Getting started with the model for improvement: the model in practice

Although the case for quality in hospitals is compelling, doctors are often uncertain about how to achieve it. This article forms the second part of a series providing practical guidance on getting started with a first quality improvement project.

Introduction

As the importance of quality improvement is increasingly recognized in health care, the 'know how' for undertaking such efforts becomes vital (Batalden and Davidoff, 2007). The first article in this series (Pratap et al, 2012) introduced the model for improvement (*Figure 1*; Langley et al, 1992) and the allied technique of statistical process control. Thor et al (2007) have demonstrated that these tools are effective together in generating lasting and relevant changes in health-care delivery and outcomes.

Tests of change

Generating ideas for interventions

After establishing appropriate aims and measures for a quality improvement project, as discussed in the previous article, the next step is to formulate interventions to be tested through 'plan-do-study-act' (PDSA) cycles. In this way the model for improvement's third question is answered: what changes can we make that will result in an improvement?

Several, complementary approaches generate notions for interventions. One strategy is to agree on a list of preconditions accepted by team members as necessary for the project's goal to be achieved. These are known as key drivers. To ensure prompt assessment of patients arriving in an emergency department, for example, it

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Quality improvement case study

The previous article in this series introduced an example quality improvement project. A cardiologist at St Elsewhere University Hospital NHS Foundation Trust is leading a team to improve outcomes, and focuses on reliable delivery of a bundle to acute myocardial infarction patients. The project's primary outcome is defined as the proportion of troponin-positive patients receiving all of antiplatelet medications, beta-blocker, statin and angiotensin-converting enzyme (ACE) inhibitor (if indicated) at first clinic follow up. A specific aim is set to raise the primary outcome from 30% to 90% by June 2013. This case study observes early progress in the project.

The team draws up a process map of care for myocardial infarction patients from arrival in the emergency department, medical admissions unit or coronary care unit, through to hospital discharge. Making use of the team's wide and deep experience of the system, they brainstorm reasons for failure. For the patients to be taking the drugs as desired by the project by the time of clinic follow up, several key drivers must be in place: the medications need to be prescribed and available to the patient, and the patient has to take them. The team comes up with a shortlist of interventions to trial: pharmacist provides education to patient before discharge, community nurse ensures patient has adequate supply each week at home, GP receives discharge notification by e-mail, advisory hotline number made available to patient. These form the basis for starting the project's key driver diagram.

The team are particularly concerned that few patients with abnormal left ventricular function receive ACE inhibitors. Although the time point of clinic follow up has been chosen for the project, drugs not on the discharge instructions will not be continued by GPs, so discharge is an important step in the process. For the first 'test of change' it will be better to measure success at the time of discharge. In this way the results of any interventions can be interpreted more rapidly.

A staff nurse on the team, who often works nights and weekends, points out that discharge medications at these times are often written by doctors cross-covering from other specialties. The team agrees that education of junior doctors could remediate this problem. By good fortune the team leader is due to address the new house officers' induction session next week. She will highlight to them the importance of post-myocardial infarction pharmacotherapy.

Data collected over the next 3 weeks shows substantial improvement in ACE inhibitor prescriptions at discharge. The team leader brings a cake to the next meeting to celebrate. By the following week, however, the prescription rate is back to baseline. Like many one-off educational interventions, the effect dissipates with the passage of time. The dispirited team reluctantly abandons this approach.

At this point another nurse speaks up. At his previous hospital he participated in a successful medicines safety project. They stapled reminders to the front of each prescription chart. The pharmacist proposes to try this on his ward the very next weekend. With the nurse and a foundation year 1 doctor, he designs a message to be printed on red card by the team leader's secretary by Friday. The pharmacist offers to check on Monday that the test has gone to plan. The team predicts that all myocardial infarction patients discharged from that ward will have the correct medication, even though the rheumatology and gastroenterology foundation year 1 doctors will be covering for the weekend. It turns out that, although only one patient is discharged that weekend, the correct medications are indeed prescribed. The test is repeated the next three weekends, and all patients receive the correct drugs. Over the following four weekends (including the Christmas period) the reminder is tested by all pharmacists on all medical wards with such ease and success that the team decides to implement the red card reminder affixed to the drug chart.

They now move on to their next challenge…

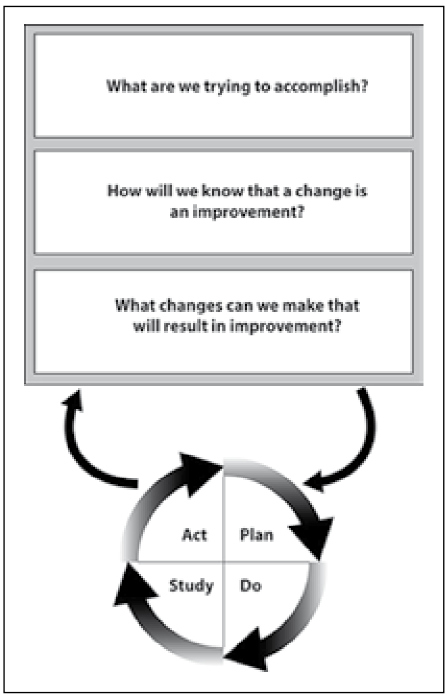
To be continued

will be necessary to have continuous availability of a nurse trained in triage, equipment for measuring vital signs and a private space in which to see the patient. Consideration of each in turn, in combination with the knowledge of those familiar with the system, will often suggest possible interventions. So, if the pulse oximeter is often missing when needed by the nurse, it will likely help to purchase a new one and fix it to the wall of the triage cubicle.

Frontline workers come up with some of the best ideas for change, perhaps borne out of frustration or of long familiarity (Mandel et al, 2009). At the very least it is good psychology to engage them. Sometimes, however, individuals deeply embedded within a long-standing system cannot see its flaws. There is a dichotomy: to improve a process it is vital to have a good working knowledge of it, but the benefits of looking afresh cannot be overemphasized.

Especially for large or complex systems, drawing a process map to show each step can spark ideas for interventions. The task itself can pull together a multidisciplinary team whose members may not otherwise even meet – perhaps because they work in different departments or even locations.

Figure 1. The model for improvement. After Langley et al (1992).

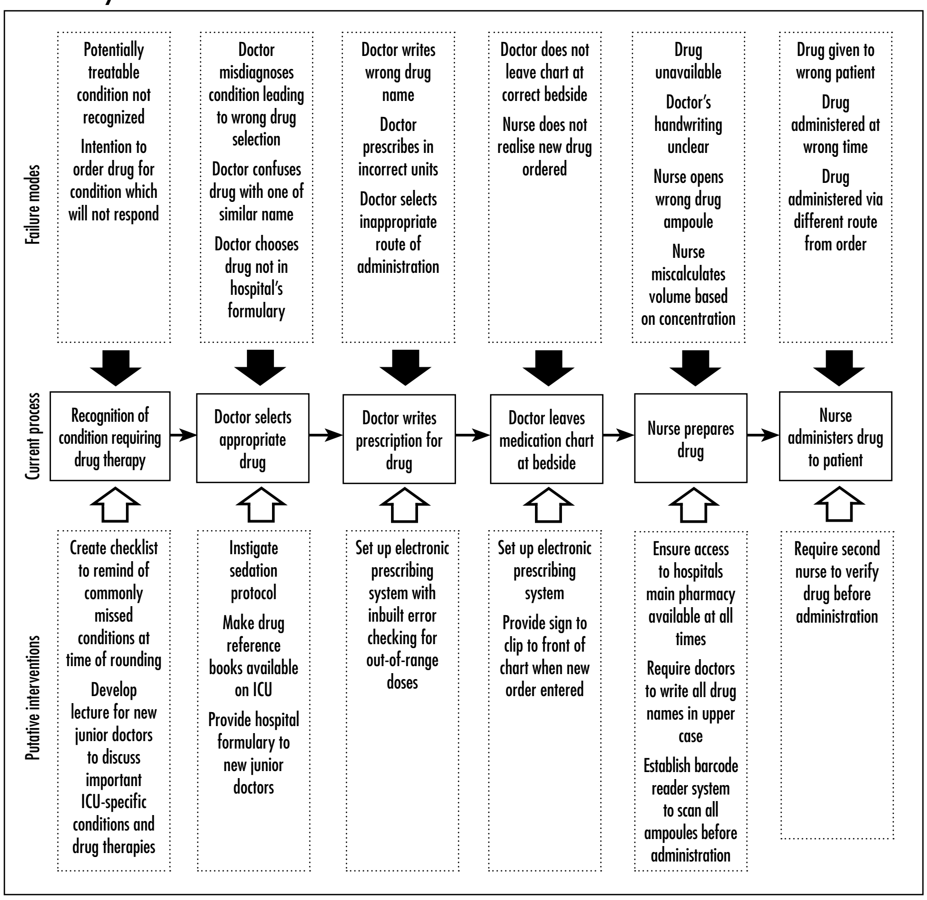


Team members are frequently unfamiliar with details of system components outside their own areas (Woodhouse et al, 2004). Consider carefully where the boundaries of the process are drawn, as too narrow a definition may neglect vital steps, but too wide can dissipate the focus of the project. Consider the example of prompt revascularization after myocardial infarction or stroke. Here focussing improvements only on reducing the interval from hospital arrival to therapy, while of undoubted importance, will provide no benefit to those patients presenting to hospital many hours after their cardiovascular event (or not at all). Those individuals will be better served through increased awareness of the need to seek help urgently and also by interventions to expedite their path to hospital.

Process mapping can be extended to a failure modes and effects analysis to identify potential obstacles to smooth running of the system. (A tool to aid failure modes and effects analysis is available at http://app.ihi.org/Workspace/tools/fmea.) As reasons for possible failure are proposed at each stage, potential remedial strategies can be added to the list of putative interventions. An example is given in *Figure 2.* A full-scale failure modes and effects analysis estimates the probability of each failure mode and quantifies its likely impact, but a qualitative, abbreviated version often suffices.

Contemplation of concepts that have worked well in other quality improvement projects, even ones appearing at first sight very distantly related, often sparks ideas. For example, interventions that reduced 'did not attend' rates at a speech therapy clinic may offer useful content to a team trying to reduce cancellations on the day of elective surgery. Be wary of rejecting radical suggestions out of hand, especially if they can be put to the test easily. Quality improvement systems such as Lean and Six Sigma incorporate useful banks of 'change concepts' that can generate ideas, but a superset has been compiled by Langley et

Figure 2. An example process map: prescribing and administering a medication in an intensive care unit (ICU). Top and bottom rows reflect elaboration of the process map into a simplified failure modes and effects analysis.



al (2009) and provides useful reference. An exemplar might be the change concept 'use reminders'. This could stimulate provision of a 'cheat sheet' to aid nurses in drawing up a particular intravenous infusion which has been subject to many errors in the past.

The Pareto principle, proposed by Juran but named for an Italian economist, states that around 80% of the effects felt in most systems come from 20% of the causes (Juran, 1950). An illustration would be 80% of injuries resulting from 20% of possible hazards. For quality improvement purposes therefore we can achieve most of our aims by concentrating on the most common one-fifth. Failures that draw attention are often rarer ones, perhaps as the more mundane are overfamiliar to those engaged in the system every day. Until there are figures to support it, be wary of what people say is the problem, even if everyone seems to agree. Collecting firm data demonstrates clearly where most benefit stands to be attained. This is visualized effectively on a Pareto chart (*Figure 3*).

The key driver diagram

The 'key driver' diagram is a useful mental aid in quality improvement. Its benefit is to summarize, on a single page, the project team's current thinking, both for the benefit of the team and also for those outside it. As implied by this statement, it is a dynamic document, subject to continual revision as the group learns through conducting PDSA cycles.

The key driver diagram states both global and specific aims, associating these with agreed prerequisites for improvement (the key drivers themselves) along with interventions expected to achieve these. By convention, key drivers are nouns and interventions are verbs; both are expressed in the positive. A key driver might be 'presence of a paediatric-trained nurse during all shifts' and an accompanying intervention 'recruit more children's nurses'. Arrows are added to link them appropriately. An example key driver diagram for a fictitious project is shown in *Figure 4*.

Some advocate variations to the key driver diagram, such as differentiating interventions currently being tested from those already implemented. Any such modifications should be annotated for clarity. The guiding principle is that perusal of the key driver diagram and run chart together will give an outsider an overview of the project and its current progress.

Reliability of interventions

When contemplating an intervention, an important consideration is its level of reliability (Luria et al, 2006) – this is intrinsic to the class of intervention. There is a clear hierarchy in reliability and levels that Amalberti et al (2005) have even quantified in terms of the probability of failure.

Level 1 interventions (~10% or 10^{-1} chance of failure) are characterized by intent, vigilance and hard work. Educating or increasing awareness are level 1 interventions frequently cited in quality improvement efforts. An example would be showing a video on hand washing technique at the next staff meeting. While initially attractive, the resultant knowledge and/or skills tend to dissipate over time, especially if there is an increase in the time consumed or complexity of a step. Staff turnover will also dilute the benefit of educational initiatives, unless incorporated in the orientation of new employees, such as teaching hand washing to all new staff.

Financial and other incentives are likewise of limited use (Berwick, 1996) but would include a cash bonus to anaesthetists who administer antibiotic prophylaxis to more than 95% of indicated patients at induction. Feedback on compliance, use of checklists and basic standardization are all regarded as level 1 interventions.

Figure 3. An example Pareto chart.

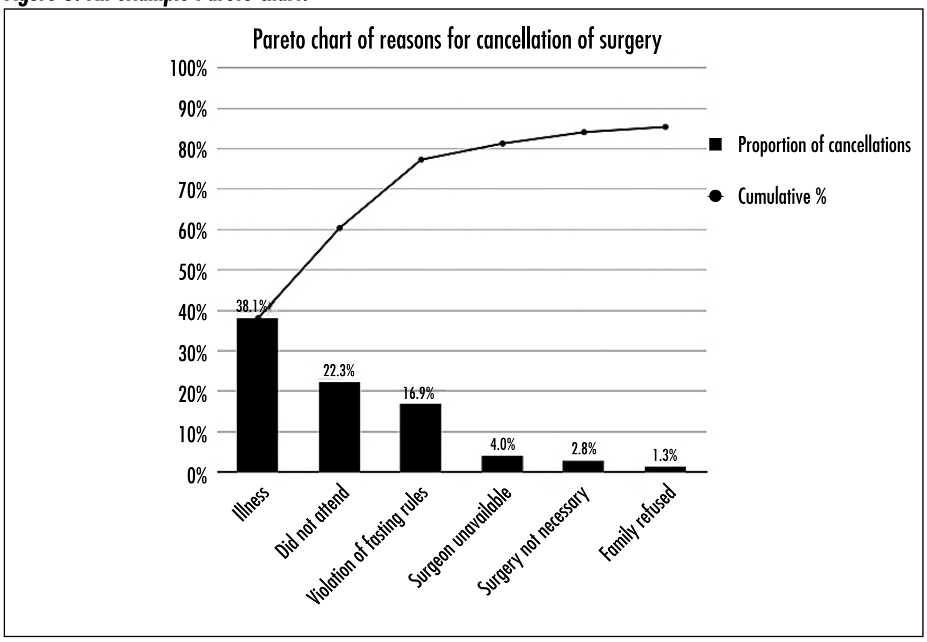
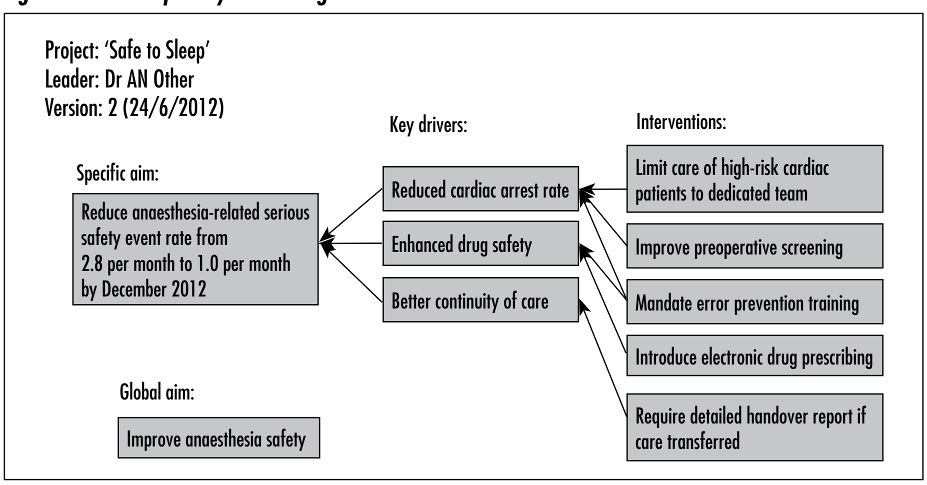


Figure 4. An example key driver diagram.



Double checking, automated reminders, standardization or scheduling of essential tasks (Rozich et al, 2004), making the desired action the default, and 'piggybacking' onto existing habits or patterns are all examples of level 2 interventions. For instance, nurses could be required to check all intravenous infusions with a second nurse before starting them. Muething et al (2004) found that these achieve better success rates with less than 5 failures out of 100 (probability ~10^{-2}). Design for the very highest levels of reliability requires prediction of failures, and identification and mitigation of their impact, and is discussed by Weick and Sutcliffe (2007).

Conducting PDSA cycles

The 'plan' phase

Planning is fundamental to learning from tests of change. All contributors must agree and be clear what is expected of them. Do not allow testing to be delayed unduly by wrangling, as getting down to testing early is pivotal to a project's progress. In a recent project undertaken by one of the authors, there was much discussion about which team members should take particular roles in a new daily planning meeting. As soon as testing began, however, it became clear that lunch breaks were getting in the way of the meeting being held at all.

The scale of testing

In planning the first-level test of an unfamiliar intervention, think small. 'One' is often the right scale at the outset (e.g. one patient, one appointment or one operating theatre). All manner of unexpected effects may be thrown up, which might have been unmanageable if the change had been trialled on a wider scale. For example, the new beds are just a fraction too long to fit into the lifts in the old wing of the hospital. If a single bed is being tested, this is annoying, but if all beds in the hospital have been replaced before this is uncovered, it would have wide-reaching consequences.

If a first test is successful (see below), for the next step consider maintaining the same small scale, but running the test under different conditions. If both are successful, the degree of belief in the intervention increases considerably. For example, it is easy to see how a highly successful test conducted mid-morning on a weekday may play out quite differently in the middle of the night at the weekend.

The population subject to each test must be clearly specified. Early tests are often better conducted within defined subpopulations (such as tonsillectomy patients rather than all ear, nose and throat cases), especially where the project focuses on a frequent event. Choose a common situation to start with, or one with a rapid cycle time, such that learning can be achieved quickly. For instance, when trialling early discharge planning on the neonatal unit, start with term babies with simple problems rather than those born at 23 weeks of gestation who are sure to be inpatients for months.

Requirements for testing

In setting up the test, ensure clear agreement on the prerequisites with all involved. Clarify who must do what – and when and where – before the test begins. Who will draft the new checklist? Who will photocopy it? Distribute it? Someone passionate for the project may be an appropriate individual to undertake the first test of an intervention but, if successful, be sure to re-test with someone less enthusiastic.

It is vital to collect data appropriate to maximizing learning from the test. Sometimes collection of data on the performance of the system is a well-established routine (think of wait times in the modern emergency department), but often it is not, in which case pay particular attention to planning this component of the test. Also everyone must know when the test starts, and how long it will continue.

How to interpret the results of testing

Before starting a test, be clear what improvement will actually look like. For early PDSA cycles the project's key measure may not be the best way to determine this. Qualitative impressions are equally valid at these early stages. The key to choosing a measure for testing is the learning that can be derived from it. Sampling, rather than studying the whole population, is often more feasible. For instance, if testing a new process to improve patient satisfaction in a busy outpatient department, maybe give patient surveys to only three patients per clinic. At this early point in the quality improvement effort the usefulness of a measure trumps perfection (Berwick, 1996). If the measure is not an established one, trying it out may well justify a PDSA ramp in itself. Consider also balancing measures. For example, does the intervention substantially increase the workload of those undertaking it? Asking participants to record the time taken, or the clinic end time each day, for example, will help to address this.

Finally, commit to paper the anticipated consequences of the test before actually conducting it. For instance, record your belief that the new process for obtaining drugs from the pharmacy will halve the wait time and reduce errors. The discipline of comparing your prediction with the actual results increases the potential for learning.

The 'do' phase

When the 'test of change' is being performed, check if it is being carried out as planned. If not, why not? Perhaps only a few of the doctors used the new computer system, because the majority could not understand how to do so. A deviation from the plan often reveals a lack of clarity or a fundamental aspect of the intervention that is unworkable (at least in present form). Chastisement of team members or of frontline workers is rarely appropriate.

As the plan is enacted, look out for unintended consequences. It could be that the new outpatient pharmacy ordering process causes such chaos that the car parks fill up and many patients are late for their clinic appointments. At the other end of the spectrum, lateral thinking by an enthusiastic team member may have generated an intervention far more effective than the one originally conceived. Both reveal much about the system of interest.

The 'study' phase

The first step in studying a completed test is to decide if the results match the prediction. If the test 'worked', what exactly has been learned? Let us, for instance, suppose that a rapid response team worked well in the main hospital. Be cognizant that success has been demonstrated only under the conditions extant for the test. How would the same intervention fare with different patients, different staff or at a different time? Perhaps the rapid response team would be unable to find the mental health unit hidden in the woods at the edge of the hospital's site.

If the test 'failed', what unforeseen property of the system has been revealed? In the above example, we find that the geography of the site is unexpectedly unfamiliar to some important staff members.

The 'act' phase

The final step of the PDSA cycle is to decide how to take forward the tested intervention. There are three options: adapt, adopt or abandon.

Adapt

Perhaps the most common decision, when reflecting on a test of change, is to adapt the intervention and try again. Maybe it showed some promise, but certain difficulties were encountered. Maybe the new emergency department triage system reduced the average waiting time to see a doctor overall, but elderly patients were found to spend an unacceptably long time on trolleys. In this case, revise and test again. It is usually wise to maintain the same small scale for the test until you have it just right.

A failure may not be the result of a flawed intervention. Sometimes the problem lies instead in the conduct of the test – someone misunderstood the plan or, in the event, the data collection was inadequate for definitive decision-making. In this case, keep the intervention the same, but redesign the test.

Abandon

Sometimes the test was an unexpected disaster, but do not be too disappointed as this presents a great opportunity to adapt your mental conception of the system. If there is no way to modify the test to fit the new picture, do not be afraid to let this idea go. Clinging to disproven ideas can only stifle the generation of new ones.

Adopt

When the degree of belief in an intervention is high enough, it is time to make it standard practice. Be sure that it really works for all cases and in all circumstances. Not only must the team themselves be convinced, but they also need enough evidence to win over the 'naysayers'. Few interventions are so clear-cut that they can be implemented (i.e. made permanent) without extensive testing. Even a roll-out should be treated as a PDSA cycle – monitor that it is conducted according to the plan, has the expected benefits, and does not have unintended negative consequences. Would it be feasible to roll back to the old way if something goes wrong?

PDSA ramps

If early tests of an intervention are successful, test under different conditions: another type of patient, a different staff member, an alternative day of the week. Have tests conducted both by staff members who are enthusiastic about the project and also by those who are less so. If multiple conditions have been tested already, it may be time to scale up. For example, test the intervention on every patient for a day, or with every staff member in the department, as appropriate.

It is important to note that data collection alone does not constitute a 'test of change' and is not a PDSA cycle in itself. Gathering information about the system is vital to design putative interventions, but it is axiomatic of the model for improvement that perturbing the system is the only path to understanding it fully.

A true PDSA ramp takes the same intervention through various versions and upwards in scale (e.g. one patient on Monday morning, one each Tuesday morning and afternoon, all patients between 8am and 5pm on Thursday, and then every case throughout a full 24 hours from 8am on Friday). A different intervention – even if inspired by learning from a PDSA cycle – warrants starting another ramp back at the beginning.

Conclusions

The discipline of 'plan-do-study-act' (PDSA) cycles facilitates achievement of a project's goal by defining a clear structure to maximize the potential for learning from each rapid cycle test. The psychological benefits of this approach, for both the quality improvement team and other stakeholders, will form the basis of the next article in this series. **BJHM**

Conflict of interest: none.

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LEARNING POINTS

- Learning for improvement is achieved by perturbing the system through conducting many rapid 'tests of change' known as 'plan-do-study-act' (PDSA) cycles.
- Ideas for tests of change often come from close analysis of the system and from the experience of those familiar with it.
- Detailed, careful planning is an essential component of well-conducted PDSA cycles.
- After completing each PDSA cycle, make an active decision to adopt, adapt or abandon it.