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The extent of selected essential medicines stockouts in South Africa (2013-2015)

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Abstract

Access to essential medicines in South Africa has been compromised by stockouts in health facilities. This study analyses the occurrence of stockouts for a selection of essential medicines for the period 2013-2015. An analytical cross-sectional design was undertaken using secondary data retrieved from the Stop Stock Outs Project (SSP). Specifically, a descriptive analysis was conducted on data from the 2013-2015 SSP's case management database of routinely reported stockouts. The Chi-square test of independence was conducted on data from the SSP's 2015 annual telephonic survey to investigate associations between the occurrence of stockouts, level of health facilities and type of health professionals in the facilities. Two hundred and thirty-one health facilities reported 609 stockouts. Antiretroviral medication had the most stockout reports (77.9%; n=475/609), followed by anti-infectives (17.1%; n=104/609) and tuberculosis medication (4.9%; n=30/609). The highest number of stockout reports were received from Gauteng province and the majority (71.1%; n=150/211) of facilities reporting stockouts were in urban areas. There were more stockouts in ambulatory (level 1) rather than inpatient care facilities (level 2); however, this was not statistically significant ($p>0.05$). There was a significant difference in the type of health professional and occurrence of stockouts with stockouts being more likely to occur with pharmacy personnel than nurses. This study confirms that South Africa experiences medicine stockouts for many of the essential medicines, with antiretroviral medication being the category most affected. The stockouts vary between provinces and urban-rural divide, but threaten both levels 1 and 2 facilities similarly.

Keywords: Stockouts, essential medicines, availability, access.

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Introduction

South Africa has adopted the essential medicines concept as part of delivering quality health services to the population (National Department of Health [NDoH], 2018). The availability and access to essential medicines is compromised by stockouts. The public sector in South Africa provides services to the majority (more than 80%) of the population (Statistics South Africa [StatsSA], 2013), and yet frequently experiences stockouts of essential medicines (Medicine Sans

Frontier [MSF], 2015). An audit of the public health care facilities in South Africa in 2011 showed that only 54% of facilities were compliant to the Ministerial priority area: 'availability of medicines and supplies'. One of the measurements used to determine this was the availability of tracer essential medicines (Health Systems Trust [HST], 2013). It was found that 77% of clinics, 70% of community health centres and 66% of hospitals did not have all the tracer medicines (as per the applicable essential drugs list or formulary) available during the audit (HST, 2013).

In order to assist the government to address medicine stockouts, civil society organisations in South Africa formed a coalition: the Stop Stock Outs Project (SSP). The aim of the SSP is to ensure that all patients have access to the medicines they require. The SSP uses complaint reports of medicines stockouts (received through a confidential hotline) as well as results from an annual survey conducted by the SSP, to liaise with the National Department of Health (NDoH), along different levels of the supply chain to resolve and prevent medicine stockouts (Stop Stockouts, 2015a). An analysis of tuberculosis (TB) drug stockouts using the District Health Information System (DHIS) and the SSP's 2013 annual survey showed a correlation between the DHIS and the SSP's data using the indicator for "any ARV/TB drugs" out of stock (Seunanden & Day, 2014), thereby suggesting that the data collected by the SSP are accurate and reliable.

Studies in Kenya and Tanzania reported a significant reduction in the percentage of drug stockouts following the introduction of the SMS system for reporting stockouts of antimalaria drugs (Barrington, Wereko-Brobby, Ward, Mwafondo & Kungulwe, 2010; Githinji *et al.,* 2013). This system is similar to the confidential SSP's hotline method. According to the SSP's 2013 telephonic survey, 21% of facilities in the country reported having experienced TB and antiretroviral (ARV) drug stockouts in the three-month survey period (MSF *et al.*, 2016). This percentage increased to 25% in 2014 and 36% in 2015 (MSF *et al.,* 2016). The public health care system aims to provide quality integrated health care for all citizens through the principles of primary health care (PHC) using the district health system (DHS) approach (National Planning Commission, 2012). Implementation of the DHS in South Africa has resulted in a decentralised management system with the NDoH, characterised by nine provincial health departments and 52 health districts (Gray, Riddin & Jugathpal, 2016). South African public health care facilities are composed of a network of facilities providing PHC such as clinics and community health centres (CHCs), and the supporting higher levels like hospitals (HST, 2013).

In South Africa, the public sector uses the Central Medicines Stores (CMS) system to ensure the availability of essential medicines. Essential medicines are those which are "intended to be available within the context of functioning health systems at all times, in adequate amounts, in the appropriate dosage forms, with assured quality, and at a price the individual and community can afford." (WHO, 2017). With the CMS system, medicines are procured and distributed by a centralised government unit (Management Sciences for Health [MSH], 2012). According to the NDoH, several characteristics of the public sector pharmaceutical supply chain system affect medicine stockouts (NDoH, 2010). The NDoH's report highlighted the late award of tenders and the dual tender process where both the NDoH and the provincial departments of health may tender for supply of medicines as problematic. In addition, the national treasury's electronic systems do not interface with provincial depot systems, leading to delays in capturing of prices and orders. Similarly, another issue raised in the report was the use of both equitable shares and conditional grants to fund medication. For example, funding for HIV/AIDS services is done through conditional grants, while the financing of all other health services is done through the equitable shares mechanism. Finally, the task team found that many of the pharmaceutical depots did not comply with the some of the *Medicines Control Act* (101 of 1985) regulations and were deficient in many respects (NDoH, 2006).

The World Health Organization (WHO) states that gathering data on medicine availability is a crucial component of monitoring access to essential medicines (WHO, 2010). The WHO also recommends using an integrated list of tracer medicines, or at a minimum, the list of 14 medicines in use worldwide (WHO, 2010). In addition to these 14 medicines, the integrated list should include regionally-specific medicines and medicines of national importance (WHO, 2010). In South Africa essential medicines, including medicines of national importance, are selected by the ministerial appointed National Essential Medicines List Committee as well as provincial and facility Pharmacy and Therapeutic Committees. National Essential Medicines lists are regularly updated (Pharasi & Miot, 2013; NDoH, 2018).

Causes of essential medicines stockouts

Stockouts may be caused by different factors which could be either demand-side or supply-side factors (International Pharmaceutical Federation [FIP], 2013). Demand-side factors refer to all changes in the demand for a particular drug or dosage form which may be affected by drug pricing, tenders, surges in epidemics or certain disease states necessitating emergency medicines and changes in prescribing guidelines (FIP, 2013).

Supply-side factors refer to changes or inefficiencies in the supply chain for a particular drug or dosage form and are largely responsible for stockouts (Bateman, 2013; FIP, 2013). At the medicines regulation level of the supply chain, these factors may include medicine registration changes, registration process backlogs, unavailability of funds and delays in the awarding of tenders and medicine procurement (Gray & Manasse, 2012; FIP, 2013; Leng, Sanders & Pollok, 2015). Common factors that contribute to stockouts at the health facility and depot levels include inaccurate and non-participatory forecasting at the procurement level, insufficient buffer stock, inefficient distribution systems, short-dated stock and inadequate record keeping (Bateman, 2013; Mori & Owenya, 2014; Stop Stockouts, 2015b).

Stockouts can also be affected by the availability of human resources with the right skills. Wagenaar *et al.* (2014) found that in Mozambique, facilities with fewer staff than other facilities were more likely to experience more medicine stockouts. Masters *et al.* (2014) conducted facility surveys on pharmaceutical availability in Ghana, Kenya and Uganda and found that there was no significant difference in stockouts based on whether a pharmacist, accountant or medical personnel was in charge of pharmaceutical records. This study implies that facilities without experienced pharmaceutical personnel are capable of monitoring their stock.

In South Africa, pharmacists and pharmacy support personnel are the professionals most expected to manage the procurement and supply management systems of medicines in the public sector. Pharmacy support personnel comprise various categories of support personnel prescribed and registered in the *Pharmacy Act* (53 of 1974), who work under the direct supervision of a pharmacist. These include categories of pharmacist assistants such as the post-basic pharmacist assistant (NDoH, 1974). The post-basic pharmacist assistant is permitted to render services under the indirect personal supervision of a pharmacist at a PHC clinic. Due to constraints of human resources, the *Medicines and Related Substances Control Act* (101 of 1985) allows for professional nurses to apply for a permit to acquire, possess, use and supply medication (NDoH, 1985).

A shortage of pharmacists has been cited as one of the causes for medicine stockouts in South Africa (Bateman, 2013). In 2011, 12% of both district and specialised hospitals in South Africa had no pharmacists. In the same year, 84% of clinics were found to have no input from a pharmacist or post-basic pharmacist assistant (HST, 2013). In 2015, a study in the uMgungundlovu district of KwaZulu-Natal province evaluated the adequacy of pharmaceutical services in PHC clinics and reported that 80% of the clinics had stockouts of essential medicines (Crowley & Stellenberg, 2015).

Medicines stockouts in facilities may also be caused by the distance of a health facility from a district distribution centre or depot. In Mozambique, the stockouts of essential medicines was found to be significantly higher in areas far from district capitals and distribution centres. These stockouts occurred despite depots having sufficient stock (Wagenaar *et al.,* 2014). According to Masters *et al.* (2014), community health facilities had the highest proportion of stockouts. The authors found that the effect of the rural versus urban location of the health facility on medicine stockout differs from country to country. Rural facilities in Uganda were found to be more likely to experience stockouts while rural facilities in Kenya were less likely to experience stockouts (Masters *et al.,* 2014).

Essential medicines stockouts affect the general public's confidence and might discourage them from using health facilities (Stop Stockouts, 2015b). The consequences of essential medicines stockouts are borne by patients and the health care system (Medecins Sans Frontieres [MSF], 2015). These consequences may include the increased likelihood of drug resistance, a decrease in patient medication adherence, increased risk of interruption in care, increased patient costs to access care (such as travel time and money) and greater pressure and costs on the health care system as scarce resources are spent in managing stockouts (Kangwana at al., 2009; Pasquet *et al.,* 2010; FIP, 2013; MSF, 2015).

The problem of frequent stockouts of essential medicines in the health facilities of the South African public sector is known. However, little has been documented on the extent of essential medicines stockouts (beyond ARV and TB medication) as well as the contributing factors of stockouts in South Africa. Therefore, this study described and analysed the occurrence of stockouts for a selection of essential medicines in South Africa between 2013 and 2015. This was done by determining the selected essential medicines which had stockouts, comparing stockouts in different geographical areas (i.e. provincial and urban vs rural locations), and investigating any association between level of facility, type of health professional and stockouts.

Methodology

An analytical cross-sectional study design was used to evaluate secondary data collected by the SSP. The target population comprised all the public health facilities that reported stockouts of the selected essential medicines to the SSP from 2013 to 2015. The SSP uses the following types of data collection tools: an annual telephonic survey as well as complaint reports of essential medicines stockouts from patients and health care workers received through a confidential hotline which are compiled into a case management database.

South African public health facilities are classified into three categories depending on the level of care offered at the facilities either ambulatory (level 1), inpatient care (level 2) or acute, sub-acute and chronic care (level 3) (NDoH, 2006). The study excluded all level 3 facilities (as these do not have direct medicine procurement functions), some satellite and mobile clinics as well as all other public health facilities that did not report any stockouts to the SSP. In the 2015 telephonic survey data, 2 448 facilities met the study's inclusion criteria. Fifty-four essential medicines were selected for the study. The medicines were selected from the WHO global core list of medicines (WHO, 2010) provided they appeared in the South African essential medicines list and the SSP's list of essential medicines.

Data collection

The following data elements were extracted into an Excel™ spreadsheet: the selected essential medicine and the health facility where the stockout occurred, the province where the health facility is located, the type of health professional responsible for ordering of medicines, the date the stockout was reported, and the date the stockout case was closed. The name and provincial location of the health facility was used to determine the district and local municipality of the health facility. The rural/urban location of the facility was obtained using a list from Statistics South Africa. Urban and rural areas were classified based on dominant settlement type and land use (StatsSA, 2004). Urban areas included cities, towns, townships and areas identified as informal settlements, hostels, institutions, industrial and recreational areas, and smallholdings within or adjacent to any formal urban settlement. Rural areas were identified as any areas that were not classified as urban and included tribal areas and commercial farms (StatsSA, 2004).

Data analysis

Data were entered into and analysed for descriptive statistics using Microsoft Excel™ 14.0.4734.1000 (Microsoft Corporation, USA). Descriptive analysis were performed on the SSP's case management database to determine the number of reports received for the selected essential medicines, the essential medicines reported out of stock, the number of facilities that reported stockouts, and the geographical distribution of the reported stockouts. Data from the SSP's 2015 annual telephonic survey were subjected to a series of Chi-square analyses to examine the associations between medicine stockouts and the level of health facility as well as type of health professional responsible for procurement and/or ordering of medicine. The analyses were conducted using STATA version 12.0 (StataCorp LP, USA) and a probability level of 0.05 or less taken to indicate significance.

Ethical Considerations

Ethical approval of the study was granted by the Faculty of Health Sciences' Ethics Committee at the University of Pretoria (Reference: 548/2015). The SSP granted permission to use the database for the purposes of this research. Only aggregated data were reported to ensure the health facilities' confidentiality and anonymity.

Results

From the SSP's 2013 to 2015 case management database of routinely reported medicine stockouts, 609 stockout reports met the inclusion criteria. The total numbers of reports are shown in Table 1. There were only five more reports in 2014 than 2015. The relatively low number of stockout complaint reports in 2013 could be related to the fact that the project started in September of that year.

Table 1: Number of stockout complaint reports received per facility level (2013-2015)

Facility level	2013	2014	2015	Total
Level 1	22	262	236	520
Level 2	2	33	54	89
Total	24	295	290	609

The complaint reports were received from 231 facilities of which 87% (n=201) were level 1 and 13% (n=30) were level 2 facilities.

The selected essential medicines that had stockouts (2013-2015)

The 54 selected essential medicines for this study included 25 ARV drugs, 13 TB drugs and 16 medicines which fell into the category of "other essential medicines". The results of the number of stockout reports received for medicines in each category per year are shown in Tables 2, 3 and 4, respectively. The tables also further categorise the selected medicines as per their primary treatment indication. In cases were the reports received for medicines stockouts did not specify the drug dosage form and strength, these were grouped together.

The essential medicines reported as stocked out are 90.7% (n=49/54) of the selected medicines. All the ARV drugs were reported as stocked out at some point during the study period and accounted for most of the stockout reports (77.9%; n=475/609). These were followed by stockout reports for medicines in the category of "other essential medicines" (17.1%; n=104/609) and essential medicines for TB treatment (4.9%; n=30/609) consecutively.

Table 2: The selected ARV medication that had stockouts reported during the study period

Type of medication	Stockout reported		Number of reports received			
	Yes	No	2013	2014	2015	Total
Adult First Line ARVs						
Stavudine 30mg	X		3	6	3	12
Efavirenz tablets (includes paediatric strengths)	X		1	19	25	45
Tenofovir tablets	X		3	10	7	20
Tenofovir/Emtricitabine/Efavirenz 300/200/600mg	X		0	28	9	37
Tenofovir/ Emtricitabine 300mg/200mg	X		0	1	0	1
Lamivudine 150 and 300 mg	X		9	11	51	71
Adult Second Line ARVs						
Zidovudine 300mg	X		0	13	18	31
Lopinavir/Ritonavir 200mg/50mg	X		1	8	60	69
Atazanavir	X		0	2	0	2
Didanosine	X		0	3	1	4
Ritonavir 100mg	X		0	0	5	5
Lamivudine/Zidovudine tablets	X		1	3	1	5
Adult Exceptional Cases ARVs						
Nevirapine tablets	X		0	4	0	4
Abacavir 300mg and 600mg	X		2	11	23	36
Abacavir/Lamivudine 600mg/300mg			0	5	0	5
Paediatric ARVs						
Abacavir 60mg tablets or 20mg/ml solution	X		0	12	14	26
Zidovudine solution &/or tablets	X		0	5	19	24
Ritonavir solution	X		0	3	1	4
Lamivudine	X		1	11	3	15
Lopinavir/Ritonavir 80/20mg/ml solution	X		0	12	8	20
Lopinavir/Ritonavir 100mg/25mg	X		0	0	13	13
Stavudine 15mg or 20 mg	X		1	5	1	7
Efavirenz 200mg	X		Number of reports included in Efavirenz listed for adult first line ARV treatment			
Efavirenz 50mg (included in first line adult counts)	X					
PMTCT (ARV)						
Nevirapine Solution	X		0	10	9	19
Total number of reports						475

Note: The X's indicate applicable options regarding whether or not stockouts were reported.

Table 3: The selected TB medication that had stockouts reported during the study

Type of medication	Stockout reported		Number of reports received			
	Yes	No	2013	2014	2015	Total
First Line TB						
Rifampicin/Isoniazid 150/75mg –Rifinah/Rimactazid	X		0	0	2	2
Rifampicin/Isoniazid 300/150mg –Rifinah/Rimactazid	X		0	1	1	2
Rifampicin/Isoniazid 60/60mg – Rimactazid for children	X		0	3	0	3
Rifampicin/Isonaizid /Pyrazinamid/Ethambutol – Rifafour	X		0	6	0	6
Complicated TB						
Pyrazinamide 150mg &/or 500mg	X		0	2	0	2
Ethambutol 400mg		X				
Ethionamide		X				
Kanamycin	X		0	1	0	1
Azithromycin	X		1	0	0	1
Levofloxacin	X		0	1	0	1
Rifampicin capsules	X		0	1	0	1
Rifampicin Suspension		X				
IPT (TB Prophylaxis)						
(INH) Isoniazid tablets	X		0	10	1	11
Total						30

Note: The X's indicate applicable options regarding whether or not stockouts were reported.

Table 4: Other selected essential medicines that had stockouts reported during the study period

Condition and type of medication	Stockout reported		Number of reports received			
	Yes	No	2013	2014	2015	Total
Asthma						
Salbutamol inhaler	X		0	5	0	5
Diabetes						
Glibenclamide capsule/tablet		X				
Metformin capsule/tablet	X		0	5	5	10
Cardiovascular disease						
Atenolol capsule/tablet	X		0	4	1	5
Enalapril &/or Perindopril capsule/tablet	X		1	10	0	11
Simvastatin capsule/tablet	X		0	7	1	8
Infectious diseases						
Ciprofloxacin capsule/tablet	X		0	1	1	2
Co-trimoxazole capsule/tablet/suspension/IVI	X		0	6	2	8
Amoxicillin capsule/tablet/suspension	X		0	17	2	19
Ceftriaxone injection	X		0	6	0	6
Central nervous system						
Amitriptyline capsule/tablet	X		0	5	1	6
Sodium Valproate capsule/tablet/syrup/injection	X		0	1	0	1
Diazepam capsule/tablet		X				
Pain and inflammation						
Diclofenac capsule/tablet	X		0	0	2	2
Paracetamol capsule/tablet/suspension	X		0	18	0	18
Ulcer						
Omeprazole capsule/tablet	X		0	3	0	3
Total						104

Note: The X's indicate applicable options regarding whether or not stockouts were reported.

Figure 1 shows a ranking of the categories from most to least number of stockout reports received, where "other essential medicines" have been further classified according to their primary treatment indication. In this case, medicines for infectious diseases had the second highest number of reports (5.7%; n=35/609) followed by those for TB treatment (4.9%; n=30/609). Lamivudine 150 and 300mg tablets which are a first line treatment option for HIV had the highest (14.9%; n=71/475) number of the reports for ARV stockouts. The fixed dose combination (FDC), Tenofovir/Emtricitabine/Efavirenz 300/200/600mg, which is most commonly prescribed in South Africa as an adult first line treatment, had the fourth highest number of ARV stockout reports (7.8%; n=37/475) during the study period (see Table 2).

Ethambutol, Ethionamide and Rifampicin suspension are the only three TB drugs that were not reported as stocked out. These are all drugs recommended for complicated TB treatment. All the selected essential medicines recommended for first line TB treatment were reported as stocked out at some point during the study period (see Table 3). In the category of "other essential medicines", medicines indicated for infectious diseases, which include Ciprofloxacin capsule/tablet, Co-trimoxazole capsule/tablet/suspension/IVI, Amoxicillin capsule/tablet/suspension and Ceftriaxone injection, had the most (33.7%; n=35/104) stockout reports. This was followed by essential medicines for cardiovascular diseases (23.1%; n=24/104) which include medicines for chronic diseases such as hypertension.

Medicines for ulcer treatment which consisted of Omeprazole tablets/capsules had the least reported number of stockouts (2.9%; n=3/104). There were no stockout reports received for the diabetes medication Glibenclamide and the central nervous system drug Diazepam (Table 4).

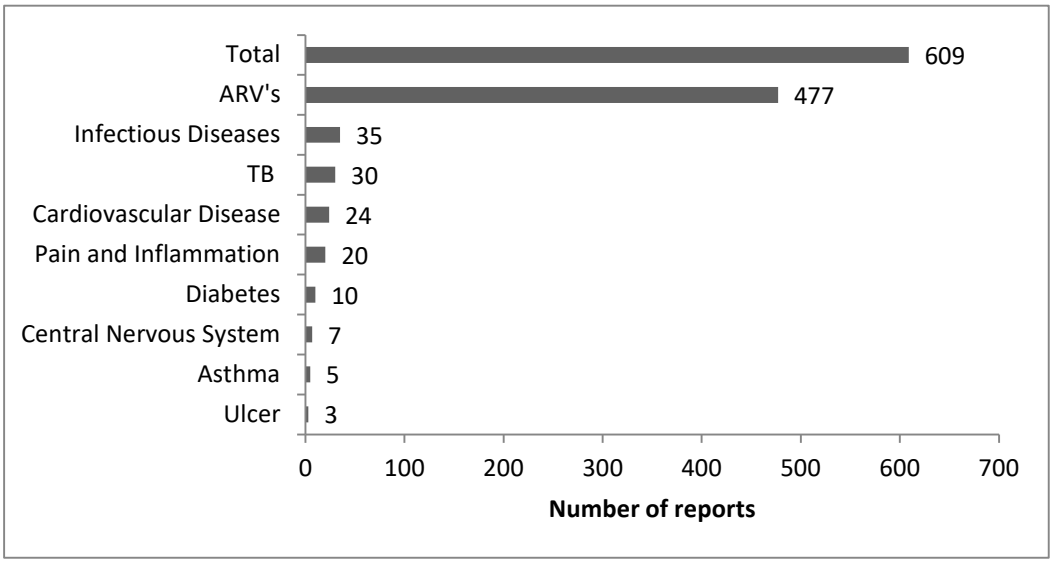

Figure 1: Ranking of the selected essential medicines categories as per number of stockout reports received (2013-2015).

Geographical distribution of selected essential medicines stockouts

Figure 2 shows the total number of selected essential medicines stockout reports and the number of facilities where the stockouts were reported per province. The highest number of stockout complaint reports were received from Gauteng province followed by Eastern Cape and Limpopo province, respectively. This pattern was the same for the number of facilities reporting the stockouts. The Northern Cape Province had the fewest reports received from two facilities in 2014 and no medicine stockouts were reported in 2015.

There was an overall decline in the number of reports received from the Gauteng, Eastern Cape, North West and Western Cape provinces between 2014 and 2015. Similarly observed was an overall decrease in facilities with reported stockouts between 2014 and 2015 in all provinces except Free State and KwaZulu-Natal.

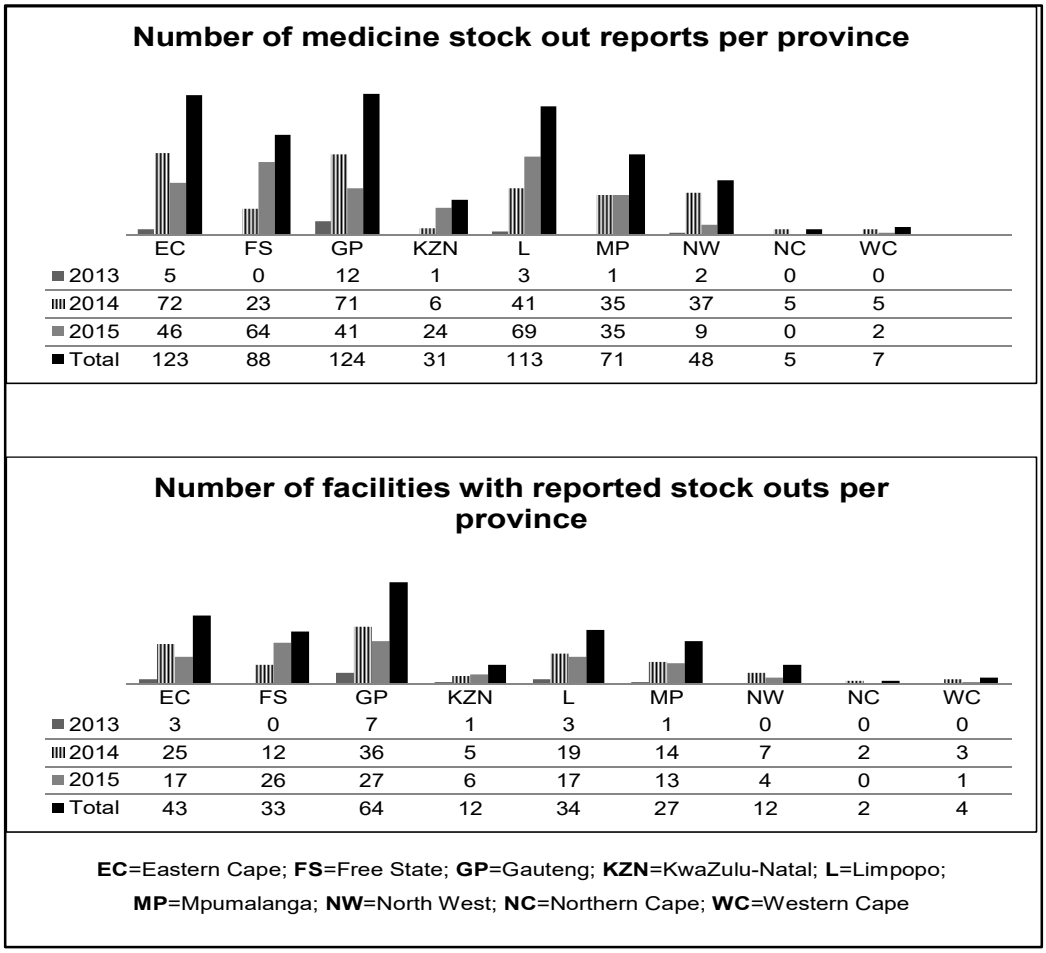

Figure 2: Number of stockout reports and facilities reporting stockouts per province, 2013-2015.

Urban versus rural distribution of selected essential medicines stockouts

Only 211 of the facilities could be classified as urban or rural. The majority (71.1%; n=150/211) of these facilities are situated in urban areas, i.e. provincial capitals and environs. These urban-based facilities accounted for 60.9% (n=371/609) of the total stockout reports. The remaining 61 facilities were situated in the rural areas. These rural-based facilities accounted for approximately a third of the total reported stockouts (32.18%; n=196/609).

Association between medicine stockouts and the level of facility

The 2015 SSP survey identified 2 183 facilities as level 1 facilities and 257 facilities as level 2 facilities, while 8 facilities could not be classified. Of the level 1 facilities, 27.39% (n=598/2 183) and of the level 2 facilities, 26.85% (n=69/257) facilities experienced stockouts of the selected essential medicines included in the survey.

A Chi-squared test was performed under the test conditions of α=0.05 and 1 degree of freedom to examine whether the occurrence of stockouts is independent of the health facility level. The test yielded statistically non-significant results as the p-value was greater than 0.05 (p=0.85). It is therefore assumed that there was no association between the level of the health facility and the occurrence of stockouts. This finding suggests that even though there are more stockout reports from level 1 facilities, these facilities are not more likely to experience stockouts than level 2 facilities.

Association between medicine stockouts and the health professional responsible for procurement

The majority of health professionals who were responsible for ordering medicine were registered nurses (73.9%; n=1810). Pharmacists comprised 16.2% (n=397) of the health professionals, whereas 9.4% (n=229) were pharmacist assistants. Twelve respondents either did not identify their category or were not one of the three categories of health professionals listed above (e.g. dispensing doctor and operational manager).

Table 5: Results of the Chi square test of independence between stockouts and type of health professional.

Stockouts occurred		**Pharmacists**	**Pharmacist assistants**	**Registered nurse**	**Other**	**Total**
No	Observed	272	154	1347	8	1781
	Expected	1.0	1.0	0.7	0.1	2.7
Yes	Observed	125	75	463	4	667
	Expected	2.6	2.5	1.8	0.2	7.2
Total	Observed	397	229	1810	12	2448
	Expected	3.6	3.5	2.5	0.2	9.9
Pearson's Chi^2(3)						9.86
***p*-value**						0.02

The test of independence was significant (p=0.02) which indicates an association between the type of health professional and the occurrence of stockouts. Based on the Chi square results, pharmacists and pharmacist assistants were more likely to experience stockouts than nurses.

Discussion

This study identified selected essential medicines which had stockouts, compared stockouts as experienced in different geographical areas and facility levels, and investigated the association between the type of health care professional responsible for procurement of stock, and the stockouts. The essential medicines stockout reports, and the number of facilities that reported to the SSP through the hotline, represent a small fraction of the stockouts experienced in South Africa when compared to the published SSP annual telephonic survey reports.

The SSP surveys reported that the percentage of facilities that had at least one ARV or TB medicine stockout were 21%, 25% and 36% in 2013, 2014 and 2015 respectively (MSF, 2016). This means that, although this study sample consisted of all public health facilities in South Africa, the results of this study (which are based on the hotline data) are less than the stockouts experienced in the country. Factors in this study that may have contributed to the low active reporting of stockouts from facilities could include a possible low level of awareness and willingness to report stockouts.

Studies by Githinji *et al.* (2013) and Barrington *et al.* (2010) that utilised SMS (short messaging service) reporting systems to document and manage stockouts in Kenya and Tanzania, respectively had high reporting rates. The high stockout report rates in those studies may be attributed to the training and incentives given to health professionals reporting the stockouts. The incentives used during the studies were loading airtime credit to the health professionals' cellular phones for personal use if they reported before specific timeframes. The study also differed in the SSP approach utilised in that the health professionals received an SMS requesting stock count data. The SSP system is reliant on health professionals and the public reporting stockouts only when they occur.

The relatively small decline in the number of stockout reports, with a difference of only 5 reports between 2014 and 2015, is contrary to the increase in the number of facilities reported to have experienced stockouts in the 2015 survey (MSF, 2015). This decline is therefore unlikely to be due to an improvement in the stockout situation but rather to a decrease in the number of stockout reports. ARV's were the category of medicine stockouts most reported. This finding is not surprising considering the magnitude of the ARV programme and the high number of patients on ARVs. The finding that ARVs, medicines for infectious diseases and TB drug stockouts were the top three categories of medicines most reported as being out of stock is a concern for the potential risk of emergence of ARV, antibiotic and TB drug resistance which has been cited as a negative consequence of stockouts (MSF, 2015). However, the absence of stockout reports for all drugs recommended for complicated TB treatment is reassuring.

The medicine stockout reports received by the SSP included cases of nationwide drug stockouts, as evidenced by the large number of reports for Lopinavir/ritonavir drug stockouts in 2015. However, the effect of the nationwide stockout varied from province to province. The country's decentralised governance system gives autonomy to provinces which allows them to procure medicines on provincial tenders. Therefore, inter-provincial variations for all stockouts found in this study may be attributed to the differences in the medicine procurement tender systems, supplier contract management, and overall pharmaceutical supply chain management between the provinces.

The Western Cape provincial health department's use of a chronic medication dispensing unit may have contributed to the low level of stockout reports in the province as the system decreases the workload in public health facilities. It has been shown that facilities with a small number of staff (and thus higher workload) experience more medicine stockouts (Wagenaar *et al.,* 2014).

The present results showed more reports from urban than rural areas which is not surprising given that the majority of facilities were situated in urban areas. The results of the urban-rural distribution of stockouts were based only on self-reported stockouts from the SSP hotline database. Unlike the SSP survey data, the hotline data did not have records from facilities who did not experience stockouts. In the absence of a comparison group, statistically significant difference between the stockouts in rural versus urban areas could therefore not be determined. Explanations for possible low reporting from facilities in rural areas might be due to communication barriers. The results are therefore, inadequate to dismiss the view that medicine stockouts occur more in rural areas than urban areas as has been shown in countries such as Mozambique (Wagenaar *et al.,* 2014) and Uganda (Master *et al.,* 2014).

South Africa's decentralised PHC system has resulted in a higher number of ambulatory care facilities (level 1) than inpatient facilities (level 2). This structure has contributed to a higher number of medicines stockout reports from level 1 than level 2 in this study. However, there was no statistically significant difference between the occurrence of stockouts and the level of the health facility. Masters *et al.* (2014) noted a higher proportion of stockouts in community-level public health facilities in Ghana, Uganda and Kenya compared to facilities at higher levels. However, the regression analysis used to test statistical significance in their study was not applied to the "type of facility" variable. Based on our findings, it can be concluded that stockouts pose a similar threat to levels 1 and 2 facilities in South Africa.

The significant association between the type of health professional and occurrence of stockouts in this study contradicts the findings of Masters *et al.*'s study (2014) which showed no significant association between health professionals responsible for stock management and stockouts. However, the higher likelihood of stockouts experienced with pharmacists and pharmacist assistants rather than with nurses as shown in this study, could be explained by the assertion of Masters *et al.* (2014) that facilities without pharmaceutical personnel are capable of efficiently managing their own stock. The higher likelihood of stockouts with pharmacy personnel was an unexpected finding as these are the health professionals whose basic training includes pharmaceutical supply management unlike that of nurses.

In our study, it was expected that nurse-managed PHC facilities would have more stockouts. This assumption was based on the study which showed that 80% of nurse-initiated and nurse-managed PHC facilities in uMgungundlovu district had stockouts (Crowley & Stellenberg, 2015). The high percentage of stockouts in nurse-managed facilities may have been influenced by the increased workload as facilities with a higher burden on the staff were shown to have experienced more stockouts (Wagenar *et al.,* 2014). The results of Crowley and Stellenberg's (2015) study are however, not generalisable to the entire country as the study was conducted in one district.

In conclusion, this study confirms that South Africa experiences medicine stockouts which affect not just ARV and TB medication, but also other essential medicines. ARVs, TB and anti-infective medication were shown to be the medicine categories with the most reported stockouts which carries the risk for the development of drug resistance. The results based on the SSP hotline database show an underreporting of stockouts through that system. The results based on the SSP hotline database showed a slight decrease in the number of stockouts between 2014 and 2015. However, this decrease was most likely due to underreporting and not an improvement in the stockout situation.

Stockouts varied between provinces and the urban-rural divide and, there was a significant association between the type of health professional and the level of stockout with pharmacy personnel being more likely to experience stockouts than nurses. Any initiatives taken towards addressing essential medicines stockouts should target the various levels of the pharmaceutical supply chain. Results from the annual telephonic data showed that although level 1 facilities experience more stockouts than level 2 facilities, stockouts are an equal threat to both levels. Initiatives taken to address stockouts at the facility level of the supply chain should be aimed at alleviating stockouts at both PHC and hospital-level facilities.

An important limitation of this study was that it was based on secondary data. The data collected by the SSP were not designed with this research in mind and the researchers did not have any control over the quality of the data. The use of secondary data may have confounded, for instance, the test for association between health professional and stockouts where the survey question used may not have been sensitive enough to determine if the health professional responding was indeed responsible for procurement. Another constraint of the secondary data was that the 2013-2015 mobile communication hotline data only consisted of medicine stockout reports for those facilities who indicated stockouts.

Implications for Health Policy

An adequate and uninterrupted supply of essential medicines is a cornerstone of providing quality health care in the public sector. The policy of having nurse-managed PHC facilities has proved successful with regard to the ability to ensure stock of essential medicines. A policy is needed to address the known weaknesses of the pharmaceutical supply chain system in South Africa. Until that time the role of civil society organisations such as SSP remains indispensible.

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