A measurement instrument for spread of quality improvement in healthcare

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Abstract

Objective. The aim of this study was to develop and test a measurement instrument for spread of quality improvement in healthcare. The instrument distinguishes: (i) spread of work practices and their results and (ii) spread practices and effectiveness. Relations between spread and sustainability of changed work practices were also explored to assess convergent validity.

Design. We developed and tested a measurement instrument for spread in a follow-up study. The instrument consisted of 18-items with four subscales.

Setting and participants. The sample consisted of former improvement teams in a quality improvement program for long-term care (n_teams = 73, n_respondents = 127). Data were collected in a questionnaire about 1 year post-pilot site implementation.

Interventions. Quality improvements in long-term care practices.

Main outcome measures. Four variables were construed: (i) actions for spread of work practices, (ii) actions for spread of results, (iii) effectiveness of spread of work practices and (iv) effectiveness of spread of results.

Results. Psychometric analysis yielded positive results on the item level. The intended four-factor model yielded satisfactory fit. The internal consistency of each scale was fine (Cronbach’s α 0.70–0.93). Bivariate correlations revealed that the spread variables were strongly related but distinct, and positively related to the sustainability variables.

Conclusions. The psychometric properties are in line with methodological standards. Convergent validity was confirmed with sustainability. The measurement instrument offers a good starting point for the analysis of spread.

Keywords: spread, measurement instrument, quality improvement, sustainability, spread practices

Background

Quality improvement in healthcare requires substantial effort during and after interventions have been implemented [1]. Although spread is often an ultimate, key improvement project goal, we know little about the spread of changed work practices and any resulting quality improvement [1–4]. Spread is generally measured by asking about intentions and plans [2, 3]; because no valid instrument is available to assess it [1, 5–7], empirical evidence on spread is lacking. We thus aim to develop a valid measurement instrument for spread of quality improvement in healthcare after interventions have been implemented.

Spread within an organization involves communication and learning for the exchange of knowledge and experience [1, 8, 9] on targeted work practices, expected results, improvement processes and development of the intervention [10]. Greenhalgh et al. [1] consider different complementary concepts to describe spread processes: Diffusion refers to the ‘unplanned, informal and decentralized’ process of spread [1], p. 601). Dissemination (also known as appropriation) is spread of innovation that is ‘planned, formal, often centralized and likely to occur more through vertical hierarchies’ [1]. Assimilation describes more complex adoption processes that typically include ‘a formal decision making process, evaluation phase(s), and planned and sustained efforts at implementation’ [1]. Last, implementation entails the ‘active and planned efforts to mainstream an innovation’ (1), p. 582) within an organization or (pilot) site. Spread within an organization requires all four processes [7, 10, 11].

Developing the measurement instrument: two key distinctions

Two key distinctions are proposed for the measurement instrument. First, we distinguish spread of a changed work
practice from spread of results [1–4]. Given the many ways to obtain results [4], seeing results in one setting does not necessarily imply whether new or changed work methods are being used effectively in other settings. And because spread of a work practice’s knowledge and experience is needed to implement improvement in other settings, spread of results appears to be instrumental to negotiating change [12]. Second, we distinguish spread practices and processes from their effects in terms of ‘effective’ spread. Spread practices comprise the work that needs to be done to change work practice and spread the results throughout the organization. Effective spread is (i) the extent to which the knowledge, skills and materials for a changed work practice are available and used beyond the pilot site and (ii) the extent to which results are known and obtained beyond the pilot site.

Sustainability and spread

Spread is often related to sustainability [1, 4, 13], which has been defined as ‘making an innovation routine until it reaches obsolescence’ [1]. In our previously developed framework for sustainability of changed work practices (presented in another article [14]), we describe sustainability by two related mechanisms through which a new or changed work practice becomes embedded in the daily activities of the organization: routinization, or the development of organizational routines for a changed work practice [15, 16], and institutionalization, or the gradual adaptation of the organizational context, including structures and processes, to the changed work practice [15, 17, 18]. From such a perspective, sustainability and spread within an organization are likely to be intimately related, since the organizational structures are often identical. In a quality improvement project on eating and drinking, for example, making an arrangement with the catering staff to change the menu serves to sustain the improvement; it serves to spread it if the arrangements affect services at other organizational sites. In such a way, sustainability is likely to enhance spread. Here, we explore the relation between spread and sustainability to assess convergent validity.

Objective of the study

We developed a measurement instrument for spread of quality improvements in organizations. Its underlying theoretical distinctions are between: (i) work practices and their results and (ii) spread and spread practices. The aim of our study is to test its psychometric properties and analyze its convergent validity with sustainability of changed work practices.

Methods

Sample and data collection

Our study’s respondents were members of improvement teams who had participated on behalf of their organizations in a national quality improvement program in the Netherlands (Care for Better), which was based on Breakthrough Methodology and aimed to improve long-term care [19, 20]. The program consisted of seven projects throughout 2006–08 on pressure ulcers, eating and drinking habits, prevention of sexual abuse, client autonomy; medication safety; fall prevention and problem behaviors. In each project, improvement teams developed and deployed small-scale practical interventions for care practices in pilot sites. Our study was part of a larger evaluation research [19, 20].

The teams had participated in the larger evaluation research. Approximately 2.9 members from 115 teams (n = 262) submitted end-of-project data [20]. We organized a follow-up data collection in 2009, inviting 171 teams who had finished the program. A total of 127 members responded from 73 teams (team response rate: 43% (73/171)). We expected about two members per team to respond in the follow-up data collection; ∼1.6 teams responded [individual response rate: 37% (127/342)]. After data cleaning, we analyzed 112 questionnaires from 63 teams. Non-response was mainly related to employee turnover and organizational dynamics, such as reorganization or mergers, but also organizational dynamics related to increased regulations and improvement agendas after managed competition was introduced in 2006 [21].

Measurement instrument development

The measurement instrument for spread pertained to a questionnaire on spread and sustainability. The framework and the content validity of draft versions of this questionnaire were assessed by a panel of experts [14].

Based on the two distinctions, four scales were designed:

(i) Spread of results (six items) measures the extent to which the results are known and used in other sites of the organization.

(ii) Spread of work practice (five items) asks for the extent to which knowledge related to the work practice is available and being used in other sites of the organization.

(iii) Action for results (four items) inquires about the actions that have been undertaken to spread the results to other organizational sites.

(iv) Action for the work practice (three items) inquires about actions for spreading knowledge about the work practice to other sites of the organization.

All items were statements on a five-point Likert scale, ranging from ‘strongly disagree’ to ‘strongly agree’ plus the option ‘I don’t know’ (Table 1). In the instructions, respondents were asked to take their own project in mind. To illustrate, the ‘eating and drinking’ project aimed to provide an inviting ambiance and reduce malnutrition. Example work practices could be setting the table with new dinnerware and distributing medication after instead of during dinner. Spread of the work practice in this case could relate to spread of: specific knowledge and skills for professionals, documentation on health and nutrition, instructional materials (e.g. how to set the table or deal with a client to enhance client-centeredness) and organizational tools (e.g. schedules with staff task allocation during dinner or table settings). Spread of results could entail items such as improved BMI scores for clients, level of client satisfaction, fewer complaints about dinner, norms for
In our organization/in other departments or other teams

Scale: Spread of work practices

1 ... practitioners also use the documentation on the new work practice
2 ... the required skills have been trained in other teams
3 ... by now they also have developed the new, care-specific knowledge and skills required for the work practice
4 ... the practitioners have been instructed how to use the materials for the work practice
5 ... the practitioners now also use the same, new materials for the work practice

Scale: Spread of results

1 Other teams or department strive for results like ours
2 Other teams or department achieve similar results in the quality of care
3 Our results have set a standard in new improvement projects in other departments or teams
4 Professionals in other departments or teams use the documentation and information that is available on our results
5 In sum, to what extent have the changes in your care practices, as developed and implemented by your improvement team, been spread to other departments or teams?
6 To what extent have the changes been implemented effectively in other departments or teams in your organization?

Scale: Action for results

The results of the new work practice have been made public:
1 ... in presentations (in discussions of progress, formal meetings or other occasions)
2 ... in the annual reports or other reports
3 ... informally in discussions of progress or consultations
4 ... in refresher courses or activities

Scale: Action for the work practice

To spread the new work practice(s) we have ...
1 ... presented the work practice in discussions of progress
2 ... organized clinical trainings, workshops or other refresher courses.
3 ... organized guest visits and exchanges for professionals in the other teams/departments

Table 1  Item characteristics and the factor loadings for the three factor model

<table>
<thead>
<tr>
<th>Items</th>
<th>Scale: Spread of work practices</th>
<th>Scale: Action for results</th>
<th>Scale: Action for the work practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>In our organization/in other departments or other teams ... practitioners also use the documentation on the new work practice ... the required skills have been trained in other teams ... by now they also have developed the new, care-specific knowledge and skills required for the work practice ... the practitioners have been instructed how to use the materials for the work practice ... the practitioners now also use the same, new materials for the work practice</td>
<td>In our organization/in other departments or other teams ... practitioners also use the documentation on the new work practice ... the required skills have been trained in other teams ... by now they also have developed the new, care-specific knowledge and skills required for the work practice ... the practitioners have been instructed how to use the materials for the work practice ... the practitioners now also use the same, new materials for the work practice</td>
<td>In our organization/in other departments or other teams ... practitioners also use the documentation on the new work practice ... the required skills have been trained in other teams ... by now they also have developed the new, care-specific knowledge and skills required for the work practice ... the practitioners have been instructed how to use the materials for the work practice ... the practitioners now also use the same, new materials for the work practice</td>
<td>In our organization/in other departments or other teams ... practitioners also use the documentation on the new work practice ... the required skills have been trained in other teams ... by now they also have developed the new, care-specific knowledge and skills required for the work practice ... the practitioners have been instructed how to use the materials for the work practice ... the practitioners now also use the same, new materials for the work practice</td>
</tr>
<tr>
<td>1 ... practitioners also use the documentation on the new work practice</td>
<td>99  30.3  0.9  0.76</td>
<td>108  3.8  0.8  0.47</td>
<td>109  3.7  0.9  0.60</td>
</tr>
<tr>
<td>2 ... the required skills have been trained in other teams</td>
<td>98  30.3  0.9  0.79</td>
<td>95  3.8  0.8  0.55</td>
<td>104  3.3  1.0  0.74</td>
</tr>
<tr>
<td>3 ... by now they also have developed the new, care-specific knowledge and skills required for the work practice</td>
<td>99  30.4  0.9  0.73</td>
<td>110  4.0  0.5  0.34</td>
<td>100  2.7  1.0  0.50</td>
</tr>
<tr>
<td>4 ... the practitioners have been instructed how to use the materials for the work practice</td>
<td>105  30.6  0.7  0.51</td>
<td>95  3.8  0.9  0.55</td>
<td>100  30.4  0.9  0.68</td>
</tr>
<tr>
<td>5 ... the practitioners now also use the same, new materials for the work practice</td>
<td>100  30.4  0.9  0.68</td>
<td>95  3.8  0.9  0.55</td>
<td>100  30.4  0.9  0.68</td>
</tr>
</tbody>
</table>

'SNumeric range of response options is 1–5 on a likert scale for all items (1 signifies 'strongly disagree', 2 signifies 'disagree', 3 signifies 'neither agree nor disagree', 4 signifies 'agree'; and 5 signifies 'strongly agree').

Measurement instrument for sustainability

We measured sustainability on two scales: routinization and institutionalization [14]. All items were scored on a five-point Likert scale with the additional option of ‘I don’t know’. Scores were summed to construe the two variables.

The routinization scale (16 items; Cronbach’s α = 0.90) evaluated the extent to which supporting conditions for the changed new work practice were created. Scores ranged from 23 to 115. Examples were ‘We regularly train all staff in the required skills’; ‘Documentation is accessible to everybody’; and ‘The new work practice is a regular topic in team meetings’.

Data screening

All items were screened for univariate and bivariate normality and for outliers. Skewness and kurtosis were seen for some items, but in general extreme values were not found. Notably, the items in the subscale ‘spread of results’ yielded a relatively high number of missing data and ‘I don’t know’ answers (Table 1). For the structural equation modeling, these were imputed with the EM-imputation procedure in LISREL [22] and tested for differences with valid responses.
in the spread variables at hand. The tests did not yield significant differences.

**Three-step analysis**

In Step 1, the sample characteristics were analyzed using descriptive statistics. The second step involved confirmatory factor analyses with structural equation modeling to analyze both the items and the underlying structure. The items were assessed using the following criteria: (i) descriptive statistics, factor loadings, modification indices (checking for cross-loading) and reliability estimates (with Cronbach’s α); (ii) content validity and conceptual arguments and (iii) respondents’ comments and missing values. The models were compared with $\chi^2$ difference tests on the likelihood ratio $\chi^2$.

To evaluate the model’s goodness-of-fit and structure, we report four commonly used indices as recommended by Kline [22]: (i) the $-2\log$ likelihood ratio $\chi^2$, (ii) Steiger-Lind’s root mean square error of approximation (RMSEA), (iii) comparative fit index (CFI) and (iv) the standardized root mean square residual (SRMR). The bivariate correlations for the four variables for spread were also reported.

Thirdly, to explore convergent validity, the bivariate correlations were computed between the spread variables and the sustainability variables. The correlation coefficients were compared with Steiger’s $Z$ tests (two-tailed, only significant results were reported) [23].

All tests were conducted with a significance level $\alpha = 0.05$. All analyses were performed in SPSS 17.0 and LISREL 8.80.

**Results**

**Sample characteristics**

The sample ($n = 112$) consisted of 45 former project leaders (42%) and 67 team members (58%); most of whom were females ($n = 80$; 77%), had been employed in the organization for more than 6 years ($n = 96$; 66%) and worked more than 30 h per week ($n = 78$, 65%). The largest job position groups were management, health policy and quality staff ($n = 65$; 55%) and nurses ($n = 27$; 22%); smaller groups were medical assistants (2%) and medical/social specialists. Such a distribution roughly corresponds with improvement teams in healthcare in general [21]. The relatively high proportion of managers may have resulted from our communication being addressed to contact persons, who were mostly former project leaders. All improvement projects were represented in the sample. Team distribution was: 16 in pressure ulcer care (25%), 16 in client autonomy (25%), 10 in eating and drinking (16%), 9 in medication safety (14%), 5 in prevention of sexual abuse (8%) and 2 in fall prevention (3%).

**Analyses of the items and the structure**

Descriptive statistics were computed for each item (Table 1) and for each scale (Table 2). The confirmatory factor analysis yielded the following results: likelihood ratio $\chi^2(129) = 239.6$; RMSEA = 0.09 (with a 90% confidence interval of 0.07–0.10); CFI = 0.96 and SRMR = 0.07. The four-factor model met the above-mentioned criteria for goodness-of-fit, reflected by the positive and high factor loadings of the items (Table 1). Given these results, it was not necessary to remove items to optimize the model fit. Several alternative models were compared, but they did not yield significantly better results (results available on request). Next, the internal consistency was computed for each of the four scales (Table 2). Values ranged from sufficient to excellent (0.70–0.93).

**Correlations between the spread variables and with the sustainability variables**

The bivariate correlations between the spread variables were positive and high (Table 3); comparison of correlations are reported in the footnote. Furthermore, ‘spread of results’ related quite strongly to ‘spread of work practice’, while the coefficients of the two action-variables yielded moderate, relatively lower values. The spread variables related positively to the two sustainability variables, confirming convergent validity. In general, the relation with ‘institutionalization’ was stronger than with ‘routinization’, although this difference was only found significant for ‘action for results’. We also found that two variables for ‘effective spread’ related somewhat higher to ‘sustainability’ than the action variables; for ‘routinization’, this concerned both action variables; for ‘institutionalization’, it concerned only ‘action for work practices’.

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**Table 2** Psychometric characteristics of the four scales for spread

<table>
<thead>
<tr>
<th></th>
<th>Spread of results</th>
<th>Spread of work practice</th>
<th>Action for results</th>
<th>Action for the work practice</th>
</tr>
</thead>
<tbody>
<tr>
<td># items (total of 18 items)</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>$n$</td>
<td>64</td>
<td>88</td>
<td>85</td>
<td>96</td>
</tr>
<tr>
<td>Item mean (SD)</td>
<td>3.2 (0.9)</td>
<td>3.4 (0.9)</td>
<td>3.8 (0.2)</td>
<td>3.2 (0.5)</td>
</tr>
<tr>
<td>Scale mean (SD)</td>
<td>19 (4.5)</td>
<td>17 (3.8)</td>
<td>15 (0.3)</td>
<td>10 (2.5)</td>
</tr>
<tr>
<td>Theoretical scale range</td>
<td>6–30</td>
<td>5–25</td>
<td>4–20</td>
<td>3–15</td>
</tr>
<tr>
<td>Average inter-item correlation (min.; max.)</td>
<td>0.70 (0.56–0.83)</td>
<td>0.68 (0.58–0.77)</td>
<td>0.55 (0.50–0.59)</td>
<td>0.59 (0.51–0.66)</td>
</tr>
<tr>
<td>Cronbach’s $\alpha$</td>
<td>0.93</td>
<td>0.91</td>
<td>0.70</td>
<td>0.80</td>
</tr>
</tbody>
</table>
Measurement of spread • Quality improvement

Table 3  Bivariate correlations between the spread variables and with the sustainability variables

<table>
<thead>
<tr>
<th>Spread of results</th>
<th>Spread of work practices</th>
<th>Action for results</th>
<th>Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread of results</td>
<td>0.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.51&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>n</td>
<td>78</td>
<td>80</td>
<td>78</td>
</tr>
<tr>
<td>Spread of work practices</td>
<td>0.62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>n</td>
<td>100</td>
<td>96</td>
<td>99</td>
</tr>
<tr>
<td>Action for results</td>
<td>0.62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.56&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>n</td>
<td>102</td>
<td>106</td>
<td>102</td>
</tr>
<tr>
<td>Action for work practices</td>
<td>0.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td>0.35</td>
</tr>
<tr>
<td>n</td>
<td>102</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>Routinization</td>
<td>0.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>103</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Significance level α = 0.05. Note on comparison of correlation coefficients. Correlation between 'spread of results and 'spread of the work practice' (r = 0.73) is significantly higher than with 'action for results' (r = 0.51), Steiger's Z = 2.7, n = 76 and with 'action for the work practice' (r = 0.54), Steiger's Z = 2.7, n = 74, both P < 0.01. Horizontal comparisons: we found a significantly higher coefficient for institutionalization and 'action for results' (r = 0.56), Steiger's Z = 2.4, n = 100, P < 0.05, compared with routinization (r = 0.37). Vertical comparisons: routinization and 'action for the work practice' (r = 0.28) versus 'spread of results' (r = 0.61), Steiger's Z = 2.2, n = 76 P < 0.05; and versus 'spread of the work practice' (r = 0.54), Steiger's Z = 3.1, n = 93, P < 0.01. Routinization and 'action for results' (r = 0.37) versus with 'spread of results' (r = 0.61), Steiger's Z = 1.7, n = 77; versus with 'spread of the work practice' (r = 0.54), Steiger's Z = 1.8, n = 96, both P < 0.10. Finally, institutionalization and 'action for the work practice' (r = 0.35) versus with 'spread of results' (r = 0.67), Steiger's Z = 3.9, n = 72, and versus with 'spread of the work practice' (r = 0.65), Steiger's Z = 2.8, n = 89, both P < 0.01.

Discussion/conclusion

We reported on the development and field testing of a measurement instrument for spread of quality improvement in healthcare. The results revealed that the instrument items have sufficient consistency within the scales and cross loading on other scales was minimal. In the confirmatory factor analyses, the four-factor model yielded a good model fit. The reliability coefficients for the scales demonstrated high internal consistency. Convergent validity with sustainability of changed work practices was confirmed. The results offer tentative evidence that the measurement instrument is in line with psychometric properties as defined in the literature.

Following Greenhalgh et al. [1], we described spread in terms of different, intertwined processes, including diffusion, dissemination, adoption, assimilation and implementation. We proposed two key distinctions for the measurement instrument: (i) between the changed work practice and its results and (ii) between spread practices and their effects (effective spread). The findings confirm the distinctions in several ways. The good fit of the four-factor model indicated that the intended latent factors were statistically distinct from one other. Secondly, the correlations between the four variables were all moderately high and positive. Thirdly, the distinctions were also demonstrated in the analyses of convergent validity with the two sustainability variables.

The finding that spread of the changed work practice and spread of results are positively related conforms to the literature [4]. Still, we want to emphasize the value of distinguishing between spread of the changed work practice and spread of results. Spread of the changed work practice focused on spread of the main ingredients of a work practice (skilled and knowledgeable workers armed with the right materials), which are essential to replicate work practices [24]. In connection to this, spread of results is deemed important to show benefits to negotiate further investment in spread [12]. An improvement team may be well informed to spread knowledge related to the changed work practice, but the ability to spread results may require different skills and a different network in the organization.

Our results confirmed the relationship between sustainability and spread. That the variables for spread strongly related to routinization and even more strongly with institutionalization of the changed work practice confirms that sustainability and spread co-evolve and the organizational structures required for both may overlap. This could be the very reason that these concepts are often conflated (cf. [13]). It seems inefficient to institutionalize only locally when other sites could benefit; sustainability could thus naturally invoke
the question of spread. This relation may be mediated through spread of results, which was strongly related to sustainability as the correlations showed. In connection to this, we point out that lack of visible results has been found to hinder spread [25]. To understand the relationships between the aspects of spread and sustainability, further research is required.

**Limitations**

Some methodological issues need consideration. First, the sample size created limitations in the analyses. The response rates were low but reasonable given the field dynamics and respondents’ circumstances. However, while non-response is of less significance in this exploratory study, we caution that non-response may have an important impact on the use of this instrument to assess spread. One consequence of the low response rates is that our sample included relatively more successful improvement teams, although we found negative scores and a large variation in answers. The second consequence is that we were only able to analyze the instrument on an individual level. Future research may explore opportunities to study spread dimensions on the team level to take the multi-level nature into account.

Secondly, concerning validity, we realize that our variables were based on questionnaire data, i.e. perceptions. Embedding our follow-up study in the program evaluation research necessitated this strategy. Further research should include multiple measures for sustainability and spread, shedding light on their convergent and divergent validity.

Thirdly, the sample population has advantages and disadvantages. Former improvement teams are informed about the changed work practices but are probably biased toward the quality improvement. Nor could we expect each team member to be fully informed on work practices in other sites. Indeed, for some items, especially those concerning results, we encountered rather high percentages of sites. Indeed, for some items, especially those concerning member to be fully informed on work practices in other sites. The next step would be to ask receivers about their experiences.

**Conclusions**

We described the development and testing of a measurement instrument for spread of quality improvements in healthcare. The findings confirmed the validity of the measurement instrument and proposed structure, and convergent validity with sustainability. The psychometric properties were in line with recommended methodological standards.

**Authors’ contributions**

S.S.S. conceived of the study, developed the conceptualization, the measurement instrument and the design of the field testing, performed the statistical analyses and drafted the manuscript. M.M.H.S. supervised the work and conceived the study, participated in the design and data collection, participated in the statistical analyses and helped to draft the manuscript. R.A.B. conceived the study, participated in the design and reviewed the manuscript. A.P.N. supervised the work and conceived the study, participated in the design, advised on the statistical analyses and helped to draft the manuscript.

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