

■ *Prispevek s kongresa MI'2014*

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Economic assessment of telemedicine in Slovenian Blood Transfusion Service

Abstract. Pre-transfusion testing is required for all patients 24/7 at a point of care. The Blood Transfusion Center of Slovenia has developed a telemedicine system which allows the remote inspection and interpretation of pre-transfusion tests from the central reference laboratory to any remote site. The study evaluates how a telemedicine alternative (experienced transfusion medicine specialists interpreting pre-transfusion tests remotely via telemedicine) compares to the standard pre-telemedicine mode of interpreting pre-transfusion cases (under specialized in-person care locally or delayed in-person care locally in some transfusion departments) in terms of cost performance and organizational change. The health care provider perspective is considered. Based on the 2013 actual workload, overall yearly cost savings of telemedicine, operating regionally, is estimated to be 0,68mil€ per year. Additional 0,22mil€ of net savings could be realized by implementing a nation-wide telemedicine network. In addition to cost savings, medical professionals feel the strongest impact of telemedicine is intra- and inter-organizational. Telemedicine has improved service delivery by streamlining the pre-transfusion testing process, bringing experienced professionals to transfusion units that were unable to recruit medical specialists and enable an immediate second opinion, which in effect could result in an improved quality of service delivery and patient outcomes.

Ekonomski učinki telemedicine v slovenski transfuzijski službi

Povzetek. Predtransfuzijske preiskave sestavlja nabor obveznih laboratorijskih testiranj, ki se izvedejo pred začetkom transfuzije, da prejemniku zagotovimo skladne krvne komponente. Rezultate testiranj interpretira zdravnik specialist transfuzijske medicine v lokalni transfuzijski ustanovi, ki matični bolnišnici zagotavlja varno in kakovostno preskrbo s krvjo in krvnimi komponentami. Zavod Republike Slovenije za transfuzijsko medicino je razvil telemedicinski sistem, ki zdravniku specialistu transfuzijske medicine iz centra omogoča interpretacijo predtransfuzijskih preiskav za več laboratorijev v drugih ustanovah. Študija primerja ekonomske učinke uvedbe telemedicine v primerjavi s klasičnim načinom dela pred uvedbo telemedicine. Študija je izdelana z vidika izvajalca zdravstvenih storitev. Rezultati kažejo, da je bilo z uporabo telemedicine v letu 2013 ustvarjeno 0,68 mil.€ prihranka v primerjavi s klasičnim načinom dela. Dodatnih 0,22 mil.€ neto prihrankov bi lahko ustvarili z izvajanjem telemedicine v enoviti organiziranosti slovenske transfuzijske službe. Poleg prihrankov pri izvajalcih zdravstvenih storitev pa je mnenje stroke, da se največji učinki telemedicine izražajo v optimizaciji organizacije dela. S telemedicino se je izboljšala kakovost storitev, prav tako se je racionaliziral proces predtransfuzijskih testiranj. Oddelki za transfuzijo krvi, ki zaradi ekonomskih vidikov niso mogli zaposliti transfuziologov specialistov v 24/7 službo, so z uporabo telemedicine pridobili storitve izkušenih strokovnjakov.

■ **MI'2014 Zbornik / Proceedings 1**

Background

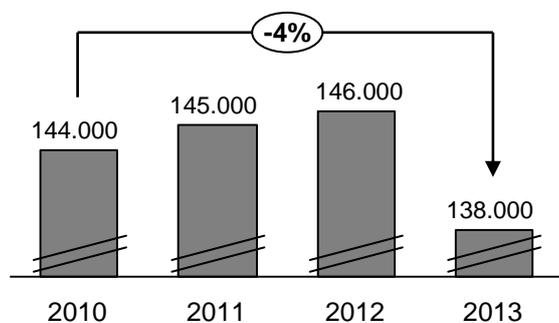
The Slovenian Transfusion Service Network is comprised of the Blood Transfusion Center of Slovenia (hereinafter referred to as BTCS) with six accompanying departments, the Center of Transfusion Medicine in Maribor, with two accompanying departments, and the Center of Transfusion Medicine in Celje. BTCS also serves as the serological reference laboratory. Hospital blood banks remained under hospitals supervision due to their limited activity (depots of blood components). Organization of transfusion network is shown in Picture 1.



Picture 1: Slovenian Transfusion Service Network

Pre-transfusion testing

Transfusion medicine is practiced under a strict regulatory framework to ensure the safe and appropriate use of blood and blood components¹. One of the safety measures is also obligatory pre-transfusion serological testing before a blood transfusion is given to the patient, in order to confirm donor-patient compatibility. In 2013, the Slovenian Transfusion Service Network performed almost 140.000 pre-transfusion cases (Picture 2), or on average around 370 cases per day.



Picture 2: The number of pre-transfusion cases in the Slovenia Transfusion Service Network, 2010-2013

In 2013 one center on average performed 31 cases per day. Nevertheless, we observe a big variation in workload between the sites, with the largest one performing on average 131 cases and the smallest one only 5 cases per day. The largest three centers had covered almost 70% of all 2013 pre-transfusion cases, while the smallest three centers covered only 4%.

Standard service provision of pre-transfusion testing in Slovenia before telemedicine

The provision of hospitals with blood products and pre-transfusion serological testing requires the continuous availability of a well-qualified medical team (24h per day, 7 days a week) in each institution. The transfusion laboratory personnel perform the tests, while the read-out and interpretation are carried out by transfusion medicine specialists. This requires an experienced specialist to be present 24/7 at all units (gold standard).

A dedicated transfusion specialist for reading out and interpreting the pre-transfusion tests is, due to volume of work, physically present 24/7 only in the two largest transfusion centers in the country. For most units, the continuous presence of a transfusion medicine specialist presents a great staffing (not enough available) and financial challenge. Consequently, departments have thought up two solutions to the problem: a) to have their own medical specialist on standby and called in when necessary (delayed in-person care locally, requiring specialist physician travel) and b) to have medical specialists from other fields working in nearby hospitals called in when a pre-transfusion case appears (under specialized in-person care locally and delayed in-person care locally). Both alternatives have certain drawbacks in service quality compared to having medical specialists present on site.

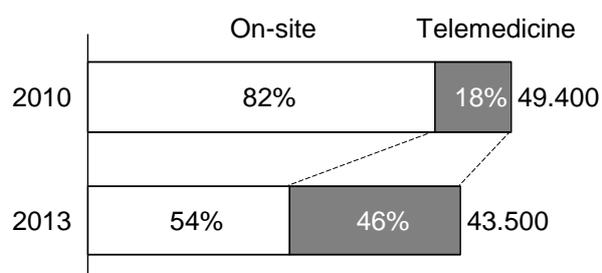
Telemedicine for pre-transfusion testing

According to the law, each patient in Slovenia has to be treated with the same quality of service regardless of geographic location¹. Professionals argued that having standby physicians translated into unequal access to care across the country and was more prone to mistakes, especially with emergency and complicated cases. Consequently, a group of medical and engineering specialists has developed a telemedicine system which allows remote inspection and interpretation of pre-transfusion tests from the central reference laboratory to any remote site.

Until 2009 the system was mostly used by medical specialists seeking a second opinion. Since mid-2010, all sites within the national blood supply network have joined the telemedicine network. Due to increasing use, BTCS opted for a complete rewrite and upgrade of the telemedicine system in 2012.

Telemedicine network is organized in the same, regional manner, as transfusion network. One medical specialist via telemedicine covers Ljubljana region (6 accompanying departments and hospital blood bank in Brežice) and one Maribor region.

The increasing importance of telemedicine in Slovenian transfusion network is backed by the numbers. While in 2010, only 18% of all pre-transfusion cases at smaller sites were performed via telemedicine, in 2013 that number grew to 46% (Picture 3). Some sites (Trbovlje and Brežice) are almost fully covered by telemedicine.



Picture 3: Pretransfusion cases performed via telemedicine in blood transfusion departments (nine departments), 2010 and 2013

Although the telemedicine system technically allows cooperation and exchange of data between all three transfusion entities, pre-transfusion testing is still performed independently among regional centers. The group that developed and implemented the system wishes that a true national pre-transfusion service network becomes common practice. It is technically already viable, that medical specialists working at any unit or even at home could interpret or offer a second opinion to any other unit throughout Slovenia.

Objective

The study evaluates how a telemedicine alternative (experienced transfusion medicine specialists interpreting pre-transfusion tests remotely via telemedicine) compares to standard (pre-telemedicine) mode of interpreting pre-transfusion cases (under specialized in-person care locally or delayed in-person care locally in some transfusion

departments) in terms of cost performance. We also estimated potential savings if nation-wide telemedicine network would be established.

A main research question was posed as follows: How does telemedicine alternative perform in terms of costs compared to standard, pre-telemedicine practice?

Methods

Within economic evaluation we carried out a cost minimization study to determine the cost difference between performing pre-transfusion testing in blood supply by teleconsultation versus standard pre-telemedicine practice². Cost minimization study requires the health outcomes of competing interventions to be equivalent. We have chosen a cost minimization study since we lack evidence on the clinical effectiveness of the alternatives in question. Only incremental resource use was included; costs common to both alternatives were eliminated. The analysis was performed from the health care provider perspective.

Study design

The framework examined the actual volume of pre-transfusion tests performed by the Slovenian Transfusion Service Network in 2013, and compared the costs of providing the pre-transfusion service between the telemedicine alternative and standard (pre-telemedicine) practice for one year. Basic scenario encompasses regionally organized telemedicine network (Ljubljana, Celje, Maribor).

Data collection

The data on resource consumption and unit costs were gathered by primary data collection. The pre-transfusion case volumes were collected from the Slovenian Transfusion Service Network database DATEC. It has been in use country-wide for over 20 years, and it is a comprehensive database on all medical and personal information regarding blood donation, collection, processing and blood issuing (services and products). The database administration and manipulation was performed with Navicat Premium software.

The cost information was obtained from the Blood Transfusion Center of Slovenia. The data on development, implementation, operational and personnel costs was collected from the finance and accountancy department. Additional information or clarification was obtained through interviews with

medical specialists, IT professionals and laboratory technicians. An ingredient approach to costing was used, where every cost item was broken down into its underlying components.

Cost analysis

The identification of the costs was done together with the team involved in the development and implementation of the telemedicine project. Only direct health care costs were estimated; indirect and intangible costs were excluded as non-applicable.

Cost estimate telemedicine alternative

Costs are divided in two separate groups: costs of running a telemedicine network (development, implementation and operational costs) and costs of medical specialist in charge of performing pre-transfusion activities.

Costs of telemedicine network

Development and implementation costs are internal personnel costs. They include the costs of project group (two medical doctors and IT specialists), validation and training. Personnel logs were used to estimate the required in-house input for internal development costs in numbers of hours per different type of professional. These costs were treated as capital costs and calculated in terms of equivalent annual costs (the useful life was estimated to be five years, an interest rate of 5% was used, costs occurring at the beginning of the year).

Operational costs include yearly depreciation rate of tangible and intangible fixed assets and maintenance costs. Each blood transfusion center has two sets of telemedicine terminals (hardware component for gel card image reading and software component). Maintenance costs are associated with the support for the use of the system and incremental network connection charges. Both are paid as a fixed monthly fee per location to outside vendors.

Costs medical specialists

Special attention was given to personnel costs, as they are the main cost driver. Estimations of unit costs and quantities were performed separately.

Estimation of unit cost

We obtained annual individual gross salaries and working hours for 14 medical specialists (45% of all employed medical specialists) and 4 interns. The salaries and hours reported were presented in detail

between regular and overtime work (regular overtime, night shifts, Sunday and holiday work). Based on total salary volume and hours reported we calculated the average price per hour separately for: regular rate, regular overtime = afternoon rate (also Saturday morning rate), night rate, weekend day rate, weekend night and holiday rate, and stand-by rate (professionals not present on the premises but called in in the case of an emergency). Hourly wage rates were additionally upwardly adjusted according to three different factors in order to receive an actual cost per hour from a provider's perspective:

- Paid absenteeism due to vacation, training, sick leave and obligatory free days (after a certain number of hours are exceeded during a week, medical professionals are obliged to take a day off). The total costs for these components were added up and divided by effective working hours. The fixed amount was added to the above wage rates.
- Bonus payments (mentoring, education, performance, experience, attendance, extra responsibility). The total costs for these components were added up and divided by effective working hours. The fixed amount was added to the above wage rates.
- An additional 16.1% was added in order to calculate cost per hour from a provider's perspective. In Slovenia each employer pays an additional 16.1% above the gross salary for the employee to cover social security expenses.

The regular rate applied on weekdays from 7.00 till 15.00, the afternoon rate from 15.00 till 23.00 and the night rate from 23.00 till 7.00.

Estimation of quantities of resource use

To calculate the total personnel cost, information on hours required by the medical specialists was needed. Based on the current knowledge on work dynamics and statistics on production volume, the medical specialists determined the minimum cost capacity (number of physicians) required to achieve the given 2013 production with both alternatives.

According to current practice, 4 medical specialists are required 24/7 to cover total pre-transfusion demand throughout the Slovenian Transfusion Service Network.

Cost estimate standard, pre-telemedicine practice

Unit costs: The same cost rates per hour apply as above. We have one additional cost rate, which is a fixed amount per case if the medical specialists are called in for read-outs.

Resource use: According to the medical specialists and laboratory technicians, three large centers are able to be covered 24/7 by their own personnel; two units cover mornings with their own specialists on site, and during afternoons, weekends and holidays they had their own personnel on standby. In some smaller units a medical specialist is present five (in some units) or fewer days during the working week, and the rest was covered by an external medical specialist. Medical specialists in smaller units performed additional tasks during their working hours, most often screening of donors. Consequently the allocation of time dedicated to pre-transfusion testing needed to be estimated. Official tracking of time allocation between the tasks had not been performed; FTE associated with blood transfusions were estimated with the help of medical specialists. For example, two larger centers from the remaining ten spent 50% of the morning shift Monday to Friday dedicated to other tasks, while in the smaller units this percentage fell to 50% of the morning shift only one day a week. The smaller three units were fully covered by external medical specialists.

Results

Telemedicine alternative

The annual equivalent internal development and implementation costs were 43.000€ per year. Yearly costs of equipment are estimated to be 86.500€. The yearly maintenance fee totals 76.460€ per year. The total annual incremental fixed cost of running a telemedicine network is 206.000€.

The total yearly costs for the medical specialists working 24/7 are estimated to be 260.000€. Additional correction was made for a medical specialists in Celje (50% of morning shifts on weekday were deducted). Basic scenario requires 4 medical specialists, which sums up to 1.020.000€.

The total incremental cost for the telemedicine alternative, as currently introduced, is estimated to be 1.226.000€.

If nation-wide telemedicine was to be implemented, additional optimization could be introduced. Instead of 4 medical specialists, the number could be reduced to three in the afternoon and night and on the weekend, bringing additional 200.000 of savings.

Current practice

An incremental cost analysis of the current alternative includes solely the cost of the medical specialists. For each site we estimated the number of days that a medical specialist was present on site; for larger units that meant five times, and for smaller units only one time per working week (due to donor screening) during morning shifts. With a specialist on site, the work-load associated with pre-transfusion testing was estimated to be 50%. The rest of the time pre-transfusion testing in these units was performed by a medical specialist on standby (two such centers were able to cover shifts with their own employees, the rest outsourced to external medical professionals), called in when necessary.

The total annual incremental cost for standard pre-telemedicine practice is estimated to be 1.906.908€.

The incremental cost of having a medical specialist present 24/7 at each site (which would in terms of service quality be comparable to telemedicine implementation), is estimated to be 2.980.000€ per year.

Cost differences

In 2013, regionally implemented telemedicine, has saved 681.000€ to Slovenian Blood Transfusion Network compared to standard, pre-telemedicine practice. Additional 220.000€ could be realized by introducing nation-wide telemedicine network.

The incremental cost of having a medical specialist present 24/7 at each site is estimated to be almost 3mil€. Telemedicine alternative offers the same quality of service for as much as 1,8mil€ less.

Conclusion

Pre-transfusion testing is carried out at 12 centers throughout Slovenia. Most of the procedures are performed by laboratory technicians, while the read-outs and interpretations are carried out by transfusion medicine specialists. The service needs to be available 24/7. For smaller units, the continuous presence of a transfusion medicine specialist was too expensive, so pre-telemedicine practice was to have medical specialists on standby or medical specialist from other fields working in nearby hospitals called in when a pre-transfusion case appears. The

transfusion network has developed a system allowing the remote interpretation of pre-transfusion tests from any remote site.

The essence of this study was to investigate and synthesize findings as to whether telemedicine is able to deliver in terms of cost savings. Compared to standard pre-telemedicine practice, the nationwide implementation of telemedicine in pre-transfusion testing brings approximately 0.65 mil€ of yearly savings. Short-term savings are mainly realized through a reduced number of medical specialists by combining pre-transfusion cases throughout the country.

While this study is limited to economic evaluation, the effect of introducing telemedicine in transfusion network is much broader. Medical professionals feel the strongest impact of telemedicine on pre-transfusion testing is intra- and inter-organizational, especially the improvements in the work processes which in effect could result in an improved quality of service delivery and patient outcomes. The following effects were most prominent: Streamlining the work process for laboratory technicians, having dedicated medical specialist positions, bringing experienced professionals to every transfusion unit, and instant second opinions.

Further research should consider longer-term horizons and broader perspectives to evaluate if and how the identified effects are transferred throughout the transfusion chain.

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