Although we have fantasti
colic lifelike manikins, vir-
tual reality surgeries, artificial
intelligence models, engaging software
simulators and even medical games,
very little innovation has gone to the
medical practice environment where the
vast majority of patient encounters are:
the clinic.

After graduating residency, physi-
cians are often left to their own devices
in regards to the nature of their ongoing
continuing medical education (CME),
typically taking a number of self-selected
CME credits per year and following a re-
certification process periodically. Such a
system has proven helpful in maintaining
an overall level of global demonstrable
knowledge within the physician popu-
lation. Current CME and maintenance
of certification (MOC) regimen currently
do not target maintaining a physician’s
breadth of competency nor do they tar-
get an individual’s weaknesses because
they do not assess the physician under
practice.

To maintain a full-breadth capability
for a physician in a particular specialty,
there is interest in developing adap-
tive competency management systems
such as the Continuous Observation of
Medical Records for Advanced Doctor
Education (COMRADE) concept. This
concept constructs a model of physi-
cian encounters by collating diagnostic
codes from clinical visits and comparing
the data to a list of expected competen-
cies for that specialty. When combined
with predictive models of clinical skills
decay, it should be possible to statisti-
cally determine an actual or impending
degradation and counter it.

The Need for Adaptive
Competency Management
To understand how such a concept can
work, let’s examine three physicians and
how their situations can be improved
through adaptive competency manage-
ment. Dr. Allen is a successful family
practice and aerospace medicine physi-
cian. He primarily sees pilots and their
families. His practice is light on women’s
medicine and chronic diseases of the
elderly. He worries that he is not seeing
enough women to handle patient com-
plaints about conditions he rarely sees.
Major Brown is a military pediatrician
who has just returned from a one year de-
ployment to Afghanistan which involved
administrative duties and sporadic adult
medical encounters. He is now at a me-
dium size hospital where he is respon-
sible for complex patients and a fairly large
number of neonatal intensive care gradu-
ates that he has rarely encountered since
residency. Dr. Cohen is a busy internist
who keeps up her CME, though she is
unaware that she will be seeing one pa-
tient with unusual complaints of vertigo
and another with Klippel-Trenaunay-We-
ber syndrome the next week and she will
be unprepared to comfortably manage
these encounters.

Each of these three are good doctors,
but can benefit from adaptive compe-
tency management. Dr. Allen needs to
maintain broad competency as a fam-
ily physician. Dr. Brown has been out of
practice and needs to be reintegrated; Dr.
Cohen sees a variety of patients, but will
be unprepared for two unfamiliar cases
in her upcoming schedule.

How Does Adaptive Compe-
tency Management Work?
My COMRADE concept addresses these
issues. The theory is that physicians will
tend to be familiar with patient condi-
tions they see on a regular basis, but over
time, will become increasingly uncom-
fortable with conditions rarely or infre-
quently seen. It is important to note that
board examination tests may easily miss
this unfamiliarity. Physicians are astute
test takers who can leverage scaffold-
ing within multiple choice questions to
find associations that make them appear
knowledgeable. When a physician en-
counters a symptom or diagnoses that
have become unfamiliar, they struggle to
come up with interview questions and
feel uncomfortable trying to recall the
proper diagnostic approach and man-
agement of that condition.

Since military physicians have been
using a unified electronic medical record
(EMR) for about 10 years, it is a trivial
matter to construct a map of the diag-
noses that they see and compare that
against that physician’s expected range
of knowledge for their board specialty. Using mathematical models to predict clinical skill decay, the COMRADE system will determine areas of likely weakness and schedule appropriate virtual standardized patient (VSP) encounters into their schedules.

The COMRADE concept requires use of four technologies which are either currently available or can be made available in the near future: 1) EMR Data Mining, 2) A Skill Decay Model, 3) A Training Intervention Scheduler and 4) Virtual Standardized Patients (Figure 1).

The first COMRADE technology is electronic medical record (EMR) data mining. This is necessary to construct a map of a particular physician’s encounters. The easiest method will probably be to poll the ICD-9/10 codes of all encounters under that physician and aggregate them. A running map will be generated of encounters over the last 3-5 years, the last year and the last three months. It may be possible to delve deeper into medical records for additional data to answer questions about quality of care. An example would be aggregation of the physician’s ADHD, diabetes and asthma cases; the system could determine if they appear to meet clinical practice guidelines. The initial COMRADE concept, however, is designed to use only ICD-9/10 codes as a frequency of exposure indicator. If a practice record is not available, it may be possible to substitute a screening test or even specialty board scores for baseline data.

The second COMRADE technology is skill decay determination (Figure 2). The clinical exposure map produced by EMR data mining and other measures will provide a frequency of exposure estimate across a range of conditions. This can be compared against a physician’s expected clinical knowledge set that is determined by their specialty board organization’s list of expected competencies. The ability for an automated system to do this depends on having an accurate skill decay model that can predict areas of weakness. The Defense Medical Research Development Program (DMRDP) and TATRC have funded work to construct these skill decay models. Currently, the Nemours Foundation is constructing a clinical skill decay model using their pediatricians and Design Interactive is constructing a model in the general medicine arena. These groups are also investigating the intervention level necessary to maintain skills. Additionally, research is underway at the University of Maryland and the University of Wisconsin which are independently constructing procedural skill decay models.

The third COMRADE technology is a training intervention scheduler. The training scheduler takes a training priority list from the skills decay model. With access to the physician’s patient schedule, the training scheduler looks for appointment openings and schedules training. It is important to note that this training is not scheduled ad hoc, after hours, during lunch or on the physician’s free time – it is scheduled during the clinical day like any other clinical encounter, as it is a substitute patient experience.

The amount of time needed for training will vary considerably. For Dr. Allen, who needs to maintain competency and breadth of practice, the scheduler might put in 1-2 training appointments per week. For Dr. Brown, who is reintegrating into practice, the scheduler may reserve half his time for simulated patients, then gradually ramp down the percentage of training time. Dr. Cohen’s case represents a particular opportunity, that of just-in-time training. A training scheduler can look ahead in her booking schedule for unusual conditions. If an unusual patient is encountered, the scheduler can poll the skills decay model to determine the likelihood the physician is familiar with that condition. If it appears unfamiliar, the scheduler can preemptively provide a simulated encounter or can even review materials in advance so that she is prepared.

The fourth COMRADE technology is the Virtual Standardized Patient (VSP). The VSP (Figure 3), a near future technology, is an interactive virtual human avatar with a number of advanced features. VSPs are capable of understanding natural language questions from the physician and responding by verbally answering both open and closed ended questions with either an evolving narrative or direct responses. VSPs are non-verbally and emotionally expressive. VSPs have very sophisticated assessment systems that evaluate interviewing skills and case specific diagnostic skills. VSPs can be bundled with review material.

The creation of VSPs is the focus of my work at USC Institute for Creative Technologies (ICT) and will result in the USC Standard Patient to be beta tested in early 2015. Standard Patient Hospital will be freeware and include an authoring system in the attempt to achieve the critical mass of patient variety that will
be needed by a system such as COMRADE. The VSP represents a considerable advance in simulated patient interaction, standardization and assessment (Talbot 2012a).

It is important to note that VSP encounters are employed instead of review questions, case presentations, or multimedia Virtual Patients (VP). VPs are effective for clinical decision making, but provide a lot of scaffolding to the learner that impairs our ability to assess their current level of interview skills which are also case knowledge (Talbot 2012b). VSPs are interview skill specific and will, in my opinion, give an excellent approximation of how well a physician is likely to perform in an actual patient encounter.

Obtaining un-scaffolded physician performance data is critical because accurate assessment closes the COMRADE feedback loop and provides retargeting information to the skills decay model. In a typical intervention, the physician will have their ‘appointment’ with the VSP. After the initial VSP encounter, the physician’s performance is assessed and they are provided with specific feedback about what they got right and where they can improve for a case interview. The physician is then given the opportunity to repeat the encounter and assess their improvement. The encounter may even be rescheduled later to take advantage of the ‘graduated interval recall’ effect (Pavlik 2008, May 2014).

What would this intervention look like to our model doctors? Dr. Allen is likely to see cases like a VSP with dysmenorrhea. This VSP will assess his ability to take a proper gynecological history, followed by an assessment and a review of the management of various causes. Dr. Brown will see lots of VSPs to ramp up his skill levels, but will be given extra materials targeting late management of preemies. Dr. Cohen, our just-in-time candidate, will rehearse with a VSP to review how to investigate vertigo symptoms. She also might receive a Medscape, Wikipedia or CDC link to review material for a rare condition like Klippel-Trenaunay-Weber which has no VSP case in the COMRADE library.

**Conclusion**

For a COMRADE concept to work, the assessment, statistical evaluation, and interventions will need to be closely integrated into the physician’s electronic health record interface and have a low burden on the user. Adaptive knowledge management has the potential to keep physicians keen on a broad basis and allow primary care physicians to feel comfortable managing more complex diagnoses without constant specialist input. The potential for improved physician satisfaction, patient safety and improved efficiency for the medical system is great. Current work is at the stage of developing virtual standardized patient technologies and proving the breadth/exposure relationship as well as constructing the mathematical models that can predict likely clinical skills decay and the optimal refresher intervals.

Although work has been done to enable a concept like COMRADE, there is no guarantee that such a system will be created. The success of adaptive competency management will depend on political will, organizational commitment, technology development, testing & evaluation, and significant funding. The current state of this concept, as of the date of this publication, is that the virtual standardized patient technology is functioning and about to be fielded with an eye toward extending capabilities to a high-fidelity virtual physical examination. Research to validate skills decay model employing EMR data is underway through two independent efforts by Nemours Foundation & Design Interactive.

If such an adaptive competency management system is created, the benefits will be enormous. Physicians will have guidance and support during their clinical career and primary care physicians will maintain masteries that allow them to handle a great number of medical complaints and conditions that have been moving, often unnecessarily, to expensive specialists. This will save time and money. It will improve physician career satisfaction, especially in primary care, where the work is devolving into the role of super nurse practitioner and gatekeeper for any complaint requiring a bit of thought. This system will also largely automate the execution and documentation maintenance of competency efforts.

The EMR must not be a cross to bear for the physician, it must be a tool that empowers them, and makes their job easier. It must serve to improve the lives of our patients. The priorities we set today will determine our course.

**About the Author**

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