distribution of moments of hand hygiene of staff observed for all hospitals studied, while figure 1 shows mean moments of hand hygiene by region studied. It was generally observed that hand hygiene was performed after procedures than before. The national IPC policy and guidelines state that hand hygiene should be done before and after contact with each patient or their surroundings<sup>26</sup>.

Proof



**Table 43. Frequency distribution of moments of hand hygiene for hospitals studied**

No.	Moments of hand hygiene	Frequency		Interpretation ('Yes' % only)		
		N	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81- 100%)
1	Staff1- Arrival at work	505	170 (34)	√		
2	Staff2- Arrival at work	489	137(28)	√		
3	Staff3- Arrival at work	460	137(30)	√		
4	Staff1- Before touching a patient	530	176(33)	√		
5	Staff2- Before touching a patient	499	164(33)	√		
6	Staff3- Before touching a patient	475	159(34)	√		
7	Staff1- Before putting on gloves or other PPEs	535	224(42)	√		
8	Staff2- Before putting on gloves or other PPEs	515	205(40)	√		
9	Staff3- Before putting on gloves or other PPEs	469	190(40)	√		
10	Staff1- After touching patient	518	264(51)		√	
11	Staff2- After touching patient	506	265(52)		√	
12	Staff3- After touching patient	466	243(52)		√	
13	Staff1- After attending to a patient	517	397(77)		√	
14	Staff2- After attending to a patient	505	373(74)		√	
15	Staff3- After attending to a patient	467	365(78)		√	
16	Staff1- Before contact with blood and body fluid	503	216(43)	√		
17	Staff2- Before contact with blood and body fluid	488	194(40)	√		
18	Staff3- Before contact with blood and body fluid	454	181(40)	√		
19	Staff1- After contact with blood and body fluid	507	417(82)			√
20	Staff2- After contact with blood and body fluid	495	411(83)			√
21	Staff3- After contact with blood and body fluid	458	398(87)			√
	Mean moments of hand hygiene	493	251(51)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of moments of hand hygiene

### Performance of hygienic hand washing

Table 4 shows the performance of hygienic hand washing observed for three persons in clinical departments of all hospitals studied. The average performance score on hygienic hand washing for all hospitals was 86%. Out of 48 steps in hygienic hand washing, 32 (66%) had 81% to 98% compliance. The remaining 16 (34%) steps had compliance 71% to 80%.

**Table 54. [AW1]Frequency distribution of steps involved in performance of hygienic hand washing**

No.	Hygienic hand wash	Frequency		Interpretation ('Yes' % only)		
		N (100%)	Yes N(%)	Un-desirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	<del>Staff1_Staff bare below the elbow with 0 rings, bracelets, watches etc.</del>	541	422(78)		√	
2	<del>Staff2_Staff bare below the elbow with 0 rings, bracelets, watches etc.</del>	535	426(80)		√	
3	<del>Staff3_Staff bare below the elbow with 0 rings, bracelets, watches etc.</del>	493	400(81)			√
4	Staff1_ Opens tap	546	531(97)			√
5	<del>Staff2_Opens tap</del>	536	512(95)			√
6	<del>Staff3_Opens tap</del>	498	482(97)			√
7	Staff1_ Wets hands under running water	546	513(94)			√
8	<del>Staff2_Wets hands under running water</del>	535	500(93)			√
9	<del>Staff3_Wets hands under running water</del>	499	463(93)			√
10	Staff1_ Dispenses soap	543	531(98)			√
11	<del>Staff2_Dispenses soap</del>	535	520(97)			√
12	<del>Staff3_Dispenses soap</del>	496	486(98)			√
13	Staff1_ Lathers soap evenly over palms	541	418(77)		√	
14	<del>Staff2_Lathers soap evenly over palms</del>	535	416(78)		√	
15	<del>Staff3_Lathers soap evenly over palms</del>	500	393(79)		√	
16	Staff1_ Washes hands palm to palm	543	412(94)			√
17	<del>Staff2_Washes hands palm to palm</del>	533	500(94)			√
18	<del>Staff3_Washes hands palm to palm</del>	498	460(92)			√
19	Staff1_ Washes hands palm to dorsum with interlaced fingers and vice versa	545	500(92)			√
20	<del>Staff2_Washes hands palm to dorsum with interlaced fingers and vice versa</del>	536	477(89)			√
21	<del>Staff3_Washes hands palm to dorsum with interlaced fingers and vice versa</del>	499	442(89)			√
22	Staff1_ Interlace fingers with palms facing each other and rub the webs of the fingers	545	430(79)		√	
23	<del>Staff2_Interlace fingers with palms facing each other and rub the webs of the fingers</del>	535	416(78)		√	
24	<del>Staff3_Interlace fingers with palms facing each other and rub the webs of the fingers</del>	500	397(79)		√	
25	Staff1_ Cup hands together to massage/rub the back of the fingers of the right hand in the left palm and vice versa	546	443(81)			√
26	<del>Staff2_Cup hands together to massage/rub the back of the fingers of the right hand in the left palm and vice versa</del>	536	397(74)		√	
27	Staff3_ Cup hands together to massage/rub the back of the fingers of the right hand in the left palm and vice versa	499	389(78)		√	
28	Staff1_ Rubbing the fingers in the palm in a circular manner	544	460(85)			√
29	<del>Staff2_Rubbing the fingers in the palm in a circular manner</del>	536	448(84)			√
30	<del>Staff3_Rubbing the fingers in the palm in a circular manner</del>	501	426(85)			√
31	Staff1_ Washes thumbs	545	477(88)			√
32	<del>Staff2_Washes thumbs</del>	536	463(86)			√

33	<del>Staff3_Washes thumbs</del>	500	438(88)	62(12)		√
11	Staff1_Washes wrists	545	510(94)	35(6)		√
35	<del>Staff2_Washes wrists</del>	535	496(93)	39(7)		√
36	<del>Staff3_Washes wrists</del>	499	461(92)	38(8)		√
12	Staff1_Rinses hands and wrists thoroughly under running water	545	539(99)	6(1)		√
38	<del>Staff2_Rinses hands and wrists thoroughly under running water</del>	534	525(98)	9(2)		√
39	<del>Staff3_Rinses hands and wrists thoroughly under running water</del>	498	479(96)	19(4)		√
13	Staff1_Dries hands using single-use drying material	544	448(82)	96(18)		√
41	<del>Staff2_Dries hands using single-use drying material</del>	534	436(82)	98(18)		√
42	<del>Staff3_Dries hands using single-use drying material</del>	496	405(82)	91(18)		√
14	Staff1_Uses single-use hand towel or paper towel to turn off the faucet	535	382(71)	153(29)		√
44	<del>Staff2_Uses single-use hand towel or paper towel to turn off the faucet</del>	524	370(71)	154(29)		√
45	<del>Staff3_Uses single-use hand towel or paper towel to turn off the faucet</del>	497	370(74)	127(26)		√
15	Staff1_Discards single-use towel in appropriate receptacle	520	393(76)	127(24)		√
47	<del>Staff2_Discards single-use towel in appropriate receptacle</del>	484	366(76)	118(24)		√
48	<del>Staff3_Discards single-use towel in appropriate receptacle</del>	467	362(77)	105(28)		√
	Average hand hygiene material	523	450(86)	73(14)		√

Source: Data from IPC study

The tick (√) sign in a box indicates the level of hygienic hand wash

### Correlations among moments of hand hygiene, hygienic hand washing, availability of hand hygiene materials and alcohol hand rub

Preliminary analyses were performed to test assumptions of normality, linearity and homoscedasticity. As hypothesized, there was a weak, positive correlation between availability of hand hygiene materials and moments of hand hygiene,  $r = .12$ ,  $n = 546$ ,  $p$

$< .001$ , with high availability of hand hygiene materials associated with high moments of hand hygiene. Similarly, a weak positive correlation was observed between availability of alcohol hand rub and moments of hand hygiene,  $r = .11$ ,  $n = 546$ ,  $p < .001$ . There was also a weak, positive correlation between availability of alcohol hand rub and hygienic hand washing,  $r = .09$ ,  $n = 546$ ,  $p < .05$ . (Table 5). However, there was no significant correlation between availability of hand hygiene materials and hygienic hand washing.

Table 6.5. Pearson bivariate correlation analysis among moments of hand hygiene, hygienic hand washing, availability of hand hygiene materials and alcohol hand rub (N=546)

Correlations			Moments of Hand Hygiene	Hygienic Hand Washing	Availability of Hand Hygiene Materials	Availability of Alcohol hand rub
Hand Moments	Hygiene	Pearson Correlation	1			
		Sig. (2-tailed)				
		N	546			
Hygienic Washing	Hand	Pearson Correlation	-.030	1		
		Sig. (2-tailed)	.478			
		N	546	546		
Availability of Hand Hygiene Materials	of	Pearson Correlation	.118**	.045	1	
		Sig. (2-tailed)	.006	.299		
		N	546	546	546	
Availability of Alcohol hand rub	of	Pearson Correlation	.113**	.092*	.239**	1
		Sig. (2-tailed)	.008	.031	.000	
		N	546	546	546	546

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

### Regional comparisons

#### Availability of hand hygiene hand washing materials

Availability of hygienic hand washing materials for Northern, Volta, Greater Accra and Central Regions, ranged from 62% to 80%. However, availability of hand hygiene material was higher in the Western region with average availability score of 83% (see Figure 1). A chi-square test for independence indicated a significant association between respondents' region and availability of hand hygiene materials,  $\chi^2(8, n = 546) = 63.095, p < .001, \text{Cramer's } V = .24$ . The Western region was the region with higher availability of hand hygiene materials, followed by Central, then Volta, Greater Accra and Northern regions (Table 7). The effect size as measured by Cramer's V was .24, indicating medium effect.

Table 7. Region \* Availability of hand hygiene materials Crosstabulation

		Availability of Hand Hygiene Materials			Total	
		Low availability	Moderate availability	High availability		
Region	Western	Count	28	31	40	99
		% within Region	28.3%	31.3%	40.4%	100.0%
		Adjusted Residual	-3.9	2.1	2.3	
	Central	Count	46	38	46	130
		% within Region	35.4%	29.2%	35.4%	100.0%
		Adjusted Residual	-2.8	1.8	1.3	
	Greater Accra	Count	41	18	18	77
		% within Region	53.2%	23.4%	23.4%	100.0%
		Adjusted Residual	1.4	.0	-1.5	
	Volta	Count	46	33	38	117
		% within Region	39.3%	28.2%	32.5%	100.0%

		<u>Adjusted Residual</u>	<u>-1.6</u>	<u>1.4</u>	<u>.5</u>	
	<u>Northern</u>	<u>Count</u>	<u>90</u>	<u>7</u>	<u>26</u>	<u>123</u>
		<u>% within Region</u>	<u>73.2%</u>	<u>5.7%</u>	<u>21.1%</u>	<u>100.0%</u>
		<u>Adjusted Residual</u>	<u>6.9</u>	<u>-5.2</u>	<u>-2.6</u>	
<u>Total</u>		<u>Count</u>	<u>251</u>	<u>127</u>	<u>168</u>	<u>546</u>
		<u>% within Region</u>	<u>46.0%</u>	<u>23.3%</u>	<u>30.8%</u>	<u>100.0%</u>

Proof

### Availability of alcohol hand rub

Availability of hygienic hand washing materials for Northern, Volta, Greater Accra and Central Regions, ranged from 62% to 80%. However, availability of hand hygiene material was higher in the Western region with average availability score of 83% (see Figure 1). A chi-square test for independence indicated a significant association between respondents' region and availability of alcohol hand rub,  $\chi^2(4, n = 546) = 37.793, p < .001, \text{Cramer's } V = .26$ . The Volta region was the region with higher availability of alcohol hand rub, followed by Western, then Greater Accra, Northern and Central regions (Table 8). The effect size as measured by Cramer's V was .26, indicating medium effect.

**Table 8. Region \* Availability of alcohol hand rub Crosstabulation**

			Availability of alcohol hand rub		Total
			Low availability	High availability	
Region	Western	Count	26	73	99
		% within Region	26.3%	73.7%	100.0%
		Adjusted Residual	-2.5	2.5	
	Central	Count	65	65	130
		% within Region	50.0%	50.0%	100.0%
		Adjusted Residual	3.4	-3.4	
	Greater Accra	Count	32	45	77
		% within Region	41.6%	58.4%	100.0%
		Adjusted Residual	.8	-.8	
	Volta	Count	22	95	117
		% within Region	18.8%	81.2%	100.0%
		Adjusted Residual	-4.7	4.7	
Northern	Count	59	64	123	
	% within Region	48.0%	52.0%	100.0%	
	Adjusted Residual	2.8	-2.8		
Total	Count	204	342	546	
	% within Region	37.4%	62.6%	100.0%	

### Compliance with moments of hand hygiene

Availability of hygienic hand washing materials for Northern, Volta, Greater Accra and Central Regions, ranged from 62% to 80%. However, availability of hand hygiene material was higher in the Western region with average availability score of 83% (see Figure 1). A chi-square test for independence indicated a significant association between respondents' region and compliance with hand hygiene moments,  $\chi^2(8, n = 546) = 48.655, p < .001, \text{Cramer's } V = .21$ . The Western region was the region with higher compliance with hand hygiene moments, followed by Northern, then Central, Greater Accra and Volta regions (Table 9). The effect size as measured by Cramer's V was .21, indicating medium effect.

**Table 9. Region \* Compliance with hand hygiene moments Crosstabulation**

			Hand Hygiene Moments			Total
			Low Compliance	Moderate Compliance	High Compliance	
Region	Western	Count	28	38	33	99
		% within Region	28.3%	38.4%	33.3%	100.0%
		Adjusted Residual	-4.1	1.9	2.7	
	Central	Count	62	37	31	130
		% within Region	47.7%	28.5%	23.8%	100.0%
		Adjusted Residual	.3	-.6	.3	
	Greater Accra	Count	41	21	15	77
		% within Region	53.2%	27.3%	19.5%	100.0%
		Adjusted Residual	1.2	-.6	-.8	
	Volta	Count	80	29	8	117
		% within Region	68.4%	24.8%	6.8%	100.0%
		Adjusted Residual	5.3	-1.5	-4.7	
Northern	Count	44	41	38	123	
	% within Region	35.8%	33.3%	30.9%	100.0%	
	Adjusted Residual	-2.8	.8	2.4		
Total	Count	255	166	125	546	
	% within Region	46.7%	30.4%	22.9%	100.0%	

**Table 10. Region \* Compliance with hygienic hand washing Crosstabulation**

A chi-square test for independence indicated no significant association between respondents' region and compliance with hygienic hand washing,  $\chi^2(8, n = 546) = 14.705, p = .065, \text{Cramer's } V = .12$ . The effect size as measured by Cramer's V was .12, indicating small effect.

		Hygienic hand washing			Total	
		Low compliance	Moderate compliance	High compliance		
Region	Western	Count	49	30	8	87
		% within Region	56.3%	34.5%	9.2%	100.0%
		Adjusted Residual	1.0	.2	-1.7	
	Central	Count	52	46	21	119
		% within Region	43.7%	38.7%	17.6%	100.0%
		Adjusted Residual	-1.9	1.4	.9	
	Greater Accra	Count	35	24	11	70
		% within Region	50.0%	34.3%	15.7%	100.0%
		Adjusted Residual	-.2	.1	.1	
	Volta	Count	48	39	22	109
		% within Region	44.0%	35.8%	20.2%	100.0%

	Adjusted Residual	-1.7	.6	1.6	
Northern	Count	73	29	14	116
	% within Region	62.9%	25.0%	12.1%	100.0%
	Adjusted Residual	2.9	-2.2	-1.1	
Total	Count	257	168	76	501
	% within Region	51.3%	33.5%	15.2%	100.0%

## Discussion

This study sought to assess hand hygiene compliance among healthcare workers in selected hospitals from five out of Ghana's nine regions. All health facilities in the study regions visited were assessed for availability of hand hygiene materials and alcohol hand rub, moments of hand hygiene, and performance of hygienic hand washing. The mean availability of hand hygiene materials and alcohol hand rub was in the moderately high but less desirable range. However, there was high availability of hand hygiene materials such as hand wash basin for staff, hand washing facility within 6 meters, running water, soap, and clean soap containers recorded high availability.

The study had several strengths. Independent observation of hand hygiene practices of three staff in each clinical department by two experts likely reduced bias and increase the validity of the findings. The observation of actual performance of hygienic hand washing, beyond the mere observance of moments of hand hygiene is important to determine healthcare workers level of competence in hygienic handwashing. Direct observation method remains the gold standard in studying hand hygiene compliance. The Hawthorne effect was absent because healthcare workers were not informed that they were being observed.

The rates of compliance observed in this study differs from the findings of Sax, et al.<sup>14</sup>, in their study on hand hygiene compliance and associated factors among health care providers in a university hospital in Ethiopia. The authors found that 36.5% of respondents reported the availability of individual towel or tissue paper for drying in their working area, while 57% assured the presence of alcohol hand rub. Another study in Uganda also reported low availability of hand hygiene materials.<sup>27</sup> It should be noted however, that the Ghana study was a follow-up after training staff of the hospitals studied the previous six months. The recency of training is likely to have influenced the availability of hand hygiene materials. The availability of materials is likely to have been lower before the training was done.

With respect to moments of hand hygiene, ~~hand hygiene-it~~ was generally performed after procedures than before. This runs contrary to Ghana's national IPC policy and guidelines which state that hand hygiene should be done before and after contact with each patient or their surroundings.<sup>26</sup> However, the finding is consistent with literature.<sup>15</sup> The mean moments of hand hygiene score of 51% was also inadequate, considering that the facilities studied had just received training the previous six months. On the other hand, the steps in actual hand hygiene generally showed high performance.

The lack of ~~relationship-correlation in all regions~~ between ~~compliance performance of with~~ the moments of hand hygiene and performance of hygienic hand washing implies that compliance with moments of hand hygiene was not influenced by HCW competence in hygienic hand washing. Similarly, the weak ~~correlation association~~ between availability of hand hygiene materials and alcohol hand rub ~~of~~ and performance on the moments of hand hygiene, suggests that availability of materials alone was not enough to result in compliance. Several barriers affecting hand hygiene compliance have been reported in the literature. These include time, religion, lack of concern about healthcare-associated infections (HCAI), time, peer pressure, gloves, perception and knowledge of the transmission risk and of the impact of HCAI, HCWs' conviction of their self-efficacy, the evaluation of perceived benefits against the existing barriers, lack of products and facilities as well as their inappropriate and non-ergonomic location.<sup>28-31</sup> The explanation for the relatively low compliance with moments of hand hygiene ~~despite in spite~~ of the recent training of HCWs may also be due to lack of continuous monitoring and feedback. Walker, et al.<sup>20</sup> evaluated the effectiveness of a new hand hygiene monitoring program and measured the sustainability of this effectiveness over a one-year period. They concluded that continuous monitoring by salient observers and immediate feedback are critical to the success of hand hygiene programs. Another possible reason is poor safety



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3 culture, although this was not measured. Further study is required in Ghana to explore ways to improve HCWs'  
4 compliance with proper hand hygiene.

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6 Regarding regional comparisons, the Western Region, for example, was observed to be more likely than the other  
7 regions to have hand hygiene materials. This seems to have reflected in the Western Region having a higher  
8 compliance with hand hygiene moments, relative to the other regions. However, even though the Volta Region was  
9 observed to have more availability of alcohol hand rub, this did not reflect on compliance with hand hygiene moments  
10 in the Volta region. These conclusions, together with the weak correlation among the availability of hand hygiene  
11 materials and alcohol hand rub, and compliance with hand hygiene moments, further buttress the point that availability  
12 of materials alone was not enough to result in compliance.

### 13 14 **Limitations of the study**

15 The study had some limitations. The major limitation of this study is the selection of five regions based on the  
16 operational area of the non-governmental organizations and rather than -a random sampling strategy which could  
17 have provide a more representative sample of the ten regions of Ghana. In addition, measurement directly following  
18 training may have inflated the presence of hand hygiene supplies. It is likely that the findings in this study over-  
19 represented the usual availability of these materials, as well as the performance of staff.

### 20 21 **Conclusions**

22 Even though HCWs were given prior training based on the national IPC guidelines, it was still observed that health  
23 care workers were more likely to perform hand hygiene ~~was performed~~ after procedures than before. HCWs'  
24 compliance with the moments of hand hygiene was less than expected, despite recent training in IPC. However,  
25 HCWs generally demonstrated high competence in the skills of hygienic hand washing. This strength should be  
26 tapped into, as efforts are needed to ensure willingness of HCWs to comply with moments of hand hygiene. Conscious  
27 attention must particularly be focused on hand hygiene before procedures. Efforts must be made by health  
28 facility managers to provide adequate hand hygiene materials and alcohol hand rub so that no HCW has any excuse  
29 for failing to comply with hand hygiene. Further study is required to explore ~~additional barriers~~  
30 to HCWs' compliance with proper performance of hand hygiene when it is needed in patient care.

### 31 32 **Acknowledgements**

33 The authors are grateful to the Ghana Health Service, and by extension USAID and Systems for Health, for providing  
34 this data for analysis towards publication.

### 35 36 **Author Contributions**

37 The coauthors have all contributed substantially to this manuscript and approve of this submission. AAA, JA and PAA:  
38 study concept and design. SKA and GN: acquisition of data. AAA, JA, AAD and RKA: analysis and interpretation.  
39 All authors: critical revision of the manuscript for important intellectual content. SKA: study supervision.

### 40 41 **Declaration of Conflicting Interests**

42 The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of  
43 this article.

44 **Funding** This study was undertaken by the Ghana Health Service with funding support from USAID and Systems for  
45 Health. The University of Ghana Business School supported with funding for data analysis and report writing.

### 46 47 **Supplementary Material**

48 Supplementary material for this study is available on request to the corresponding author.  
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### Ethical Approval /Patient consent

This study was undertaken by the Ghana Health Service as part of their routine monitoring and evaluation of programmes in the Ghana health sector.

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## Introduction

Infection prevention and control (IPC) is a universally important component of all health systems and affects the health and safety of both people who use services and those who provide them. Healthcare associated infection (HAI) is a common adverse event that can result in prolonged hospital stay, long-term disability, and death, and increased resistance of microorganisms to antimicrobial agents. It also creates an additional financial burden for the health system, patients and their families.<sup>1 2</sup> Threats posed by epidemics, pandemics and antimicrobial resistance (AMR) have become a top priority for action on the global health agenda. Instituting an effective infection prevention and control program is key to address these challenges. The International Health Regulations has therefore positioned effective IPC as a key strategy for dealing with public health threats.<sup>3</sup> The United Nations Sustainable Development Goals (SDG) emphasised the importance of IPC as a contributor to safe, effective high-quality health service delivery, in particular those related to water, sanitation and hygiene (WASH) and universal health coverage.

Hand hygiene is acknowledged to be the single most important measure to prevent HAI.<sup>4</sup> The transfer of microorganisms by health care workers (HCWs) has been identified as a major factor in the transmission of hospital-acquired infections.<sup>5-7</sup> However, HCW compliance with good hand hygiene practice is low in most settings<sup>8-10</sup>. Multiple factors influence hand hygiene performance, and its promotion is particularly complex in developing countries where limited resources and culture-specific issues can strongly influence practices.<sup>9 11-13</sup> A study by Sax, et al. on determinants of good adherence to hand hygiene among HCWs with extensive exposure to hand hygiene campaigns found that high self-reported rates of adherence to hand hygiene was independently associated with female sex, receipt of hand hygiene training, participation in a previous hand hygiene campaign, peer pressure from colleagues, perceived good adherence by colleagues, and the perception that hand hygiene is relatively easy to perform.<sup>14</sup>

Several studies have reported large differences with hand hygiene compliance among HCWs before patient contact. A systematic review of 35 studies by Erasmus, et al.<sup>15</sup> reported median compliance rates with hand hygiene by all HCWs before patient contact of 21%, whereas compliance after patient contact was higher, with a median compliance rate of 47%. They also reported that high compliance associated with glove use (8 of 8 studies), accessibility of hand hygiene materials (4 of 7 studies) and type of task, with higher compliance with dirty tasks (5 of 5 studies).

In Ghana, a cross-sectional observational study at the Komfo Anokye Teaching Hospital in Kumasi<sup>16</sup> indicated that the most commonly identified barriers to hand hygiene by HCWs were limited resources and lack of knowledge on appropriate times to perform hand hygiene. A 2009 study of the Neonatal Intensive Care Unit (NICU) of the Department of Child Health in the Korle-Bu Teaching Hospital<sup>17</sup>, indicated low hand hygiene compliance by physicians and nurses. In 2011, a cross-sectional, observational study assessed personal and care-related hand hygiene compliance among doctors and nurses and hand hygiene resources in 15 service provision centres of the Korle-Bu Teaching Hospital (KBTH). The authors found that care-related hand hygiene compliance of doctors and nurses was low and basic hand hygiene resources were deficient in all 15 service centres, ranging from 9.2% to 57% and 9.6% to 54% among nurses. Hand hygiene compliance was higher when risk was perceived to be higher (i.e., in emergency and wound dressing/treatment rooms and labour wards).

Even though these studies reveal that hand hygiene compliance is low in Ghana, they focused on only teaching hospitals which are tertiary level or referral hospitals, excluding primary hospitals. This is a majority limitation since in Ghana, primary hospitals are in the majority. Whereas Ghana had 10 regional (secondary) hospitals corresponding to the ten regions of Ghana and four teaching (tertiary) hospitals in 2013, the total number of primary hospitals distributed across the 134 Districts of Ghana was 392.<sup>18</sup> Primary hospitals play important roles because, unlike regional and teaching hospitals that are expected to attend mainly to referred patients, primary hospitals serve as the primary contacts for patients and only refer to regional or tertiary hospitals for specialist attention. In addition, primary hospitals also serve as referral hospitals to health centres and clinics in remote and rural communities. However, primary hospitals have fewer professional HCWs compared with teaching hospitals. It might be expected that hand hygiene compliance in primary hospitals will be lower than teaching hospitals. However, to our knowledge there have been no studies of hand hygiene compliance at the primary level of care in Ghana. Previous studies have also focused on observations of moments of hand hygiene to the neglect of the steps in performing hygienic hand washing. It is important to assess the competence of HCWs in performing hygienic hand washing since this could have an influence

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3 on compliance. We hypothesize that the more competent HCW are in performing hand hygiene, the more likely  
4 they will be to comply with hand washing requirements.

## 5 6 **METHODS**

### 7 **Study design**

8 This was a cross-sectional, observational study of HCWs in selected primary hospitals in Ghana. It is based on  
9 primary data collected from September to November 2017 by the Ghana Health Service as a follow-  
10 up study on compliance to IPC training organized during the previous six months in 106 health facilities in  
11 five regions of Ghana. Direct observation of HCWs during patient care activity by trained and validated observers has  
12 been recognized as the gold standard for hand hygiene monitoring.<sup>19-21</sup>

### 14 15 **Sampling methods/selection of survey site**

16 The five regions were selected for training by Systems for Health', an agency of USAID through the Ghana Health  
17 Service, with funding support from USAID. In all, 546 HCWs from the 106 health facilities participated in the  
18 study. The study regions include Western, Central, Greater Accra, Volta and Northern. These regions were selected  
19 based on the operational areas of Systems for Health. The other five regions were under a different non-governmental  
20 organization (NGO), JHPIEGO. However, unlike Systems for Health, JHPIEGO's IPC activities were not co-  
21 ordinated by the national headquarters of the Ghana Health Service where these data were obtained. JHPIEGO dealt  
22 directly with the five regions under them.

### 23 24 **Zoning the regions**

25 The Deputy Director of Clinical Care in each of the five regions zoned their region into three areas, based on  
26 proximity between health facilities and numbers to be monitored in each region. The facilities visited range from  
27 nine facilities per zone in the northern region to five facilities per zone in the Greater Accra region with an average of  
28 seven health facilities per zone.

### 29 30 **Study population**

31 The population for the survey comprised health care workers including doctors, nurses, midwives and laboratory  
32 personnel in the selected service centres.

### 33 34 **Data collection**

35 Trained health personnel collected the data using a modified version of WHO standardized infection prevention  
36 checklist.<sup>22</sup> The checklist took into consideration availability of hand hygiene materials and alcohol hand rub,  
37 hand hygiene moments and steps in hygienic handwashing. Overall, 68 health personnel who had prior training  
38 and experience in infection prevention procedures collected the data. The personnel were grouped into teams for  
39 data collection. Each team comprised of a national trainer and three regional trainers. Each region had three teams  
40 except Greater Accra region which had five, in view of the many health facilities in Greater Accra. The teams  
41 worked in their allocated zones. Each team spent three to four days in a facility. The team spent about a month on  
42 the field working concurrently in the regions.

43 In each facility seven clinical departments were scheduled for monitoring. These were; Accident/Emergency,  
44 Laboratory, Maternity, Out-patient/Treatment Room, Neonatal Intensive Care Unit (NICU) and Surgical Wards.  
45 However, some of the facilities had a combined ward named adult ward for both male and female and others  
46 did not have all the seven units. The Central Sterile Supply Department (CSSD) was also visited to observe the  
47 display of job aids for wrapping of instruments. The clinical departments were observed by two trained experts  
48 for availability of hand hygiene materials and alcohol hand rub. Three persons were observed in each unit on  
49 moments of hand hygiene and performance of hygienic hand washing.

### 50 51 **Patient and public involvement**

52 Patients were not involved in this study.

### 53 54 **Moments of Hand hygiene**

55 Moments of hand hygiene are specific occasions when workers should perform hand hygiene. Seven items were scored  
56 during monitoring: arrival at work; before touching a patient; before putting on gloves or other personal protective  
57 equipment (PPE); after touching patient environment; after attending to a patient; before contact with blood and body

fluid, and after contact with blood or body fluids. Three staff from each facility were observed on their performance of these items.

### Data analysis

We hypothesized that:

H1: Availability of hand hygiene materials will have a significant positive correlation with moments of hand hygiene and hygienic hand washing.

H2: Availability of alcohol hand rub will have a significant positive correlation with moments of hand hygiene and hygienic hand washing.

The positive hypotheses are motivated by the fact that staff of the hospitals studied were trained on infection prevention and control (IPC) six months prior to the study. It is expected that in the light of the recent training, hospital management will be motivated to provide more hand hygiene materials and alcohol hand rub. It is also expected that staff of the hospitals studied will easily remember the skills acquired during the recent IPC training and, given the availability of hand hygiene materials and alcohol hand rub, will highly comply with hand hygiene.

Frequency distributions of compliance were calculated. The mean compliance of the three staff observed were reported. The five regions studied were compared in respect of availability of hygienic hand washing materials, availability of alcohol hand rub, moments of hand hygienic and hygienic hand washing practice.

We categorized hand hygiene compliance into three group: below 50% were considered low compliance and were categorized as 'undesirable'; between 50% to 80% were considered moderately high compliance and categorized as less desirable; between 81% to 100% were considered as high compliance, and categorized as desirable. Pearson product-moment correlations were used to calculate the association between availability of hand hygiene materials and alcohol hand rub on one hand, and moments of hand hygiene and hygienic hand washing on the other. The strength of relationship were: weak,  $r = .10$  to  $.29$ ; medium,  $r = .30$  to  $.49$ ; strong,  $r = .50$  to  $1.0$ .<sup>24</sup> A percentage index score was generated through the addition of the indicators of each of the variables used to run the correlation analysis.

Data were entered into Microsoft Excel 2016 and analysed using SPSS (version 24).

### Ethical issues

This study did not require approval by the local ethics committee because it was deemed a quality improvement project of the Ghana Health Service. However, the management of the health facilities as well as heads of the involved clinical departments were informed of the study and the research methodology before research activities started.<sup>25</sup> The observed health care workers were however not aware of the fact that they participated in a hand hygiene study.

### Results

Hand hygiene materials and job aids for hygienic hand washing and alcohol hand rub were monitored to check if they were available and conspicuously displayed at hand hygiene areas. Moments of hand hygiene and performance of hygienic hand washing were then observed.

#### Availability of hand hygiene materials and alcohol hand rub

The performance of hand hygiene depended on the availability of hand hygiene materials and alcohol hand rub. Tables 1 and 2 show that on average, the availability of hand hygiene materials and alcohol hand rub were 75% and 71% respectively. The availability of a hand wash basin for staff, hand washing facility within 6 meters, running water, liquid or cake soap, and clean soap containers was between 82% to 98%. Conspicuous display of alcohol hand rub and staff orientation on alcohol hand rub were also generally present.



**Table 1. Frequency of respondents by region**

Region	Frequency	Percent
Western	99	18.1
Central	130	23.8
Greater Accra	77	14.1
Volta	117	21.4
Northern	123	22.5
Total	546	100.0

Source: Data from IPC study

**Table 2. Frequency distribution of availability of hand hygiene material**

No.	Hand hygiene material	Frequency		Interpretation ('Yes' % only)		
		N (100%)	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Hand wash basin for staff	539	530(98)			√
2	Hand washing facility within 6 meters	535	428(80)			√
3	Availability of running water	540	482(89)			√
4	Liquid/cake soap is available	535	522(98)			√
5	Liquid/cake soap containers are clean	533	438(82)			√
6	Cake soap dishes perforated to allow drainage	450	302(67)		√	
7	Cake soaps cut in small sizes	432	226(52)		√	
8	Single-use hand towels/absorbent paper towels	533	436(82)			√
9	Adequate number of hand towels (20 per person per shift)	520	96(18)	√		
10	Single-use hand towels/absorbent paper towel in dispensers	522	392(75)		√	
	Mean hand hygiene material	514	385(75)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of availability of hand hygiene material

**Table 3. Frequency distribution of availability of alcohol hand rub**

No.	Availability of alcohol hand rub	Frequency		Interpretation ('Yes' % only)		
		N	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Alcohol hand rub are available at the point	543	370(68)		√	
2	Alcohol (60%-90%) labelled	523	255(49)	√		
3	Conspicuously displayed	540	442(82)			√
4	Available at all hand hygiene areas	539	411(76)		√	
5	Staff oriented on the use of job aids	531	428(81)			√
	Mean availability of alcohol hand rub	535	381(71)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of availability of alcohol hand rub

### Moments of Hand hygiene

Moments of hand hygiene are specific occasions that staff are supposed to do hand hygiene. When hand hygiene is not done during those times it means they missed those moments or opportunities. Seven items were scored during the

monitoring. These were, arrival at work; before touching a patient; before putting on gloves or other personal protective equipment (PPE); after touching patient environment; after attending to a patient; before contact with blood and body fluid and after contact with blood and body fluid. Three staff from each facility were observed on their performance of these items. Table 3 shows frequency distribution of moments of hand hygiene of staff observed for all hospitals studied, while figure 1 shows mean moments of hand hygiene by region studied. It was generally observed that hand hygiene was performed after procedures than before. The national IPC policy and guidelines state that hand hygiene should be done before and after contact with each patient or their surroundings<sup>26</sup>.

**Table 4. Frequency distribution of moments of hand hygiene for hospitals studied**

No.	Moments of hand hygiene	Frequency		Interpretation ('Yes' % only)		
		N	Yes N(%)	Undesirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Staff Arrival at work	505	170 (34)	√		
2	Staff Before touching a patient	530	176(33)	√		
3	Staff Before putting on gloves or other PPEs	535	224(42)	√		
4	Staff After touching patient	518	264(51)		√	
5	Staff After attending to a patient	517	397(77)		√	
6	Staff Before contact with blood and body fluid	503	216(43)	√		
7	Staff After contact with blood and body fluid	507	417(82)			√
	Mean moments of hand hygiene	493	251(51)		√	

Source: Data from IPC study

The tick (√) sign in a box indicates the level of moments of hand hygiene

#### Performance of hygienic hand washing

Table 4 shows the performance of hygienic hand washing observed for three persons in clinical departments of all hospitals studied. The average performance score on hygienic hand washing for all hospitals was 86%. Out 48 steps in hygienic hand washing, 32 (66%) had 81% to 98% compliance. The remaining 16 (34%) steps had compliance 71% to 80%.



**Table 5. Frequency distribution of steps involved in performance of hygienic hand washing**

No.	Hygienic hand wash	Frequency		Interpretation ('Yes' % only)		
		N (100%)	Yes N(%)	Un-desirable (<50%)	Less desirable (50-80%)	Desirable (81-100%)
1	Staff bare below the elbow with 0 rings, bracelets, watches etc.	541	422(78)		√	
2	Staff Opens tap	546	531(97)			√
3	Staff Wets hands under running water	546	513(94)			√
4	Staff Dispenses soap	543	531(98)			√
5	Staff Lathers soap evenly over palms	541	418(77)		√	
6	Staff Washes hands palm to palm	543	412(94)			√
7	Staff Washes hands palm to dorsum with interlaced fingers and vice versa	545	500(92)			√
8	Staff Interlace fingers with palms facing each other and rub the webs of the fingers	545	430(79)		√	
9	Staff Cup hands together to massage/rub the back of the fingers of the right hand in the left palm and vice versa	499	389(78)		√	
10	Staff Rubbing the fingers in the palm in a circular manner	544	460(85)			√
11	Staff Washes thumbs	545	477(88)			√
12	Staff Washes wrists	545	510(94)	35(6)		√
13	Staff Rinses hands and wrists thoroughly under	545	539(99)	6(1)		√
14	Staff Dries hands using single-use drying	544	448(82)	96(18)		√
15	Staff Uses single-use hand towel or paper towel to	535	382(71)	153(29)		√
16	Staff Discards single-use towel in appropriate	520	393(76)	127(24)		√
	Average hand hygiene material	523	450(86)	73(14)		√

Source: Data from IPC study

The tick (√) sign in a box indicates the level of hygienic hand wash

### Correlations among moments of hand hygiene, hygienic hand washing, availability of hand hygiene materials and alcohol hand rub

Preliminary analyses were performed to test assumptions of normality, linearity and homoscedasticity. As hypothesized, there was a weak, positive correlation between availability of hand hygiene materials and moments of hand hygiene,  $r = .12$ ,  $n = 546$ ,  $p < .001$ , with high availability of hand hygiene materials associated with high moments of hand hygiene. Similarly, a weak positive correlation was observed between availability of alcohol hand rub and moments of hand hygiene,  $r = .11$ ,  $n = 546$ ,  $p < .001$ . There was also a weak, positive correlation between availability of alcohol hand rub and hygienic hand washing,  $r = .09$ ,  $n = 546$ ,  $p < .05$ . (Table 5). However, there was no significant correlation between availability of hand hygiene materials and hygienic hand washing.

**Table 6. Pearson bivariate correlation analysis among moments of hand hygiene, hygienic hand washing, availability of hand hygiene materials and alcohol hand rub (N=546)**

Correlations			Moments of Hand Hygiene	Hygienic Hand Washing	Availability of Hand Hygiene Materials	Availability of Alcohol hand rub
Hand Moments	Hygiene	Pearson Correlation	1			
Hygienic Washing	Hand	Pearson Correlation	-.030	1		
Availability of Hand Hygiene Materials		Pearson Correlation	.118**	.045	1	
Availability of Alcohol hand rub		Pearson Correlation	.113**	.092*	.239**	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

### Regional comparisons

#### Region and availability of hand hygiene materials

A chi-square test for independence indicated a significant association between respondents' region and availability of hand hygiene materials,  $\chi^2(8, n = 546) = 63.095, p < .001, Cramer's V = .24$ . The Western region was the region with higher availability of hand hygiene materials, followed by Central, then Volta, Greater Accra and Northern regions (Table 7). The effect size as measured by Cramer's V was .24, indicating medium effect.

**Table 7. Region \* Availability of hand hygiene materials Crosstabulation**

			Availability of Hand Hygiene Materials			Total
			Low availability	Moderate availability	High availability	
Region	Western	Count	28	31	40	99
		% within Region	28.3%	31.3%	40.4%	100.0%
		Adjusted Residual	-3.9	2.1	2.3	
	Central	Count	46	38	46	130
		% within Region	35.4%	29.2%	35.4%	100.0%
		Adjusted Residual	-2.8	1.8	1.3	
	Greater Accra	Count	41	18	18	77
		% within Region	53.2%	23.4%	23.4%	100.0%
		Adjusted Residual	1.4	.0	-1.5	
	Volta	Count	46	33	38	117
		% within Region	39.3%	28.2%	32.5%	100.0%
		Adjusted Residual	-1.6	1.4	.5	
Northern	Count	90	7	26	123	
	% within Region	73.2%	5.7%	21.1%	100.0%	
	Adjusted Residual	6.9	-5.2	-2.6		
Total		Count	251	127	168	546
		% within Region	46.0%	23.3%	30.8%	100.0%

Source: Data from IPC study

### Region and availability of alcohol hand rub

A chi-square test for independence indicated a significant association between respondents' region and availability of alcohol hand rub,  $\chi^2(4, n = 546) = 37.793, p < .001, Cramer's V = .26$ . The Volta region was the region with higher availability of alcohol hand rub, followed by Western, then Greater Accra, Northern and Central regions (Table 8). The effect size as measured by Cramer's V was .26, indicating medium effect.

**Table 8. Region \* Availability of alcohol hand rub Crosstabulation**

			Availability of alcohol hand rub		Total
			Low availability	High availability	
Region	Western	Count	26	73	99
		% within Region	26.3%	73.7%	100.0%
		Adjusted Residual	-2.5	2.5	
	Central	Count	65	65	130
		% within Region	50.0%	50.0%	100.0%
		Adjusted Residual	3.4	-3.4	
	Greater Accra	Count	32	45	77
		% within Region	41.6%	58.4%	100.0%
		Adjusted Residual	.8	-.8	
	Volta	Count	22	95	117
		% within Region	18.8%	81.2%	100.0%
		Adjusted Residual	-4.7	4.7	
	Northern	Count	59	64	123
		% within Region	48.0%	52.0%	100.0%
		Adjusted Residual	2.8	-2.8	
Total		Count	204	342	546
		% within Region	37.4%	62.6%	100.0%

Source: Data from IPC study

### Region and compliance with moments of hand hygiene

A chi-square test for independence indicated a significant association between respondents' region and compliance with hand hygiene moments,  $\chi^2(8, n = 546) = 48.655, p < .001, Cramer's V = .21$ . The Western region was the region with higher compliance with hand hygiene moments, followed by Northern, then Central, Greater Accra and Volta regions (Table 9). The effect size as measured by Cramer's V was .21, indicating medium effect.

**Table 9. Region \* Compliance with hand hygiene moments Crosstabulation**

			Hand Hygiene Moments			Total
			Low Compliance	Moderate Compliance	High Compliance	
Region	Western	Count	28	38	33	99
		% within Region	28.3%	38.4%	33.3%	100.0%
		Adjusted Residual	-4.1	1.9	2.7	
	Central	Count	62	37	31	130
		% within Region	47.7%	28.5%	23.8%	100.0%
		Adjusted Residual	.3	-.6	.3	
	Greater Accra	Count	41	21	15	77
		% within Region	53.2%	27.3%	19.5%	100.0%
		Adjusted Residual	1.2	-.6	-.8	
	Volta	Count	80	29	8	117
		% within Region	68.4%	24.8%	6.8%	100.0%
		Adjusted Residual	5.3	-1.5	-4.7	
	Northern	Count	44	41	38	123
		% within Region	35.8%	33.3%	30.9%	100.0%
		Adjusted Residual	-2.8	.8	2.4	
Total	Count	255	166	125	546	
	% within Region	46.7%	30.4%	22.9%	100.0%	

Source: Data from IPC study

#### Region and compliance with hygienic hand washing Crosstabulation

A chi-square test for independence indicated no significant association between respondents' region and compliance with hygienic hand washing,  $\chi^2(8, n = 546) = 14.705, p = .065, \text{Cramer's } V = .12$ . The effect size as measured by Cramer's V was .12, indicating small effect.

**Table 10. Region \* Compliance with hygienic hand washing Crosstabulation**

			Hygienic hand washing			Total
			Low compliance	Moderate compliance	High compliance	
Region	Western	Count	49	30	8	87
		% within Region	56.3%	34.5%	9.2%	100.0%
		Adjusted Residual	1.0	.2	-1.7	
	Central	Count	52	46	21	119
		% within Region	43.7%	38.7%	17.6%	100.0%
		Adjusted Residual	-1.9	1.4	.9	
	Greater Accra	Count	35	24	11	70
		% within Region	50.0%	34.3%	15.7%	100.0%
		Adjusted Residual	-.2	.1	.1	
	Volta	Count	48	39	22	109
		% within Region	44.0%	35.8%	20.2%	100.0%
		Adjusted Residual	-1.7	.6	1.6	
	Northern	Count	73	29	14	116
		% within Region	62.9%	25.0%	12.1%	100.0%
		Adjusted Residual	2.9	-2.2	-1.1	
Total	Count	257	168	76	501	
	% within Region	51.3%	33.5%	15.2%	100.0%	

### Discussion

This study sought to assess hand hygiene compliance among healthcare workers in selected hospitals from five out of Ghana's nine regions. All health facilities in the study regions visited were assessed for availability of hand hygiene materials and alcohol hand rub, moments of hand hygiene, and performance of hygienic hand washing. The mean availability of hand hygiene materials and alcohol hand rub was in the moderately high but less desirable range. However, there was high availability of hand hygiene materials such as hand wash basin for staff, hand washing facility within 6 meters, running water, soap, and clean soap containers recorded high availability.

The study had several strengths. Independent observation of hand hygiene practices of three staff in each clinical department by two experts likely reduced bias and increase the validity of the findings. The observation of actual performance of hygienic hand washing, beyond the mere observance of moments of hand hygiene is important to determine healthcare workers level of competence in hygienic handwashing. Direct observation method remains the gold standard in studying hand hygiene compliance. The Hawthorne effect was absent because healthcare workers were not informed that they were being observed.

The rates of compliance observed in this study differs from the findings of Sax, et al.<sup>14</sup>, in their study on hand hygiene compliance and associated factors among health care providers in a university hospital in Ethiopia. The authors found that 36.5% of respondents reported the availability of individual towel or tissue paper for drying in their working area, while 57% assured the presence of alcohol hand rub. Another study in Uganda also reported low availability of hand hygiene materials.<sup>27</sup> It should be noted however, that the Ghana study was a follow-up after training staff of the hospitals studied the previous six months. The recency of training is likely to have influenced the availability of hand hygiene materials. The availability of materials is likely to have been lower before the training was done.

With respect to moments of hand hygiene, it was generally performed after procedures than before. This runs contrary to Ghana's national IPC policy and guidelines which state that hand hygiene should be done before

1  
2  
3 and after contact with each patient or their surroundings.<sup>26</sup> However, the finding is consistent with literature.<sup>15</sup>  
4 The mean moments of hand hygiene score of 51% was also inadequate, considering that the facilities studied had  
5 just received training the previous six months. On the other hand, the steps in actual hand hygiene  
6 generally showed high performance.  
7

8 The lack of correlation between compliance with the moments of hand hygiene and performance of  
9 hygienic hand washing implies that compliance with moments of hand hygiene was not influenced by HCW  
10 competence in hygienic hand washing. Similarly, the weak correlation between availability of hand hygiene  
11 materials and alcohol hand rub and performance on the moments of hand hygiene, suggests that availability of materials  
12 alone was not enough to result in compliance. Several barriers affecting hand hygiene compliance have been reported  
13 in the literature. These include time, religion, lack of concern about healthcare-associated infections (HCAI), time,  
14 peer pressure, gloves, perception and knowledge of the transmission risk and of the impact of HCAI, HCWs'  
15 conviction of their self-efficacy, the evaluation of perceived benefits against the existing barriers, lack of products  
16 and facilities as well as their inappropriate and non-ergonomic location.<sup>28-31</sup> The explanation for the relatively low  
17 compliance with moments of hand hygiene in spite of the recent training of HCWs may also be due to lack of  
18 continuous monitoring and feedback. Walker, et al.<sup>20</sup> evaluated the effectiveness of a new hand hygiene  
19 monitoring program and measured the sustainability of this effectiveness over a one-year period. They concluded  
20 that continuous monitoring by salient observers and immediate feedback are critical to the success of hand hygiene  
21 programs. Another possible reason is poor safety culture, although this was not measured. Further study is required in  
22 Ghana to explore ways to improve HCWs' compliance with proper hand hygiene.  
23

24 Regarding regional comparisons, the Western Region, for example, was observed to be more likely than the other  
25 regions to have hand hygiene materials. This seems to have reflected in the Western Region having a higher  
26 compliance with hand hygiene moments, relative to the other regions. However, even though the Volta Region was  
27 observed to have more availability of alcohol hand rub, this did not reflect on compliance with hand hygiene moments  
28 in the Volta region. These conclusions, together with the weak correlation among the availability of hand hygiene  
29 materials and alcohol hand rub, and compliance with hand hygiene moments, further buttress the point that availability  
30 of materials alone was not enough to result in compliance.  
31

### 32 **Limitations of the study**

33 The study had some limitations. The major limitation of this study is the selection of five regions based on the  
34 operational area of the non-governmental organizations and rather than a random sampling strategy which could  
35 have provide a more representative sample of the ten regions of Ghana. In addition, measurement directly following  
36 training may have inflated the presence of hand hygiene supplies. It is likely that the findings in this study over-  
37 represented the usual availability of these materials, as well as the performance of staff.  
38

### 39 **Conclusions**

40 Even though HCWs were given prior training based on the national IPC guidelines, it was still observed that health  
41 care workers were more likely to perform hand hygiene after procedures than before. HCWs' compliance with the  
42 moments of hand hygiene was less than expected, despite recent training in IPC. However, HCWs generally  
43 demonstrated high competence in the skills of hygienic hand washing. This strength should be tapped into, as  
44 efforts are needed to ensure willingness of HCWs to comply with moments of hand hygiene. Conscious attention  
45 must particularly be focused on hand hygiene before procedures. Efforts must be made by health facility  
46 managers to provide adequate hand hygiene materials and alcohol hand rub so that no HCW has any excuse for  
47 failing to comply with hand hygiene. Further study is required to explore additional barriers  
48 to HCWs' compliance with proper performance of hand hygiene when it is needed in patient care.  
49

### 50 **Acknowledgements**

51 The authors are grateful to the Ghana Health Service, and by extension USAID and Systems for Health, for providing  
52 this data for analysis towards publication.  
53

### 54 **Author Contributions**

55 The coauthors have all contributed substantially to this manuscript and approve of this submission. AAA, JA and PAA:  
56 study concept and design. SKA and GN: acquisition of data. AAA, JA, AAD and RKA: analysis and interpretation.  
57 All authors: critical revision of the manuscript for important intellectual content. SKA: study supervision.  
58

### Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Funding** This study was undertaken by the Ghana Health Service with funding support from USAID and Systems for Health. The University of Ghana Business School supported with funding for data analysis and report writing.

### Supplementary Material

Supplementary material for this study is available on request to the corresponding author.

### Ethical Approval /Patient consent

This study was undertaken by the Ghana Health Service as part of their routine monitoring and evaluation of programmes in the Ghana health sector.

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Proof



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