Using PROC SURVEYMEANS to determine the dispensing time of prescriptions in pharmacies in South Africa: A user’s perspective

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ABSTRACT
This paper demonstrates the use of PROC SURVEYMEANS to determine the dispensing time of pharmacists in different pharmacy sectors nationally in South Africa (SA). In order to ensure that the results were representative of all pharmacy sectors in SA, a complex sampling design with stratification, clustering and unequal weighting was used. In order to make statistically valid inference from the sample to the study population, it was necessary to analyse the data taking into account the sample design.

INTRODUCTION
In 2006-2009 the South African Pharmacy Council (SAPC) in collaboration with the Department of Health, Pharmacy Schools, Head of Pharmaceutical Services of the different provinces and other interested parties embarked upon a national research project with the specific objective to assign unit values to procedures (services) for which a pharmacist may levy a fee and to determine the cost of providing these services in both community and institutional pharmacies (both private and public). This paper will focus on one of the services only namely the dispensing of prescriptions and only on the determination of the mean dispensing time of prescriptions. Dispensing was divided into three phases, namely Phase I (interpretation and evaluation of the prescription), Phase II (preparation and labelling of the prescribed medicine) and Phase III (provision of information and instructions to the patient).

RESEARCH METHODOLOGY
The research project was conducted in two phases from 2006 until 2009.

PHASE 1
The aim of the first phase was to determine which services are provided in community and institutional (public and private) pharmacies. The target population for Phase 1 consisted of all community and institutional pharmacies (N = 3421) in both the public and the private sectors recorded in the most recent register of pharmacies of the South African Pharmacy Council at the time of commencement of the survey (12 January 2007). Data were gathered during telephonic interviews by using structured questionnaires. The response rate was as follows: community pharmacies (1690 respondents), private institutional pharmacies (158 respondents), and public institutional pharmacies (352 respondents). Thus a total of 2200 pharmacies could be included.
PHASE 2
During Phase 2 time analysis data collection tools were utilised to measure the duration of each of the services and procedures that are listed in the *Rules Relating to Services for which a pharmacist may levy a fee and guidelines for levying such fees.*

Sampling process for phase 2
The results obtained in Phase 1 (n=2200) were used to determine the sample for Phase 2. A stratified random sampling design was used to select a sample (n = 680) of pharmacies from each category of pharmacy in each of 9 provinces (community [n =502], public [n = 114] and private [n = 64] institutional pharmacies). This method was used to ensure that it would geographically be representative of South Africa and would include under-serviced areas regarding pharmaceutical services (Table 1). The following strata were included in the stratified random sample:

**Group A**
All pharmacies in a specific category of pharmacy (community, public and private institutional pharmacies) in a province that provides services with prevalence lower than 15% on provincial level were included in the final sample. This method ensured that services with a low prevalence in certain provinces, as determined during the baseline survey (< 15%), were included in the final sample.

**Group B**
From the rest of the pharmacies (Population for Group B) a simple random sample of 20% was taken from each category of pharmacy in each province.

The following statistical formulas were used to calculate the sample size, for the final Group B:

The formula set out below can be used to calculate the minimum sample size (n_g) for a simple random sample drawn from a population with a 95% confidence level to obtain a given accuracy (e) for estimation of an unknown population proportion:

\[
n_g = 0.25 \left( \frac{1.96}{e} \right)^2.
\]

Minimum sample size for sample for Group B when e = 0.05 (i.e. 5% accuracy, for example when obtaining the sample proportion of 0.5 or 50%, the unknown population proportion can lie with 95% probability between 45% and 55%):

\[
n_g = 0.25 \left( \frac{1.96}{0.05} \right)^2 = 384.16,
\]

i.e. take 384 pharmacies.
Because the size of the population for Group B is known, the minimum sample size can be adjusted to:

\[ n_k = \frac{N_{g}n_{g}}{N+n_{g}} \]

where \( N = \) Size of population for Group B (\( N = 1924 \)) (refer to Table 1, Population for Stratum B) and \( n_{g} = \) minimum sample size if study population size is unknown.

\[ n_k = \frac{1924 \times 384}{1924 + 384} = 320.11 \]

i.e. take as a minimum 320 pharmacies.

In Phase 2I, 404 pharmacies were included through stratified random sampling to make provision for those pharmacies that might not give their consent to participate in this phase of the study and since stratification requires somewhat larger samples than those of simple random sampling (Table 1).

### Table 1 Summary statistics of sampling process

<table>
<thead>
<tr>
<th>CATEGORY OF PHARMACY</th>
<th>TARGET POPULATION (Register of Jan 2007)</th>
<th>STUDY POPULATION(^\blacklozenge)</th>
<th>GROUP A**</th>
<th>POPULATION FOR GROUP B***</th>
<th>GROUP B</th>
<th>TOTAL NUMBER OF PHARMACIES IN FINAL SAMPLE FOR PHASE 2♦</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>%*</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Community pharmacies</td>
<td>2693</td>
<td>1690</td>
<td>63%</td>
<td>195</td>
<td>1495</td>
<td>307</td>
</tr>
<tr>
<td>Private institutional pharmacies</td>
<td>208</td>
<td>158</td>
<td>76%</td>
<td>32</td>
<td>126</td>
<td>32</td>
</tr>
<tr>
<td>Public institutional pharmacies</td>
<td>520</td>
<td>352</td>
<td>68%</td>
<td>49</td>
<td>303</td>
<td>65</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3421</td>
<td>2200</td>
<td>64%</td>
<td>276</td>
<td>1924</td>
<td>404</td>
</tr>
</tbody>
</table>

**Notes:**

* Calculated as percentage of target population of specific category of pharmacy
** All pharmacies in a specific category of pharmacy in a province that provide services with prevalence less than 15% were included in the final sample.
*** Population for group B = Number of pharmacies in study population – number of pharmacies in group A
**** Calculated as percentage of the total number of pharmacies in population for Stratum B
♦ Total number of pharmacies in final sample for Phase 2 = Total number of pharmacies in Group A + Total number of pharmacies in Group B
♥ Total number of pharmacies respondent in Phase 1 - baseline survey
ORGANOGRAMME OF SAMPLING

TARGET POPULATION
Register of pharmacies
12 Jan 2007 (N = 3421 Pharmacies)

Baseline survey (Phase I)

STUDY POPULATION FOR
PHASE 2
Response of phase 1 (N = 2200)

GROUP A
(N = 276)
Include pharmacies that provide services with a prevalence of less than 15% (as determined with baseline survey).

GROUP B

Population used for sampling (1924) = Study population (2200) – Population of Group A (276)
Simple random sample of 20% was taken from each category of pharmacy on provincial level.

SAMPLE FOR FINAL GROUP B
(N = 404)

FINAL SAMPLE FOR PHASE 2
Group 1 + Final Group 2 = Final sample ((N = 276) + (N = 404) = (N = 680)
DATA ANALYSIS

Descriptive statistics were used to describe data in terms of frequency tables and the SURVEYMEANS procedure was used to (SAS Institute Inc. 2004. SAS OnlineDoc® 9.1.3. Cary, NC: SAS Institute Inc) produce estimates of the dispensing time of study population means and totals from the sample survey data.

A structured time analysis data collection instrument was used to capture the time spent to dispense a prescription. A total of 597 (88%) pharmacies were surveyed by trained fieldworkers. During this research project, the time it took to dispense 6862 prescriptions (average of 11 prescriptions per pharmacy) was determined in 578 pharmacies of which 421 were community, 54 were private institutional and 103 were public institutional pharmacies.

The sample was only taken on pharmacy level and a convenience sample of prescriptions was taken per pharmacy. It was therefore first necessary to determine the average time it took to dispense the prescriptions per pharmacy with the following SAS statement.

```
data b;
set sasuser.dispensing_time;
proc sort;
by study_number;
proc means noprint;
by study_number;
var service_0001a_time_0001 service_0001b_time_0001 service_0001c_time_0001 total_time_0001 total_time_0001_p total_time_0001_pi total_time_0001_pa total_time_0001_unreg;
output out=c mean=service_0001a_time_0001_mean service_0001b_time_0001_mean service_0001c_time_0001_mean total_time_0001_mean total_time_0001_p_mean total_time_0001_pi_mean total_time_0001_pa_mean total_time_0001_unreg_mean run;
```

EXPLANATION OF VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>service_0001a_time_0001</td>
<td>time for phase 1 (sec)</td>
</tr>
<tr>
<td>service_0001b_time_0001</td>
<td>time for phase 2 (sec)</td>
</tr>
<tr>
<td>service_0001c_time_0001</td>
<td>time for phase 3 (sec)</td>
</tr>
<tr>
<td>total_time_0001</td>
<td>total time spend (sec)</td>
</tr>
<tr>
<td>total_time_0001_p</td>
<td>total time spend by pharmacist (sec)</td>
</tr>
<tr>
<td>total_time_0001_pi</td>
<td>total time spend by pharmacist interns (sec)</td>
</tr>
<tr>
<td>total_time_0001_pa</td>
<td>total time spend by pharmacist interns (sec)</td>
</tr>
<tr>
<td>total_time_0001_unreg</td>
<td>total time spend by pharmacist interns (sec)</td>
</tr>
</tbody>
</table>
The primary sampling units per groups, type and provinces, where

**Group:** 1 included pharmacies that provided services with a prevalence of less than 15% (as determined with Phase 1) and consisted of 9 **provinces** with pharmacies (N = 276) in 3 pharmacy sectors (**type**).

**Group 2** consisted of 9 **provinces** with pharmacies (N = 404) in 3 pharmacy sectors (**type**)

```plaintext
data studygroup:
input provinces type group total;
datalines;
1 1 1 28
2 1 1 36
3 1 1 0
4 1 1 35
5 1 1 29
6 1 1 0
7 1 1 3
8 1 1 21
9 1 1 64
1 1 2 135
2 1 2 74
3 1 2 553
4 1 2 210
5 1 2 63
6 1 2 97
7 1 2 29
8 1 2 112
9 1 2 201
1 2 1 1
2 2 1 4
3 2 1 18
4 2 1 6
5 2 1 0
6 2 1 1
7 2 1 0
8 2 1 4
9 2 1 1
1 2 2 10
2 2 2 8
3 2 2 37
4 2 2 19
5 2 2 6
6 2 2 8
7 2 2 3
8 2 2 10
9 2 2 22
1 3 1 7
2 3 1 3
3 3 1 5
4 3 1 6
5 3 1 3
6 3 1 4
7 3 1 5
8 3 1 3
9 3 1 7
1 3 2 45
2 3 2 37
```

**EXPLANATION OF STRATA**

**provinces** - South Africa consists of 9 provinces

**type** - Pharmacy sector which consists of community (1), private (2) and public institutional pharmacies (3)

**group** - Pharmacies from Group A (1) and Final Group B (2) in

Total is the total number of selected pharmacies in the specific group, type and province
Because of nonresponse (only 88% of pharmacies from the original sample \(N = 680\) were surveyed) it was necessary to use appropriate weights to obtain valid estimates for the study population.

```r
data f;
set c;

if provinces=1 and type=1 and group=1 then prob= 22/28;
if provinces=2 and type=1 and group=1 then prob= 26/36;
if provinces=3 and type=1 and group=1 then prob=0;
if provinces=4 and type=1 and group=1 then prob=29/35;
if provinces=5 and type=1 and group=1 then prob=21/21;
if provinces=6 and type=1 and group=1 then prob=0;
if provinces=7 and type=1 and group=1 then prob=2/3;
if provinces=8 and type=1 and group=1 then prob=21/29;
if provinces=9 and type=1 and group=1 then prob=47/64;

if provinces=1 and type=1 and group=2 then prob= 31/135;
if provinces=2 and type=1 and group=2 then prob= 16/74;
if provinces=3 and type=1 and group=2 then prob=111/553;
if provinces=4 and type=1 and group=2 then prob=48/210;
if provinces=5 and type=1 and group=2 then prob=12/63;
if provinces=6 and type=1 and group=2 then prob=20/97;
if provinces=7 and type=1 and group=2 then prob=7/29;
if provinces=8 and type=1 and group=2 then prob=29/112;
if provinces=9 and type=1 and group=2 then prob=60/201;

if provinces=1 and type=2 and group=2 then prob= 4/10;
if provinces=2 and type=2 and group=2 then prob= 2/8;
if provinces=3 and type=2 and group=2 then prob= 10/37;
if provinces=4 and type=2 and group=2 then prob=4/19;
if provinces=5 and type=2 and group=2 then prob= 3/6;
if provinces=6 and type=2 and group=2 then prob= 2/8;
if provinces=7 and type=2 and group=2 then prob=2/3;
if provinces=8 and type=2 and group=2 then prob=3/10;
if provinces=9 and type=2 and group=2 then prob=4/22;

if provinces=1 and type=2 and group=1 then prob= 0;
if provinces=2 and type=2 and group=1 then prob= 4/3;
if provinces=3 and type=2 and group=1 then prob=15/5;
if provinces=4 and type=2 and group=1 then prob=6/6;
if provinces=5 and type=2 and group=1 then prob=0/3;
if provinces=6 and type=2 and group=1 then prob=1/4;
if provinces=7 and type=2 and group=1 then prob=0/3;
if provinces=8 and type=2 and group=1 then prob=3/5;
if provinces=9 and type=2 and group=1 then prob=1/7;

if provinces=1 and type=3 and group=1 then prob= 6/7;
if provinces=2 and type=3 and group=1 then prob=3/3;
```
if provinces=3 and type=3 and group=1 then prob=5/5;
if provinces=4 and type=3 and group=1 then prob=6/6;
if provinces=5 and type=3 and group=1 then prob=3/3;
if provinces=6 and type=3 and group=1 then prob=3/4;
if provinces=7 and type=3 and group=1 then prob=3/5;
if provinces=8 and type=3 and group=1 then prob=3/3;
if provinces=9 and type=3 and group=1 then prob=5/7;

if provinces=1 and type=3 and group=2 then prob=9/45;
if provinces=2 and type=3 and group=2 then prob=14/37;
if provinces=3 and type=3 and group=2 then prob=7/33;
if provinces=4 and type=3 and group=2 then prob=6/25;
if provinces=5 and type=3 and group=2 then prob=5/32;
if provinces=6 and type=3 and group=2 then prob=10/26;
if provinces=7 and type=3 and group=2 then prob=5/31;
if provinces=8 and type=3 and group=2 then prob=10/26;
if provinces=9 and type=3 and group=2 then prob=11/53;
Weight=1/Prob;
RUN;

Using a probability sample design and the appropriate sampling weights, we could obtain statistically valid estimates of the study population. The following SAS statements compute estimates for this study.

```sas
proc surveymeans data=f total=sasuser.studygroup;
strata provinces type group / list;
weight weight;
var service_001a_time_0001_mean service_001b_time_0001_mean service_001c_time_0001_mean total_time_0001_mean total_time_0001_p_mean total_time_0001_pi_mean total_time_0001_pa_mean total_time_0001_unreg_mean;
run;
```
## RESULTS

### ALL PHARMACIES

<table>
<thead>
<tr>
<th>Data Summary Procedure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Strata</td>
<td>48</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>578</td>
</tr>
<tr>
<td>Sum of Weights</td>
<td>1823.40241</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VarName</th>
<th>N</th>
<th>Mean</th>
<th>StdErr</th>
<th>Lower 95% CLMean</th>
<th>Upper 95% CLMean</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHASE I: SERVICE_0001A_TIME_0001_mean</td>
<td>553</td>
<td>93.51558</td>
<td>2.606383</td>
<td>88.39489</td>
<td>98.63626</td>
</tr>
<tr>
<td>PHASE II: SERVICE_0001B_TIME_0001_mean</td>
<td>561</td>
<td>163.5988</td>
<td>3.859849</td>
<td>156.0157</td>
<td>171.1818</td>
</tr>
<tr>
<td>PHASE III: SERVICE_0001C_TIME_0001_mean</td>
<td>564</td>
<td>73.40701</td>
<td>3.198147</td>
<td>67.12402</td>
<td>79.69</td>
</tr>
<tr>
<td>TOTAL_TIME_0001_mean</td>
<td>578</td>
<td>307.4502</td>
<td>5.337881</td>
<td>296.9642</td>
<td>317.9362</td>
</tr>
<tr>
<td>TOTAL_TIME_0001_P_mean</td>
<td>576</td>
<td>280.145</td>
<td>5.652856</td>
<td>269.0401</td>
<td>291.2498</td>
</tr>
<tr>
<td>TOTAL_TIME_0001_PI_mean</td>
<td>86</td>
<td>295.9604</td>
<td>15.77256</td>
<td>264.3246</td>
<td>327.5961</td>
</tr>
<tr>
<td>TOTAL_TIME_0001_PA_mean</td>
<td>335</td>
<td>224.0573</td>
<td>8.45964</td>
<td>207.4075</td>
<td>240.7072</td>
</tr>
<tr>
<td>TOTAL_TIME_0001_UNREG_mean</td>
<td>12</td>
<td>152.8679</td>
<td>32.88673</td>
<td>48.20766</td>
<td>257.5282</td>
</tr>
</tbody>
</table>

The weighted mean time it took to dispense a prescription in a pharmacy was 307.45 (Standard error (SE) = 5.34) seconds (slightly over 5 minutes). The small standard error of 5.34 (1.7% of the mean) seconds indicates a good estimate of the target population’s (all community, private and public institutional pharmacies) mean dispensing time, which is confirmed by the narrow 95% confidence interval of (296.96, 317.94) seconds showing that the population’s mean time is expected to lie between the limits of 296.96 and 317.94 seconds with 95% probability. Phase II (preparation and labelling of the prescribed medicine) took the longest with 163.59 (SE = 3.86) seconds and dispensers spent only 73.41 (SE = 3.17) seconds on Phase III (provision of information and instructions to the patient).
<table>
<thead>
<tr>
<th>VarName</th>
<th>N</th>
<th>Mean</th>
<th>StdErr</th>
<th>Lower 95% CLMean</th>
<th>Upper 95% CLMean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHASE I:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001A_TIME_0001_mean</td>
<td>405</td>
<td>103.668</td>
<td>3.222</td>
<td>97.333</td>
<td>110.003</td>
</tr>
<tr>
<td><strong>PHASE II:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001B_TIME_0001_mean</td>
<td>408</td>
<td>164.847</td>
<td>4.311</td>
<td>156.370</td>
<td>173.325</td>
</tr>
<tr>
<td><strong>PHASE III:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001C_TIME_0001_mean</td>
<td>412</td>
<td>73.199</td>
<td>3.886</td>
<td>65.559</td>
<td>80.839</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_mean</strong></td>
<td>421</td>
<td>117.760</td>
<td>5.913</td>
<td>106.136</td>
<td>129.385</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_P_mean</strong> (Pharmacists)</td>
<td>420</td>
<td>294.113</td>
<td>6.267</td>
<td>281.792</td>
<td>306.434</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_PI_mean</strong> (Pharmacist interns)</td>
<td>41</td>
<td>344.079</td>
<td>25.425</td>
<td>329.008</td>
<td>369.073</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_PA_mean</strong> (Pharmacist assistants)</td>
<td>231</td>
<td>240.543</td>
<td>11.844</td>
<td>218.497</td>
<td>262.588</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_UNREG_mean</strong> (Unregistered personnel)</td>
<td>10</td>
<td>145.085</td>
<td>37.994</td>
<td>24.168</td>
<td>266.002</td>
</tr>
</tbody>
</table>

**PRIVATE INSTITUTIONAL PHARMACIES (PRIVATE HOSPITAL PHARMACIES)**

<table>
<thead>
<tr>
<th>VarName</th>
<th>N</th>
<th>Mean</th>
<th>StdErr</th>
<th>Lower 95% CLMean</th>
<th>Upper 95% CLMean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PHASE I:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001A_TIME_0001_mean</td>
<td>51</td>
<td>90.579</td>
<td>6.822</td>
<td>76.756</td>
<td>104.403</td>
</tr>
<tr>
<td><strong>PHASE II:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001B_TIME_0001_mean</td>
<td>52</td>
<td>167.084</td>
<td>17.914</td>
<td>130.819</td>
<td>203.350</td>
</tr>
<tr>
<td><strong>PHASE III:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SERVICE_0001C_TIME_0001_mean</td>
<td>51</td>
<td>51.769</td>
<td>6.932</td>
<td>37.723</td>
<td>65.817</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_mean</strong></td>
<td>54</td>
<td>290.629</td>
<td>26.177</td>
<td>237.723</td>
<td>343.536</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_P_mean</strong> (Pharmacists)</td>
<td>53</td>
<td>251.525</td>
<td>29.054</td>
<td>192.758</td>
<td>310.293</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_PI_mean</strong> (Pharmacist interns)</td>
<td>15</td>
<td>296.796</td>
<td>3.358</td>
<td>289.199</td>
<td>304.392</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_PA_mean</strong> (Pharmacist assistants)</td>
<td>34</td>
<td>233.400</td>
<td>21.891</td>
<td>188.115</td>
<td>278.685</td>
</tr>
<tr>
<td><strong>TOTAL_TIME_0001_UNREG_mean</strong> (Unregistered personnel)</td>
<td>0</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>
Another factor that influenced the dispensing time was the pharmacy sector. The weighted mean time in community pharmacies was slightly longer, 317.76 (SE = 5.91) seconds compared to 290.62 (SE = 26.17) seconds and 269.64 (SE = 13.23) seconds for private and public institutional pharmacies respectively.

The weighted mean time spent on Phase I (interpretation and evaluation of the prescription) was the shortest for public institutional pharmacies, 50.47 (SE = 4.41) compared to the 103.67 (SE = 3.22) seconds for community pharmacies. The time spent to capture data during Phase I may have caused time differences between public institutional and community pharmacies. Most of the prescriptions (85.51%) were manually dispensed in public institutional pharmacies compared to computerised dispensing in community (97.47%) and private institutional pharmacies (95.66%). The weighted mean time spent on Phase III was the longest in the public institutional pharmacies (81.95, SE = 6.49 seconds).

CONCLUSION

We have shown that using the SURVEYMEANS procedure in SAS, we can conveniently and correctly analyse dispensing time analysis data from complex sample design surveys to be representative from different geographical areas and pharmacy sectors.

ACKNOWLEDGMENTS

Vincent Tjala, Sue Putter, Andries Gous, Ilse Truter, Nadine Butler, David Bayever, Desmond Nazer, Michael Naidoo, Panjasaram Naidoo.

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